Contributions to the Selection and Implementation of Standard Software for CRM and Electronic Invoicing

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Für Jonathan

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No man is an island, entire of itself;
every man is a piece of the continent.
John Donne

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Abstract

Die kontinuierliche Verbesserung von Prozessen und Systemen ist ein etablierter und praxisrelevanter Forschungszweig der Wirtschaftsinformatik. Die vorliegende Zusammenfassung gliedert sich in zwei Hauptbereiche bestehend auf vier wissenschaftlichen Publikationen.

Im ersten Bereich A wird die Thematik der Auswahl von Customer Relationship Management (CRM) Systemen behandelt. Hierbei geht es zunächst um die Evaluierung eines neu konzipierten Vorgehensmodells zur Auswahl von CRM Systemen, dass den Anbieter- und Softwarevergleich auf eine systematische und auf die individuellen Bedürfnisse des auswählenden Unternehmens zugeschnittene Weise strukturiert. Die Evaluierung des Vorgehensmodells erfolgt durch eine qualitative Fallstudie mit einem Automobilzulieferer und das Modell wird durch Interviews mit Projektbeteiligten vervollständigt und für den Praxiseinsatz optimiert. Um der Frage nachzugehen, wie sich die im Vorgehensmodell zusammengefassten Auswahlkriterien auf den späteren Erfolg des CRM-Systems auswirken, wird in einem zweiten Schritt eine quantitativ-empirische Studie basierend auf einem erweiterten DeLone & McLean IS-Erfolgsmodell mit CRM-Experten durchgeführt. Die hypothetisierten Kausalbeziehungen zwischen den Auswahlkriterien, den moderierenden latenten Variablen und der Zielvariable Systemerfolg wurden für die Umfrage operationalisiert und mittels eines Strukturgleichungsmodells (SEM) überprüft.

Der zweite Bereich B adressiert Forschungsfragen zu elektronischen Rechnungsprozessen. Hierbei wird zunächst ein Reifegradmodell für elektronische Rechnungsprozesse angestrebt. Das Forschungsdesign basiert auf einem anerkannten Vorgehensmodell und das Reifegradmodell wird in vier qualitativ-empirischen und deduktiv-argumentativen Datenerhebungsphasen methodisch rigoros entwickelt. Die Ergebnisse der letzten Iteration, basierend auf drei Fokusgruppen mit Experten für elektronische Rechnungsprozesse, werden im Detail dargestellt. Aus dem Reifegradmodell wird in einem weiteren Schritt die Thematik des Risikomanagements für elektronische Rechnungsprozesse als besonders relevant herausgegriffen. Die Fragestellung nach den Risikofaktoren für elektronische Rechnungsprozesse wird in einer quantitativen Umfrage untersucht. Durch die Anwendung von statistischen Auswertungsverfahren wurden Risikofaktoren identifiziert und sinnvollen Gruppen zugeordnet.

Stichworte: Customer Relationship Management, Systemauswahl, elektronische Rechnungsprozesse, Strukturgleichungsmodellierung, DeLone und McLean IS-Erfolgsmodell, Risikomanagement, Reifegradmodell, Vorgehensmodell.

Continuous improvement of processes and systems is an established and practically relevant research area in information systems research. This doctoral thesis presents four selected publications from two research areas.

In the first part A, selection of Customer Relationship Management (CRM) systems is addressed. The objective is to evaluate a newly developed process model for CRM systems selection (CRMSS) that structure the comparison of vendors and software and considers individual requirements of a company. The evaluation of the process model is conducted in a single case study with an automotive supplier. The model is enhanced through interviews with project members and is optimized for practical implementation. To approach the question on the impact of the CRMSS criteria on CRM system success the subsequent research step is a quantitative survey with CRM experts based on an extended DeLone and McLean (D&M) IS success model. Hypotheses about the causal relations between selection criteria, the moderating latent variable and the dependent variable information systems success is operationalized in a questionnaire and analyzed with the help of structural equation modeling (SEM).

The second part B focuses the research on electronic invoice (e-invoice) processes. First, a maturity model for e-invoice processes (EIPMM) is developed. Building on a process model four iterative design-oriented and qualitative-empirical phases are completed. The results of the last iteration based on focus groups are presented. As part of the EIPMM, risk management is further researched in a quantitative study. Risk factors for e-invoice processes are identified and grouped after applying statistical analysis techniques.

Keywords: Customer Relationship Management, system selection, electronic invoice processes, structural equation modeling, DeLone und McLean IS success model, risk management, maturity model, process model.

Management Summary

The presented thesis recapitulates four selected research publications from two distinct research areas, namely CRM system selection criteria, process, and IS success and electronic invoice process maturity and risk. The topics share a mutual research design based on merger of results from a model-based qualitative study with survey-based quantitative results (see Figure 1).

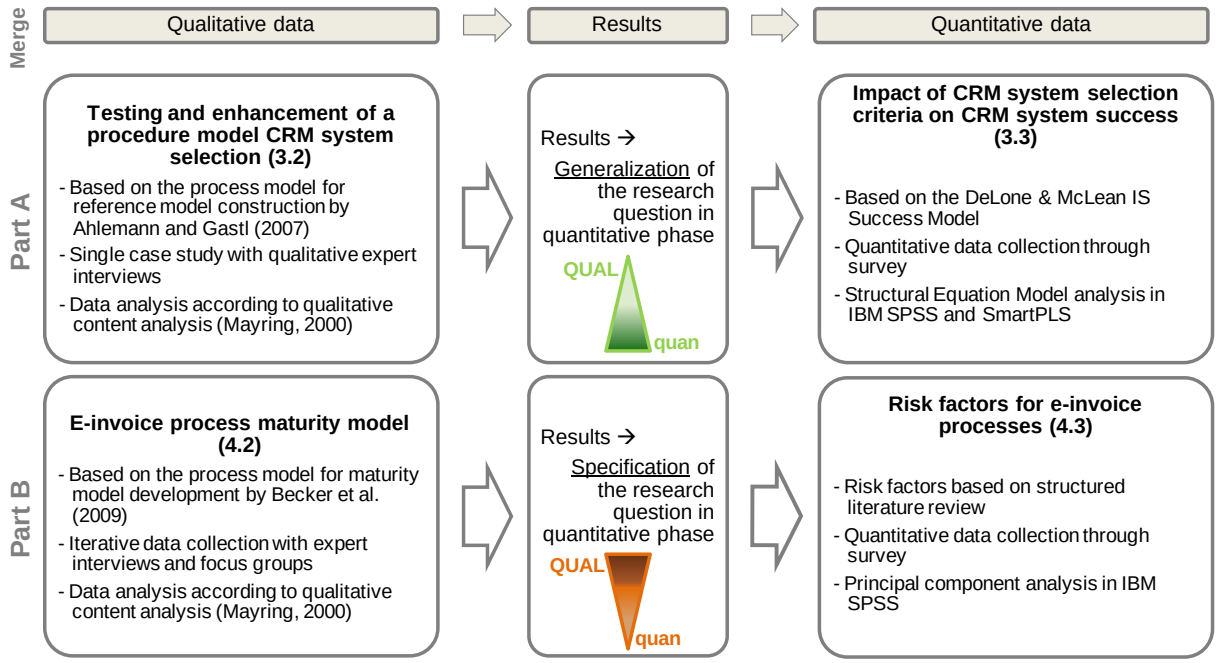


Figure 1. Classification of presented publications

Customer Relationship Management system selection – a process model and systems success

The importance of CRM as a management concept and strategy has been steadily increasing and so have been the investments in CRM software (Lee et al., 2014, Chen and Popovich, 2003). CRM integrated the various customer touch points whether electronic (e.g. e-mail, internet etc.) or physical (e.g. retail store) into a single information system (Chen and Popovich, 2003). It aims at collecting and sensibly using refined information about the (potential) customers and optimally responding to their needs (Farquad et al., 2014). Richards and Jones (2008) define CRM „as a set of business activities supported by both technology and processes that is directed by strategy and is designed to improve business performance in an area of customer management". A recent survey by Gartner from 2014 indicates once more that the budget for CRM system is to increase fourth year in a row, this time by an average of 2.5 percent (Gartner, 2014a). This backs up the importance of sound decision making and procedural guidance for the investments in CRM system selection. The

suggested CRM system selection (CRMSS) process model was rigorously developed based on the meta model by Ahlemann and Gastl (2007). Their proposed five main phases are adopted to develop the CRMSS process model by means of empirical inquiries. For the final validation a single case study with an automotive supplier company is conducted and insights and enhancements to the model are extracted from semi-structured interviews with participating team members (see Figure 2).

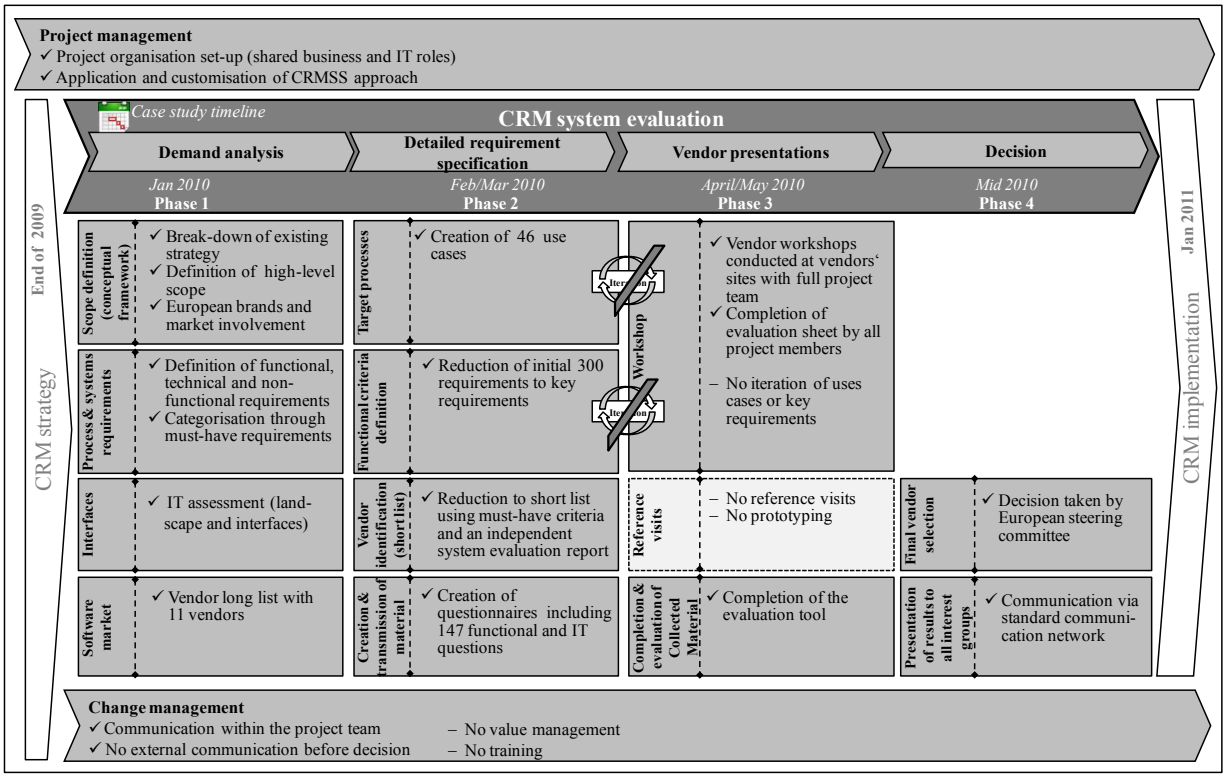


Figure 2. Consolidated results of the applied CRMSS Process Model

Research results of the single case study with an automotive supplier showed that the CRMSS process model is practically applicable. An applicability check by Rosemann and Vessey (2008) was conducted to evaluate practical applicability of the model. Rosemann and Vessey (2008) argue that "applicability checks could be conducted on emerging IS research outcomes" and "improve future research by incorporating learnings into revisions to theories or models". According to the three applicability categories (importance, accessibility, and suitability) the CRMSS model was judged positively by the interviewed project representatives in the case company. Enhancements to the model were introduced (see Table 1). The CRMSS process model contributes to IS research by applying the methodology by Ahlemann and Gastl (2007), thus proving its feasibility and effectiveness in terms of the research results. It shows how their meta model can be applied in the research discipline by following the recommended phases and customizing them to meet the specific requirements of the topic. In practical terms, this research gives guidance for

systematically selecting CRM systems and presents a portfolio of IT project-oriented phases, roles, and deliverables (see section 3.2).

Table 1. Overview of roles and deliverables derived from the case study

Phase	CRMSS Task	CRMSS selected activities	Roles	Deliverables	Additional deliverables
Phase 1: Demand analysis	Scope definition	Definition of functional high-level scope , system portfolio and IT architecture, available budget, time planning and economic demands, risk management, exit strategies	Steering committee, project management	✓Business and IT strategy documents ✓Categorization criteria	+ Exit strategies
	Process & system requirements	Define main functionality, create business processes, non-functional requirements	Template keeper (per business unit)	✓ High level process definition ✓ Initial requirements list ✓ Selection criteria	+ Business operations plan + Roll-out plan
	Interfaces	Analysis of all affected systems, technical requirements and restrictions	IT project manager	✓ Architectural Assessment	
	Software market	Standard and industry solutions, consulting support	IT project manager	✓ Vendor long list	+ Vendor assessment
Phase 2: Detailed requirement specification	Target process	Define high level target processes	Template keeper, business experts, IT and business key users	✓ Key requirements ✓ Decision criteria and weights	
	Functional criteria definition	Account management, call centre, campaign management, contact & customer management, customer service, field service, industry specifics, internet, lead & opportunity management, relationship management, reporting, sales management	Template keeper, business experts, IT and business key users	✓ Evaluation sheet	
	Vendor identification	Company and CRM project overview, requirement specifications, total cost calculation	Business project manager, IT project manager	✓ Criteria for vendor short list ✓ Vendor short list	
	Creation & transmission of material	Functional fit list, questionnaire for stakeholders	Business project manager, IT project manager, template keeper, business experts, IT and business key users	✓ Use cases ✓ Questionnaire ✓ Prototype	+ Company and project overview + Detailed standardized scope of expectations
Phase 3: Vendor presentation	Workshops	Workshop planning and organization	Business project manager, IT project manager, template keeper, business experts, IT and business key users	✓ Evaluation sheet (filled out)	+ Interview guideline for reference visits
	Completion & evaluation of collected material	Collection of relevant material	Business project manager, IT project manager	✓ Evaluation tool	+ Cost calculation
Phase 4: Decision	Final vendor selection	Stakeholder management	Steering committee		
	Presentation of results to all interest groups	Stakeholder communication	Project management	✓ Presentation	
Change management		Initiating IT and business transformation, communication, value management, training	Business project manager	✓ Communication package	+ Stakeholder analysis + Business assessment
Project management		Project organization, implementation methodology set up	Business project manager, IT project manager	✓ Project plan ✓ Project organisation chart	+ Resource plan + Business case

This research publication by Ina Friedrich, Lubov Kosch, and Michael H. Breitner titled “A practical test of a process model for customer relationship system selection with an automotive supplier“ which is published in the proceedings of the European Conference on Information Systems 2012 (see Appendix A4).

The list of selection criteria which are part of the CRMSS model are further investigated in a study of CRM system success. The criteria and their impact on later CRM systems success after implementation of the chosen system are evaluated using the DeLone and McLean (D&M) IS success model (DeLone and McLean, 1992, 2002, 2003 and 2004). The latter version of the model is extended by the relevant CRM selection criteria and a survey is completed to empirically test hypothesis of causal relations between selection criteria and system success mediated by the latent viable of the D&M IS success model. With the help of structural equation modeling (SEM) hypothesis are rejected or not rejected establishing a first insight into the relationship between CRM system selection and success (see Figure 3).

The CRM selection criteria were incorporated into the widely acknowledged D&M IS success model (DeLone and MCLean, 2004). Thus, this research contributes to the evaluation of this theoretical model in the context of CRMSS. DeLone and McLean (2003) have called for their model to continuously “be tested and challenged”. The

extended D&M IS success model adheres to the postulate that “selection of IS success dimensions and measures should be contingent on the objectives and context of the empirical investigation, but, where possible, tested and proven measures should be used” (DeLone and McLean, 2003). Quantitative data was surveyed among CRM experts. Although the original model paths could be again supported, new insights were obtained on the relationship between CRM selection criteria and their possible impact on CRM system success. The study showed that a certain selection criteria have an impact on the quality dimension and some directly on net benefits (see section 3.3). This is a practically relevant research result as it gives an idea which phases and aspects of the CRMSS process model are of higher importance for a sustainably positive IT project outcome. It is therefore decisive to individually adapt the CRMSS process model and correctly interpret the selection criteria for the specific case at hand. For example, the task *functional criteria definition* as part of *phase 2: detailed requirements specification* in the CRMSS process model has direct and highly significant impact on net benefits. These activities (functional criteria), the associated roles (template keeper and business experts), and the deliverable (evaluation sheet) have to be regarded as key issues and have to attributed sufficient budget, time and organizational priority within the CRMSS project.

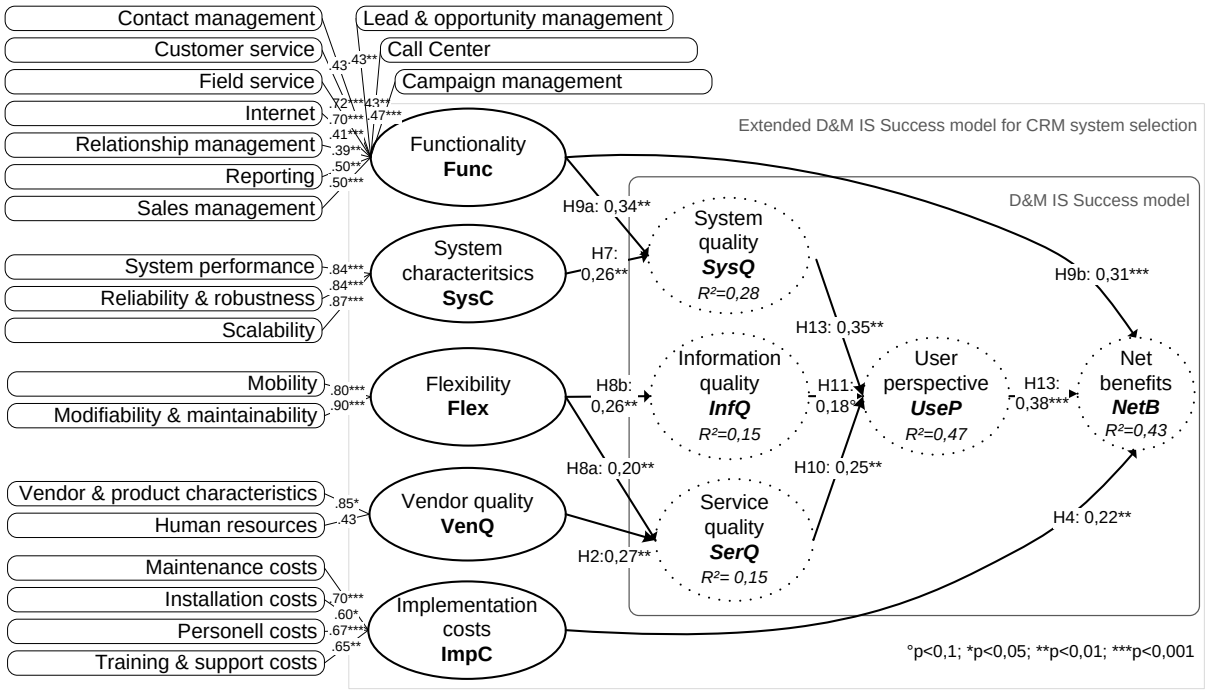


Figure 3. PLS-SEM results of the extended DeLone and McLean IS success model for CRMSS criteria

This research publication by Lubov Kosch, Halyna Zakhariya, and Michael H. Breitner titled “Beeinflussen Auswahlkriterien den Erfolg eines CRM- Systems? –

eine Strukturgleichungsmodellierung basierend auf dem DeLone und McLean IS-Erfolgsmodell (in German)“ which is published in the proceedings of the International Conference on Wirtschaftsinformatik 2013 (see appendix A3).

Electronic invoice processes – a maturity model and risk management

The European Commission (2014) defines e-invoicing as “electronic transfer of invoicing information (billing and payment) between business partners (supplier and buyer)“. They also estimate the annual saving for EU business at around 64.5 billion Euros when the e-invoicing initiative is successfully launched based on the Single Euro Paxment Area (SEPA). The benefits for users are manifold: cost reductions for printing and postage, error rate decrease, improvements in process transparency and processing times (Ibi Research, 2013, Salmony and Harald, 2010). The efforts of the European Commission, national governments and many other non-government organizations since many years, however, have not yet promoted e-invoicing in the business-to-business (B2B) area to the expected level of application. According a global study on e-invoicing from 2012 by Basware GmbH only about 15 (outbound) to 16 (inbound) percent of companies already send or receive 50 and more percent of total invoices electronically. Although the number increased from 2011 to 2012, it is still quite low for small and medium sized companies (14 percent) and large companies (19 percent) alike.

In order to support business planning to implement e-invoice processes or wanting to improve on the automation scale, a comprehensive electronic invoice process maturity model (EIPMM) is developed applying the procedure model for maturity model for developing maturity models by Becker et al. (2009). The main objective of the maturity model is to provide a generalized and standardized approach for companies of different industries and sizes to be able to efficiently adopt e-invoice processes and reap the benefits more swiftly. The EIPMM model was developed iteratively. Becker et al. (2009) argue that their procedure model provides “a methodologically well-founded development and evaluation of maturity models”.

For the time being, the last iteration included qualitative, explorative focus group interviews resulting in a maturity model with four main categories (technology, process and organization, acceptance, and strategy), 15 sub-categories and detailed categories which should be measured by five maturity levels from *0:non-existent* to *4:continous improvement* (Figure 4). These categories represent a systematic process for the implementation and operation of e-invoice processes and for decision making. From the theoretical perspective and similar to the earlier argumentation on meta model application, the EIPMM contributes to the objective of rigorous maturity model design (Becker et al., 2009) by showing the applicability of the suggested process model in a specific domain. At the same time, in comparison to the available

best-practice maturity models (see Appendix A8), the EIPMM development process is documented in a transparent and reproducible manner supporting the hypothesis that a structured model-based result leads to “more profitable results than an intuitive procedure without recourse to a reference manual” (Becker et al., 2009).

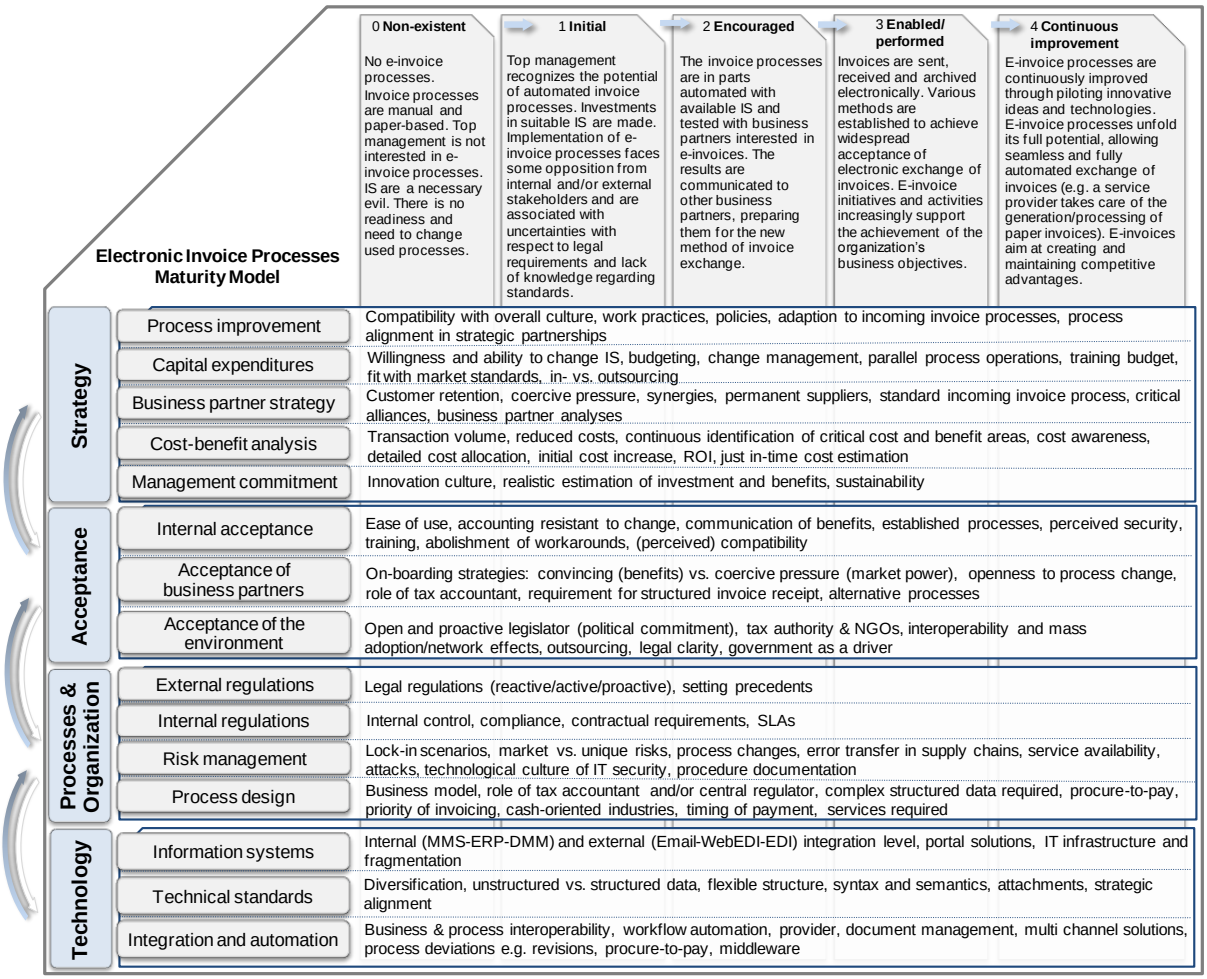


Figure 4. The current Electronic Invoice Processes Maturity Model

From the practical point of view, the EIPMM helps to provide the overall picture of the issue around e-invoicing. As most benefits occur when the procure-to-pay process is fully automated with seamlessly integrated e-invoice processes (European Commission, 2010), it makes sense to examine the maturity-oriented concept. The EIPMM shall provide information whether all possible and convenient opportunities for them are implemented and used. The EIPMM raises awareness for the e-invoice processes and shows how processes can be improved. It presents critical success factors affecting the decision as to how invoice processes should be managed. The e-invoice issue is not only a question between paper-based and electronic invoice but more of how processes are designed. The EIPMM is a valuable tool, not only for evaluation of internal capabilities, but also for discussions with partners.

This research publication by Angelica Cuylen, Lubov Kosch, and Michael H. Breitner titled “Development of a Maturity Model for Electronic Invoice Processes“ is published in the Electronic Markets Journal (see Appendix A8).

As part of the maturity model categories risk management showed to be of major importance. Therefore, a study on risk factors associated with e-invoice processes is required.

Risk management for e-invoice processes, according to the conducted structured literature review, is the first study to identify and analyze critical risk factors of e-invoice processes. A quantitative study surveying experts on e-invoicing was conducted to evaluate theoretically developed risk factors. The analysis revealed ten dimensions of risk factors that need to be considered. The 37 identified and statistically significant factors are an initial approach for the practical risk management for e-invoice processes (see Table 2).

Table 2. Risk Dimensions and Factors – Rotated Factor Loadings and Descriptive Statistics

Risk Dimension	Included Risk Factor	Rotated Factor Loadings	Risk Probability		Risk Value		One-way ANOVA mean
			Mean	SD	Mean	SD	
Strategy	Disruption or contravention due to legal ignorance	,713	2,604	1,084	2,563	1,097	2,738
	Disruption or contravention due to different international legal regulations	,637	2,848	1,026	2,721	1,081	
	Not acting in accordance to law due to a lack of knowledge within the company	,633	2,654	,993	2,655	1,066	
	Master data that is relevant for invoices is lacking quality	,558	2,733	1,059	2,724	1,117	
	Lack of knowledge of additional costs (implementation, operation,...)	,544	2,865	1,053	2,828	,955	
	Dependency on customer	,521	2,781	1,028	2,759	,976	
Process Organization	Too few business partner are using electronic invoices	,805	3,198	1,125	3,080	1,059	3,079
	Lack of willingness by suppliers to change process	,742	3,057	,984	3,011	1,006	
	Additional expenses due to parallel invoice processes (entry of invoice data in web portals, paper-based and electronic invoices,...)	,601	2,981	1,215	2,908	1,007	
System	Electronic archive is lacking or is not legally compliant	,691	2,781	1,209	2,977	1,198	2,614
	Lack of adequate information systems within the company (slow internet connection, software solutions do not suit electronic invoices,...)	,598	2,566	1,121	2,402	1,005	
	Sunk costs (e.g. printing of electronic invoices, operating parallel processes,...)	,566	2,705	1,055	2,709	1,016	
	Error proneness due to lack of experience of service provider	,542	2,467	1,029	2,558	1,001	
	Lack of functionality in service offers	,534	2,538	,968	2,494	1,031	
Standard	Adoption of too many standards	,737	2,868	1,155	2,647	1,088	2,835
	Use of different service offers due to lack of interoperability of service systems (web portals,...)	,635	3,125	1,146	2,871	1,044	
	Use of parallel systems due to lack of interoperability of information systems	,629	2,875	1,077	2,885	1,028	
	Dependency on standard being used	,542	2,781	,980	2,694	1,012	
	Selection of a standard that is not future-proof	,524	2,575	1,014	2,698	1,085	
Security	Loss of invoice (spam filter, errors in archiving...)	,818	2,226	1,035	2,345	1,055	2,250
	External threat to invoice (spying out of content, deletion of invoice file, falsified sender or receiver...)	,741	2,094	,921	2,345	1,087	
	Lack of data integrity in invoice processes (falsified data)	,642	2,133	,889	2,483	1,109	
	Lack of readability in invoice processes (visual representation of invoice)	,517	2,115	1,008	2,161	,951	
Environment	Reputation loss due to non-adaption of electronic invoices	,805	2,743	1,092	2,644	1,000	2,833
	Not exploiting competitive advantage due to non-adoption of electronic invoices	,785	2,876	1,053	2,713	,939	
	Adoption due to external pressure from business partners or government	,726	2,885	1,036	2,871	,910	
Process Execution	Error proneness of financial accounting	,814	1,991	,834	2,198	,892	2,296
	Error proneness of the control procedure of the payment process	,671	2,067	,862	2,310	,968	
	Error proneness of the control procedure of the inbound invoice process	,655	2,264	,939	2,287	,875	
	Incomplete adoption of the business processes	,620	2,857	,945	2,802	,905	
Acceptance	Lack of acceptance by top management	,802	2,619	1,095	2,655	1,098	2,615
	Lack of willingness for internal and external process changes inside the company	,558	3,198	1,099	3,035	,951	
	Lack of acceptance of new processes by staff	,545	2,802	1,018	2,793	1,058	
Change Management	More difficult cash payment process	,781	1,971	,955	2,128	,968	2,123
	Irreversibility of process changes	,526	2,283	,778	2,400	,928	
Project Management	Lack of comprehensive process and IT know-how of consultant	,626	2,613	1,065	2,701	,990	2,755
	Lack of strategic planning	,533	2,896	1,112	2,897	1,012	

This research provides support especially for companies that are starting to implement e-invoice processes. However, companies that decline e-invoice process can use these results as a starting point to reconsidering their decision. Further, this research can support companies that are trying to convince their business partners to implement e-invoice processes. Finally, the results can be used as basic frameworks for consultants, organizations or other stakeholders to analyze and design e-invoice processes and solutions. The analysis of risk factors is relevant because as the adoption rate of e- invoicing is rather low (European Commission 2010). Further, this research highlighted the importance of a risk assessment for e-invoice processes due to the fact that nearly half of the contacted experts taking part in the survey were interested in the results of the study.

This research publication by Angelica Cuylen, Lubov Kosch, and Michael H. Breitner titled “Why are Electronic Invoice Processes Risky? - Empirical Analysis and Discussion of Risk Factors“ which is published in the proceedings of the European Conference on Information Systems 2015 (see Appendix A7).

Table of Contents

Abstract I
Management Summary III
Table of Contents XI
List of Tables XIV
List of Figures XIV
List of Abbreviations XV
1. Introduction: Overview of publications 1-17
1.1. Motivation and research questions 1-21
1.2. Structure of the thesis 1-25
2. Research methodology 2-27
2.1. Applied meta models 2-30
2.2. Qualitative Research in Information Systems 2-35
2.2.1. Case Study Research 2-35
2.2.2. Expert interviews, focus groups and qualitative content analysis 2-37
2.3. Quantitative Research in Information Systems 2-40
2.3.1. Survey methodology 2-40
2.3.2. Principal Component Analysis 2-41
2.3.3. Structural Equation Modeling 2-41
3. PART A: Customer Relationship Management systems selection criteria, selection process and IS success 3-44
3.1. Preamble 3-45
3.2. A practical test of a process model for CRM system selection 3-47
3.2.1. Introduction 3-47
3.2.2. Research design and methodology 3-47
3.2.3. Discussion of results 3-49
3.2.4. Conclusions, limitations and further research 3-51
3.2.5. Classification of publication 3-52
3.3. Impact of selection criteria on CRM system success 3-54
3.3.1. Introduction 3-54

3.3.2. Research Design and Methodology 3-54
3.3.3. Discussion of results..... 3-59
3.3.4. Conclusions, limitations and further research..... 3-60
3.3.5. Classification of publication 3-61
4. PART B: Electronic invoice processes: diffusion, maturity and risk factors. 4-62
4.1. Preamble..... 4-63
4.2. Design and Discussion of a Maturity Model for Electronic Invoice Processes 4-65
4.2.1. Introduction..... 4-65
4.2.2. Research design and methodology 4-65
4.2.3. Discussion of results..... 4-66
4.2.4. Conclusions, limitations and further research..... 4-71
4.2.5. Classification of publication 4-72
4.3. Empirical analysis and discussion of risk factors for electronic invoice processes..... 4-73
4.3.1. Introduction..... 4-73
4.3.2. Research design and methodology 4-74
4.3.3. Discussion of results..... 4-76
4.3.4. Conclusions, limitations and further research..... 4-79
4.3.5. Classification of publication 4-80
5. Critical Appraisal, Limitations and Future Research 5-82
5.1. Contributions to research and practice..... 5-82
5.2. Limitations and further research..... 5-85
References LXXXIX
Overview of Appendices..... XCIX
Appendix 1 (A1)..... C
Appendix 2 (A2)..... CI
Appendix 3 (A3)..... CII
Appendix 4 (A4)..... CIII
Appendix 5 (A5)..... CIV
Appendix 6 (A6)..... CV

Appendix 7 (A7) CVI
Appendix 8 (A8) CVII
Appendix 9 (A9) CVIII
Appendix 10 (A10) CIX
Appendix 11 (A11) CX
Appendix 12 (A12) CXI
Appendix 13 (A13) CXII
Appendix 14 (A14) CXIII
Appendix 15 (A15) CXIV

List of Tables

Table 1. Overview of roles and deliverables derived from the case study V

Table 2. Risk Dimensions and Factors – Rotated Factor Loadings and Descriptive Statistics IX

Table 3. Overview of publications 1-20

Table 4. Selected single case study appraisal guidelines by Atkins and Sampson (2002) 2-37

Table 5. Overview of roles and deliverables derived from the case study 3-51

Table 6. Items of the D&M IS success model and their operationalization 3-58

Table 7. Quality criteria of the reflective and formative constructs 3-59

Table 8. Concept-centric Categorization of Risk Factors from Literature Review based on Webster and Watson (2002) 4-75

Table 9. Risk Dimensions and Factors – Rotated Factor Loadings and Descriptive Statistics 4-76

List of Figures

Figure 1. Classification of presented publications III

Figure 2. Consolidated results of the applied CRMSS Process Model IV

Figure 3. PLS-SEM results of the extended DeLone and McLean IS success model for CRMSS criteria VI

Figure 4. The current Electronic Invoice Processes Maturity Model VIII

Figure 5. The addressed research questions within the PDCA cycle 1-22

Figure 7. Thesis structure 1-25

Figure 8. Mixing qualitative and quantitative data 2-28

Figure 9. Mixed methods research design matrix (Johnson and Onwuegbuzie, 2004) 2-29

Figure 10. Classification of presented research 2-30

Figure 11. Research framework (simplified illustration from Wendler, 2012) 2-32

Figure 12. Process model for maturity model development by Becker et al. (2009) .. 2-34

Figure 13. Inductive coding procedure (Mayring, 2000) 2-39

Figure 14. Reflective and formative constructs (Freeze and Raschke, 2007) 2-42

Figure 15. CRM research framework 3-46

Figure 16. Approach to process model development (Adapted from Ahlemann and Gastl, 2007) 3-48

Figure 17. Consolidated results of the applied CRMSS Process Model (result of practical testing) 3-50

Figure 18. Proposed research model with clustered CRM system selection criteria as latent exogenous variables in an extended D&M IS success model for CRMSS ... 3-55

Figure 19. Category list of CRMSS criteria 3-57

Figure 20. PLS-SEM results 3-60

Figure 21. E-invoices research framework 4-64

Figure 22. Research design according to Becker et al. (2009) 4-66

Figure 23. The current Electronic Invoice Processes Maturity Model (EIPMM) 4-67

List of Abbreviations

A	Appendix
AIS	Association for Information Systems
AISeL	Association for Information Systems electronic library
AMCIS	Americas Conference on Information Systems
AVE	Average Variance Explained
B2B	Business-to-Business
CI	Continuous improvement
CR	Cronbach's Alpha
CRM	Customer Relationship Management
CRMSS	Customer Relationship Management system selection
D&M	DeLone and McLean
e.g.	example gratia/for example
EC	European Commission
ECIS	European Conference on Information Systems
EDI	Electronic Data Interchange
EDIFACT	Electronic Data Interchange For Administration, Commerce and Transport
E-invoice	Electronic invoice
EIPMM	Electronic Invoice Processes Maturity Model
EM	Electronic Markets Journal
etc	et cetera
EU	European Union
Flex	Flexibility

Func	Functionality
HEI	Higher Education Institutions
HICSS	Hawaii International Conference on System Science
IJSODIT	International Journal of Social and Organizational Dynamics in IT
ImpC	Implementation cost
ImpQ	Implementation quality
InfQ	Information quality
IntC	Integration capability
IS	Information Systems
IT	Information Technology
KMO	Kaiser-Mayer-Olkin criterion
MISQ	Management Information Systems Quarterly
MKWI	Multikonferenz Wirtschaftsinformatik
MSA	Measure of Adequacy
NetB	Net benefits
OEM	Original Equipment Manufacturer
PCA	Principal Component Analysis
PDCA	Plan-Do-Check-Act
PLS	Partial Least Squares
QUAL	Qualitative
QUAN	Quantitative
RQ	Research question
SEM	Structural Equation Modeling
SEPA	Single European Payment Area
SerQ	Service quality
SRM	Student Relationship Management
SysC	System cost
SysCh	System characteristics
SysQ	System quality
UseO	User orientation
UseP	User perspective
VenQ	Vendor quality
VIF	Variance Inflammation Factor
VHB	Verband der Hochschullehrer für Betriebswirtschaftslehre
WI	Wirtschaftsinformatik
WKWI	Wissenschaftliche Kommission Wirtschaftsinformatik
ZUGFeRD	Zentraler User Guide des Forum elektronische Rechnung Deutschland

1. Introduction: Overview of publications

Ever since Nicolas Carr has provocatively stated that “IT doesn’t matter” in his widely cited and discussed article from more than a decade ago (Carr, 2003), the subject of the wider term information systems (IS) has flourished in research and practice. IS is introduced to organizations in order to ameliorate procedures and positively extend and support the general capabilities of the organizations and the people working for them (Hevner et al., 2004). The answers to the questions why and how IS contribute to this purpose have been the central driver of IS research since its beginnings until now. Along the long road to eventually reaching these research objectives, many issues revolving around the selection, adoption and implementation of business process specific IS become of interest to research and practice. Among these arise questions concerning the selection process of IS, their success, internal and external prerequisites for adoption as well as the challenges around IS operations.

In this thesis which is divided into two main parts, the specific business process of customer relationship management (CRM, Part A) and electronic invoicing (Part B) are addressed in a series of academic publications as presented in Table 3. The contributions marked with an asterisk in the title column and mentioned in the chapter column will be summarized and discussed here in detail.

Publications under the block “Higher Education Institutions (HEI)” research are not directly related to the two mentioned topics. Among these, however, the first exploration of the relevant methods and areas can be found. The paper “Elektronische Drittmittelakte in der Hochschulverwaltung – Erkenntnisse aus Fallstudien” (in German) co-authored by Halyna Zakhariya proposed a reference model for a records management for higher education administrative processes. The transition from manual to semi- or fully-automated processes is the central setting for the research on electronic invoice processes (see Appendix A13). The paper “Critical success factors for adoption of integrated information systems in higher education institutions - A Meta-Analysis” co-authored by Dr. Jörg Uffen was published in the Proceedings of the Americas Conference on Information Systems (AMCIS). The aim of this paper was to provide a systematic literature review for critical success factors for selection and implementation of integrated IS in the specific context of higher education institutions. The applied method and the concept-centric analysis of existing research were reused in many of the following

research contributions while the topic of selection and implementation was later applied to CRM systems (see Appendix A14).

In the research area of CRM, insights on specific characteristics of higher education institutions were first applied to CRM processes. In this context, the requirements for a student relationship management (SRM) were investigated empirically by conducting a survey among students from Ivy League universities in the United States. The results of this research project in collaboration with Dr. Ina Friedrich were first presented in the paper “Requirements Analysis for a Student Relationship Management System - Results from an Empirical Study in Ivy League Universities” at the Hawaii International Conference on System Science (HICSS) and later in an extended version “Evaluating Customer Relationship Management in the Context of Higher Education” in the International Journal of Social and Organizational Dynamics in IT (IJSODIT) (see Appendix A5 and A6). As part of the research project to develop a process model for CRM system selection, a case study based evaluation in co-authorship with Dr. Ina Friedrich was conducted with an automotive supplier. In semi-structured interviews with project executives and members the proposed process model was tested for the first time. Results of this research were presented in the paper “A Practical Test of a Process model for Customer Relationship Management System Selection with an Automotive Supplier” at the European Conference on Information Systems (ECIS) (see Appendix A4). Building on the findings from this single case an interesting research question arose regarding the effectiveness of the defined CRM selection criteria and their impact on system success. In co-authorship with Halyna Zakhariya this question was exploratory addressed in the paper “Beeinflussen Auswahlkriterien den Erfolg eines CRM-Systems? - eine Strukturgleichungsmodellierung basierend auf dem DeLone und McLean IS-Erfolgsmodell” (in German) at the International Conference on Wirtschaftsinformatik 2013. In this contribution a quantitative-empirical approach based on structural equation modeling (SEM) was applied (see Appendix A3). As an extension of the process model for CRM system selection, a tool-based approach for prioritization of alternatives was suggested (see Appendix 2) and later further developed by comparing different mathematical methods, among these, the weighting scoring method, analytical hierarchy process and fuzzy methods (see Appendix 1), The latest version of the decision support approach for

CRM system selection is submitted to the Computers & Operations Research Journal and is currently under revision.

In the research area of electronic invoicing (e-invoices) all papers were co-authored by Angelica Cuylen in a mutual research project. The research basis in form of a structured literature review “Quo vadis elektronische Rechnung - Forschungsstand, -lücken, -fragen und –potenziale” (in German) was presented at the Multikonferenz Wirtschaftsinformatik (MKWI) 2012 (see Appendix A12). Findings from the literature review were further investigated in the paper “Voraussetzungen und Anforderungen für die Verbreitung der elektronischen Rechnungsabwicklung – Ergebnisse einer Expertenbefragung” (in German) where prerequisite and requirements for diffusion of e-invoices were discussed with experts. This paper was presented at the International Conference in Wirtschaftsinformatik 2013 (see Appendix A11). On the basis of these results, a research sub-project was initiated aiming at the development of a maturity model for e-invoice processes. The preliminary results were presented in the discussion paper #58 “Initial Design of a Maturity Model for Electronic Invoice Processes” as part of the IWI Discussion paper series (see Appendix A10). Following the procedure model suggested by Becker et al. 2009, the maturity model was further developed with the help of focus group interviews in “Development of a Maturity Model for Electronic Invoice Processes” published in the Electronic Markets Journal (see Appendix A8). The issue of risk management as part of the maturity model was addressed in the paper “Why are Electronic Invoice Processes Risky?- Empirical Analysis and Discussion of Risk Factors” which is published in the proceedings of European Conference on Information Systems (ECIS) 2015 (see Appendix A7). Current developments of the transmission formats and standards for electronic invoices are discussed in the publication titled “Will XML-Based Electronic invoice standards succeed? – an explorative study” where specifically the potential of the newly introduced standard ZUGFeRD is investigated in qualitative expert interviews. This paper is published in the proceeding of the ECIS 2015 in co-authorship with Kathrin Kühne and Angelica Cuylen (see Appendix A9).

Table 3. Overview of publications

	Title	Authors	Academic outlet	VHB/ WKWI[1]	VHB/ JQ3[2]	Chapter	Appendix	Method	Data Collection
CRM evaluation and sucess	Selecting an optimal sustainable CRM system - A decision support approach	Halyna Zakhariya, **Lubov Kosch,** Michael H. Breitner	submitted to: Computers and Operations Research Journal	B	B	-	A1	quantitative	conceptional
	Towards a multi-criteria decision support framework for customer relationship management selection	Halyna Zakhariya, **Lubov Kosch,** Ina Friedrich, Michael H. Breitner	Aspekte der Wirtschaftsinformatikforschung 2013 - IWI Discussion Paper # 55, Leibniz Universität Hannover, Institut für Wirtschaftsinformatik	-	-	-	A2	quantitative	conceptional
	*Beeinflussen Auswahlkriterien den Erfolg eines CRM-Systems? - eine Strukturgleichungsmodellierung basierend auf dem DeLone und McLean IS-Erfolgsmodell	**Lubov Kosch**, Halyna Zakhariya, Michael H. Breitner	**Wirtschaftsinformatik** Proceedings 2013. Paper 15. http://aisel.aisnet.org/wi2013/15	A	C	3.2	A3	quantitaive	survey
	*A practical test of a process model for customer relationship management system selection with an automotive supplier	Ina Friedrich, **Lubov Kosch**, Michael H. Breitner	Proceedings of the European Conference on Information Systems (**ECIS 2012**), Barcelona, Spain, 2012	A	B	3.1	A4	qualitaive	single case study
	Evaluating Customer Relationship Management in the Context of Higher Education	**Lubov Kosch**, Ina Friedrich, Michael H. Breitner	International Journal of Social and Organizational Dynamics in IT, **IJSODIT** 2(1)	-	-	-	A5	quantitaive	survey
	Requirements Analysis for a Student Relationship Management System - Results from an Empirical Study in Ivy	**Lubov Lechtchinskaia**, Ina Friedrich, Michael H. Breitner	Proceedings of the 45th Hawaii International Conference on System Sciences (**HICSS 2012**), Maui, HI, USA	B	C	-	A6	quantitaive	survey
Electronic invoice processes	*Why are Electronic Processes Risky? - Empirical Analysis and Discussion of Risk Factors	Angelica Cuylen, **Lubov Kosch**, Michael H. Breitner	Proceedings of the European Conference on Information Systems (**ECIS 2015**), Münster, Germany, 2015	A	B	4.3	A7	quantitaive	survey
	*Design and Discussion of a Maturity Model for Electronic Invoice Processes	Angelica Cuylen, **Lubov Kosch**, Michael H. Breitner	currently in 3rd revision at: **Electronic Markets** Journal	A	B	4.2	A8	qualitative	focus groups
	Will XML-Based Electronic invoice standards succeed? – an explorative study	Kathrin Kühne, **Lubov Kosch**, Angelica Cuylen	Proceedings of the European Conference on Information Systems (**ECIS 2015**), Münster, Germany, 2015	A	B	-	A9	qualitative	semi-structured interviews
	Initial Design of a Maturity Model for Electronic Invoice Processes	Angelica Cuylen, **Lubov Kosch**, Valentina Böhm, Michael H. Breitner	Aspekte der Wirtschaftsinformatikforschung 2013 - IWI Discussion Paper # 58, Leibniz Universität Hannover, Institut für Wirtschaftsinformatik	-	-	-	A10	qualitative	semi-structured interviews
	*Voraussetzungen und Anforderungen für die Verbreitung der elektronischen Rechnungsabwicklung – Ergebnisse einer	Angelica Cuylen, **Lubov Kosch**, Michael H. Breitner	**Wirtschaftsinformatik** Proceedings 2013. Paper 16. http://aisel.aisnet.org/wi2013/16	A	C	-	A11	qualitative	semi-structured interviews
	Quo vadis elektronische Rechnung Forschungsstand, -lücken, -fragen und -potenziale	Angelica Cuylen, **Lubov Kosch**, Michael H. Breitner	Tagungsband der Multikonferenz Wirtschaftsinformatik (**MKWI 2012**), 29.2.-2.3.2012, Braunschweig, Deutschland	C	D	-	A12	qualitaitve	literature review
HEI (+A5/6)	Elektronische Drittmittelakte in der Hochschulverwaltung – Erkenntnisse aus Fallstudien	Halyna Zakhariya, **Lubov Kosch**, Michael H. Breitner	Tagungsband der **Informatik 2012**, 18.-21.9.2012, Braunschweig, GI-Edition - Lecture Notes in Informatics (LNI), P-208	C	C	-	A13	qualitative	case study
	Critical success factors for adoption of integrated information systems in higher education institutions - A Meta-Analysis	**Lubov Lechtchinskaia**, Jörg Uffen, Michael H. Breitner	Proceedings of the 17th American Conference on Information Systems (**AMCIS 2011**), Detroit, MI, USA	B	D	-	A14	qualitative	literature review
Other	Sinnhafte Vollautomatisierung nach Mertens: Konzepte, Prozesse und Technologien	Angelica Cuylen, Christian Fischer, **Lubov Lechtchinskaia**	Aspekte der Wirtschaftsinformatikforschung 2010 - IWI Discussion Paper # 45, Leibniz Universität Hannover, Institut für Wirtschaftsinformatik	-	-	-	A15	qualitative	conceptional

[1] cf. WI-Notification of the WKWI and GI-FB WI "WI-Orientierungslisten 2008
[2] cf. VHB-JOURQUAL 3 (2015)

1.1. Motivation and research questions

The understanding of processes and causalities is fundamental to improvement of any kind. In the course of optimization efforts in different industries, the concept of continuous improvement (CI) has been adopted as a philosophy and set of tools to help enhance technology and processes alike (Bessant et al., 1994). According to Willam Edwards Deming, the pioneer of quality management, CI refers to “improvement initiatives that increase successes and reduce failures“(Deming cited after Juergensen (2000). The basic tool often applied for CI is Deming wheel or the Plan-Do-Check-Act (PDCA) cycle. The framework was developed by Deming (1982, 1986) based on the Shewhart cycle from 1936.The four stages of the cycle help structuring the improvement project while involving the participants and encouraging them to iteratively work towards the establishment of better processes. It also supports the better understanding of the processes of coordination leading to a more innovative and self-improving environment (Jørgensen et al., 2006). Jørgensen et al. (2006) describe the PDCA cycle as the iteration of planning, implementation, corrective action and management review which is until now the established basic procedure for any project. Meiling et al. (2013) define PDCA as follows:

Plan: Study the current situation and develop solutions for improvement.

Do: Take measures on a trial basis.

Check: Investigate the effect of changes.

Act: Start standardizing on a permanent basis.

In this PhD thesis, the high level objective is to improve specific business processes with IS by identifying potentials for optimization and finding adequate methods for business process support. It also aims at giving the ones responsible for the coordination and improvement of these areas the understanding and tools to meet the requirements of their individual business situation. In the topic of CRM the stage of system selection is emphasized while for e-invoicing processes the implementation phase is investigated. The PDCA cycle is the appropriate tool for structuring the research topics of this thesis. The discussed research papers will therefore be assigned to the relevant stage within the cycle in order to better explain how the research results can contribute to successful adoption and continuous improvement of the processes concerned. Figure 5 summarizes the

research questions addressed and assigns them the relevant stage of the PDCA cycle.

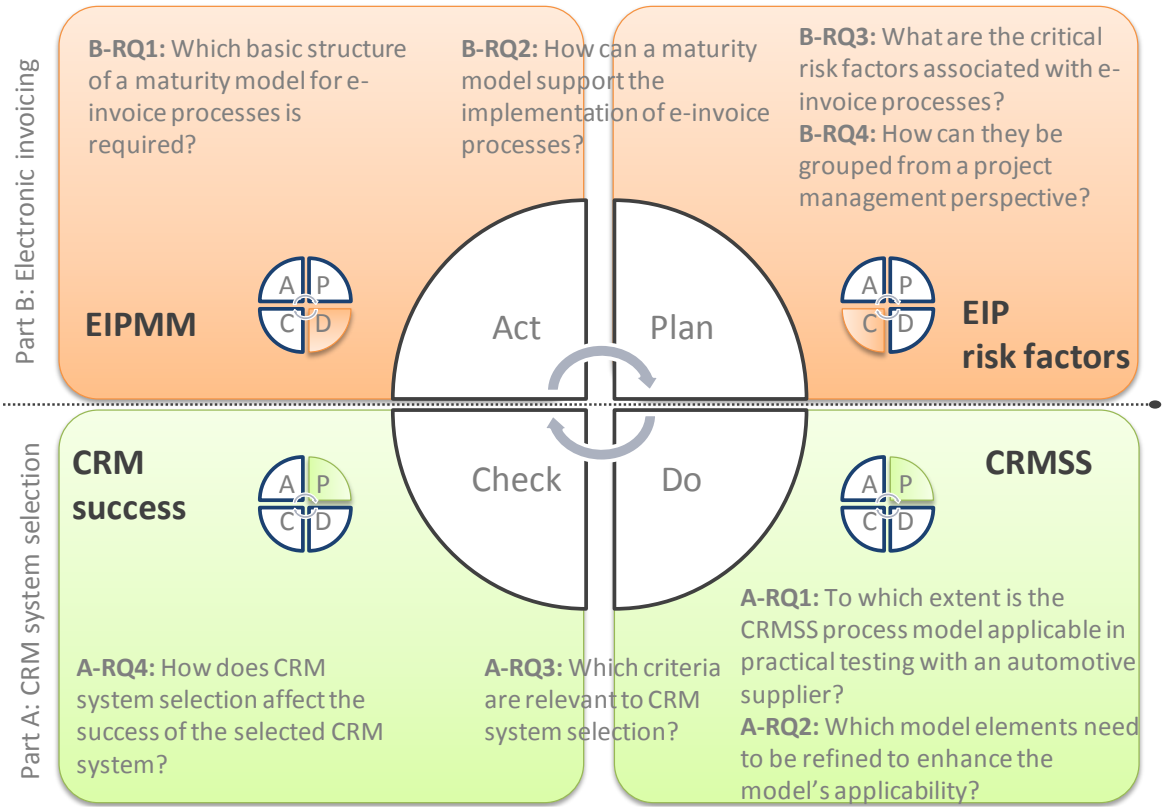


Figure 5. The addressed research questions within the PDCA cycle

In the topic of CRM system selection, two publications are chosen for thorough presentation in this thesis. The importance of CRM as a management concept and strategy has been steadily increasing and so have been the investments in CRM software (Lee et al., 2014, Chen and Popovich, 2003). CRM integrated the various customer touch points whether electronic (e.g. e-mail, internet etc.) or physical (e.g. retail store) into a single information system (Chen and Popovich, 2003). It aims at collecting and sensibly using refined information about the (potential) customers and optimally responding to their needs (Farquad et al., 2014). Richards and Jones (2008) define CRM „as a set of business activities supported by both technology and processes that is directed by strategy and is designed to improve business performance in an area of customer management". A recent survey by Gartner from 2014 indicates once more that the budget for CRM system is to increase fourth year in a row, this time by an average of 2.5 percent (Gartner, 2014a). This backs up the importance of sound decision making and procedural

guidance for the investments in CRM system selection. The suggested CRM system selection (CRMSS) process model was rigorously developed based on the meta model by Ahlemann and Gastl (2007). Their proposed five main phases are adopted to develop the CRMSS process model by means of empirical inquiries. For the final validation a single case study with an automotive supplier company is conducted and insights and enhancements to the model are extracted from semi-structured interviews with participating team members. Thus, these efforts relates well to the DO quadrant within the PDCA cycle. The research questions addressed are:

A-RQ1: *To which extent is the CRMSS process model applicable in practical testing with an automotive supplier?*

A-RQ2: *Which model elements need to be refined to enhance the model's applicability?*

The list of selection criteria which are part of the CRMSS model are further investigated in a study of CRM system success. The criteria and their impact on later CRM systems success after implementation of the chosen system are evaluated by using the DeLone and McLean (D&M) IS success model (DeLone and McLean, 1992, 2002, 2003 and 2004). The latter version of the model is extended by the relevant CRM selection criteria and a survey is completed to empirically test hypothesis of causal relations between selection criteria and system success mediated by the latent variables of the D&M IS success model. With the help of structural equation modeling (SEM) hypothesis are rejected or not rejected establishing a first insight into the relationship between CRM system selection and success. This research fits into the CHECK quadrant of the PDCA cycle as the CRMSS procedure model is now further evaluated for its selection criteria. The research questions addressed are:

A-RQ3*: Which criteria are relevant to CRM system selection?*

A-RQ4*: How does CRM system selection affect the success of the selected CRM system?*

The European Commission (2014) defines e-invoicing as "electronic transfer of invoicing information (billing and payment) between business partners (supplier and buyer)". They also estimate the annual saving for EU business at around 64.5 billion Euros when the e-invoicing initiative is successfully launched based on the

Single Euro Payment Area (SEPA). The benefits for users are manifold: cost reductions for printing and postage, error rate decrease, improvements in process transparency and processing times (Ibi Research, 2013, Salmony and Harald, 2010). The efforts of the European Commission, national governments and many other non-government organizations since many years, however, have not yet promoted e-invoicing in the business-to-business (B2B) area to the expected level of application. According to a global study on e-invoicing from 2012 by Basware GmbH only about 15 (outbound) to 16 (inbound) percent of companies already send or receive 50 and more percent of total invoices electronically. Although the number increased from 2011 to 2012, it is still quite low for small and medium sized companies (14 percent) and large companies (19 percent) alike. In order to support business planning to implement e-invoice processes or wanting to improve on the automation scale, a comprehensive electronic invoice process maturity model (EIPMM) is developed applying the procedure model for maturity model for developing maturity models by Becker et al. (2009). The main objective of the maturity model is to provide a generalized and standardized approach for companies of different industries and sizes to be able to efficiently adopt e-invoice processes and reap the benefits more swiftly. Therefore, the EIPMM fits well into the ACT quadrant of the PDCA cycle since it enables quick implementation or changes to the relevant processes and at the same time provokes the deeper understanding of the status quo as it is necessary in the following PLAN quadrant. The research questions addressed are:

B-RQ1*: Which basic structure of a maturity model for e-invoice processes is required?*
B-RQ2*: How can a maturity model support the implementation of e-invoice processes?*

As part of the maturity model categories risk management showed to be of major importance. Therefore, a study on risk factors associated with e-invoice processes is required.

B- RQ3: *What are the critical risk factors associated with e-invoice processes?*
B-RQ4: *How can they be grouped from a project management perspective?*

Producing a comprehensive framework of risk factors relating to e-invoice processes, namely their implementation and operations, give the possibility to

easily assess the companies environment regarding the critical aspects for e-invoicing and to adequately consider these factors when planning an implementation project or changes to current e-invoice processes. This research thus supports the PLAN quadrant of the PDCA cycle by providing a guideline for status-quo analysis and improvement paths. Additionally, it can be well adapted within the CHECK quadrant where the changes induced must be evaluated.

1.2. Structure of the thesis

This thesis presents four selected publications covering two topics, CRM system selection and electronic invoice processes. In the first section, all scientific publications are presented (Appendices A1-A15) referring to their research topic and scientific outlet. For the four selected publication, the motivation for research including the related research questions is explained and the structure of the overall thesis is depicted.

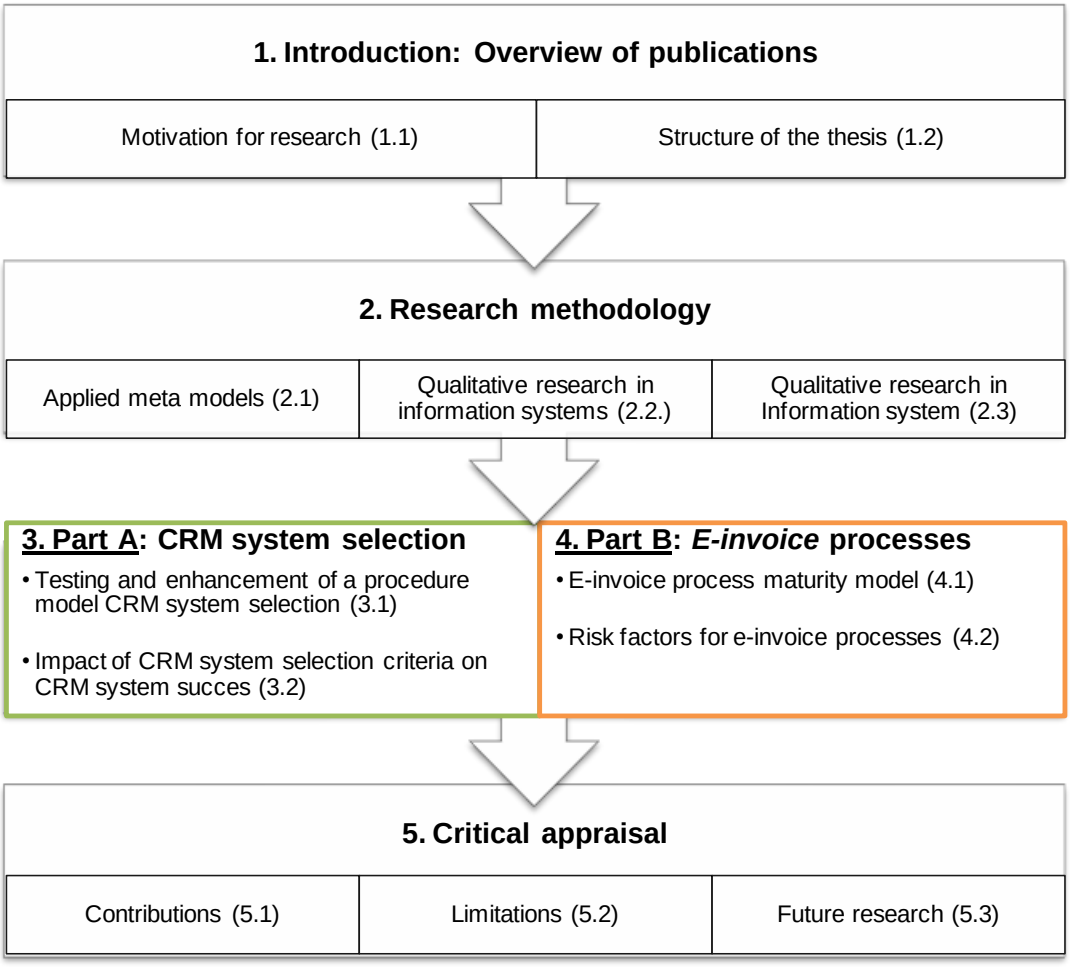


Figure 6. Thesis structure

In section 2, the underlying research methodology is discussed and placed within the theoretical mixed-methods design matrix by Johnson and Onwuegbuzie (2004). Based on this overall research framework, the meta models used (2.1) and the underlying qualitative (2.2) and quantitative (2.3) research methods are presented in more detail. The meta models are the process model for reference model construction by Ahlemann and Gastl (2007) and the reference model for maturity model development by Becker et al. (2009). Among the qualitative data collection methods the expert interview and the focus group are described. For qualitative data analysis, the qualitative content analysis technique by Mayring (2000) and Mayring and Brunner (2009) is summarized. In terms of quantitative research methods, data collection with survey methodology and data analysis with statistical methods represented by the principal component analysis (PCA) and structural equation modeling (SEM) are explained.

The third and fourth sections are related to these research topics, each presenting one qualitative study followed by a quantitative study for an aspect of the previously researched area. The presentation of each of the four selected publications will be structured into five sub-sections as follows:

(1) Introduction
(2) Research design and methodology
(3) Discussion of results
(4) Conclusions, limitations and further research
(5) Classification of publication

In section 5, the two research topics are reviewed critically in the light of the research results, the limitations underlying the research design and methodology as well as future research aspects.

Task sharing for each publication can be found in appendix titled “**Fehler! Verweisquelle konnte nicht gefunden werden.**”.

2. Research methodology

In the overwhelming number of cases, IS research is either behavioral or design-oriented in nature (Frank, 2006; Österle et al., 2011). The Anglo-American IS research widely adapts the user perspective to answer many relevant and profoundly interesting research question on the user's perception of and interaction with the IS or IS-based services. Through quantitative research methods causal relations between underlying theoretical constructs are uncovered. The research mostly originating from software engineering concepts and methods in the German-speaking IS community is taking a different approach which seeks to solve real-world problems through artifact design. According to Österle et al. (2011) artifacts in this context are defined as "constructs (e.g., concepts, terminologies and languages), models, methods, and instantiations". In practice these artifacts then are transferred into „manifestations […] axioms, guidelines, frameworks, norms, patents, software (with open source code), business models, enterprise start-ups" (Österle, 2011). Design principles are qualitative in nature and provide a path to develop artifacts which explain the research object at hand.

The behavioral and design-oriented IS research have coexisted many decades with limited points of contact and reciprocal criticism and lack of collaboration. Still most IS researchers rank among either the one or the other research paradigm. To remain in this „isolation, impeding exchange and competition" harms not only the IS communities but also the sum of their research results and the disciplines reputation and justification.

Through scientific discussions on „rigor and relevance" of IS research leading representatives of both „worlds" have induced mutual diffusion of ideas and methods and thus better mutual understanding (see e.g. Österle et al., 2011; Baskerville et al., 2011; Walsham, 2012; Gregor and Hevner, 2013).

Although this legitimate argument is not yet and probably will never be fully concluded, it is also time to move on towards more crossing paths of the long-established approaches of triangulation (Kaplan and Duchon, 1988) or mixed method research (Johnson and Onwuegbuzie, 2004). Kaplan and Duchon (1988) argue that „combining qualitative and quantitative methods [helps] to provide a richer, contextual basis for interpreting and validating results". Cresswell and Plano Clark (2010) conceptualize mixed method research as „philosophical assumptions that guide collection and analysis of data and their mixture in different research phases" and are based on collecting, analyzing, and mixing qualitative and quantitative data. Figure 7 shows how mixed methods research distinguished between different approaches, namely Figure 5 merging, connecting or embedding results from different research phases with the assumption that the "use of

quantitative and qualitative approaches, in combination, provides a better understanding of research problems than either approach alone“ (Cresswell and Plano Clark, 2010). The research presented in this thesis is adapting the approach of merging qualitative and quantitative results.

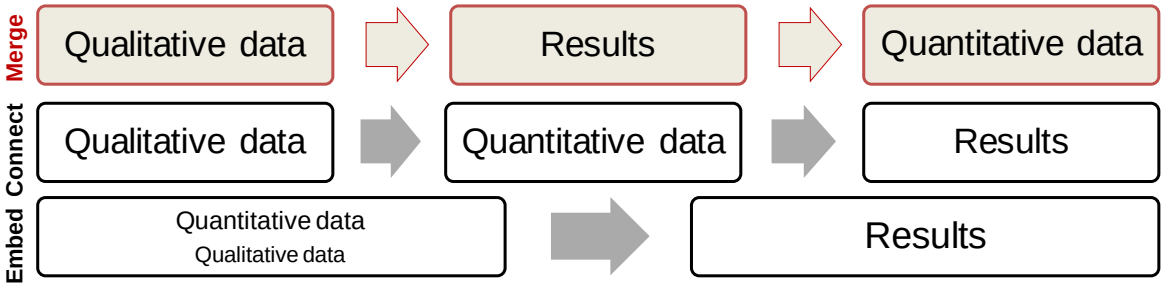


Figure 7. Mixing qualitative and quantitative data

Mixed methods research is adequate to apply when a need exists to further results from a previously quantitative or qualitative study (Cresswell and Plano Clark, 2010). Figure 8 presents the mixed methods research matrix by Johnson and Onwuegbuzie (2004) which structures the types of mixed methods research by the decision to combine time order and paradigm emphasis within one's research. Later can either be of equal status for qualitative (QUAL) and quantitative (QUAN) research or one research type can be leading. The dominant status is shown in the matrix by capitalization of the abbreviation for the respective type. The time order decision refers to the sequence of research phases where either "explanation of quantitative results" (QUAN→QUAL) or "quantitative exploration of a research problem" (QUAL→QUAN) is required.

According to Figure 8 the four presented papers can be assigned to the quadrant with sequential time order and qualitative research dominating quantitative research phases. The qualitative model based research publication is followed by quantitative exploration of a critical aspect of qualitative research results in a quantitative study. This refers equally to both, the research on CRM system selection (Part A) and electronic invoice processes (Part B) alike.

Figure 9 applies "the Partially Mixed Sequential Dominant Status Design“ (Leech and Onwuegbuzie, 2009), namely the "QUAL→quan" research framework to the research topics presented in this thesis. According to Leech and Onwuegbuzie (2009) a partially mixed sequential dominant status design refers to conducting a study with two phases that occur sequentially and giving a greater emphasis to either of the phases. In the underlying research the qualitative research phase is of greater emphasis, as the results achieved are more comprehensive. The

quantitative phase rather refers to a specific interesting aspect which was picked out based on the research results from the qualitative phase.

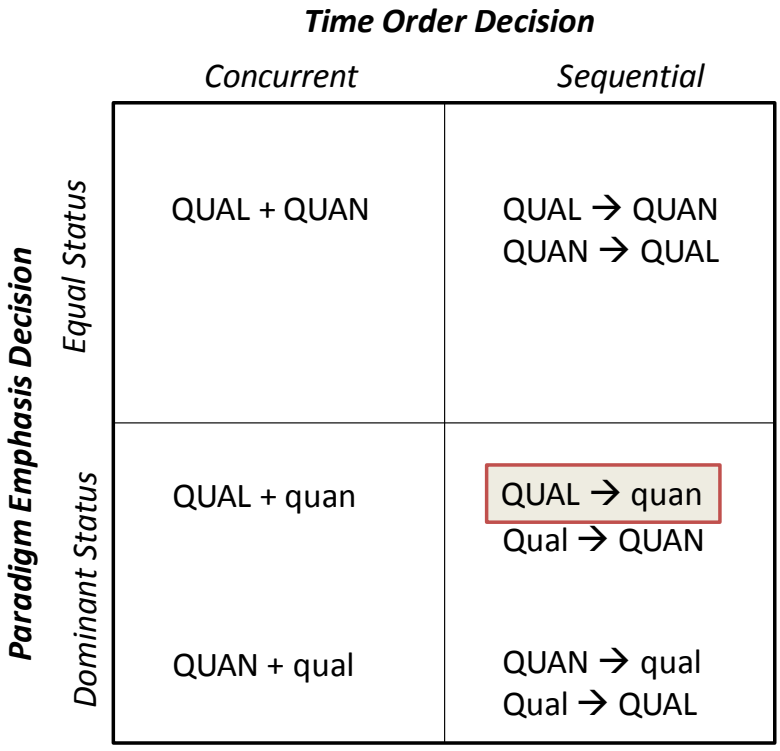


Figure 8. Mixed methods research design matrix (Johnson and Onwuegbuzie, 2004)

In part A, the procedure model for CRM systems selection was developed based on the reference model by Ahlemann and Gastl (2007) und evaluated qualitatively through a single case study approach and expert interviews within the case company. Among other things, the results of this research revealed an interesting aspect concerning CRM systems selection in practice and CRM system success which was then modeled and tested empirically in a quantitative study. Insights on the causal relations between CRM system selection criteria and CRM system success can shed light on the motivation for CRM selection projects and the emphasis which needs to be put on certain project phases. The quantitative research phase serves as a generalization of the research question.

In part B, the same research framework is used. First, a maturity model for e-invoice processes is developed based on the process model for maturity model development by Becker et al. (2009). For this purpose, qualitative data is collected through expert and focus group interviews to develop the model. As research results suggested that risk management is a crucial aspect within the topic, a quantitative study was conducted surveying data on risk factors for e-invoice processes from CRM experts. The results of the survey can be integrated with the

maturity model. The results of the quantitative phase serve as a specification of the research question.

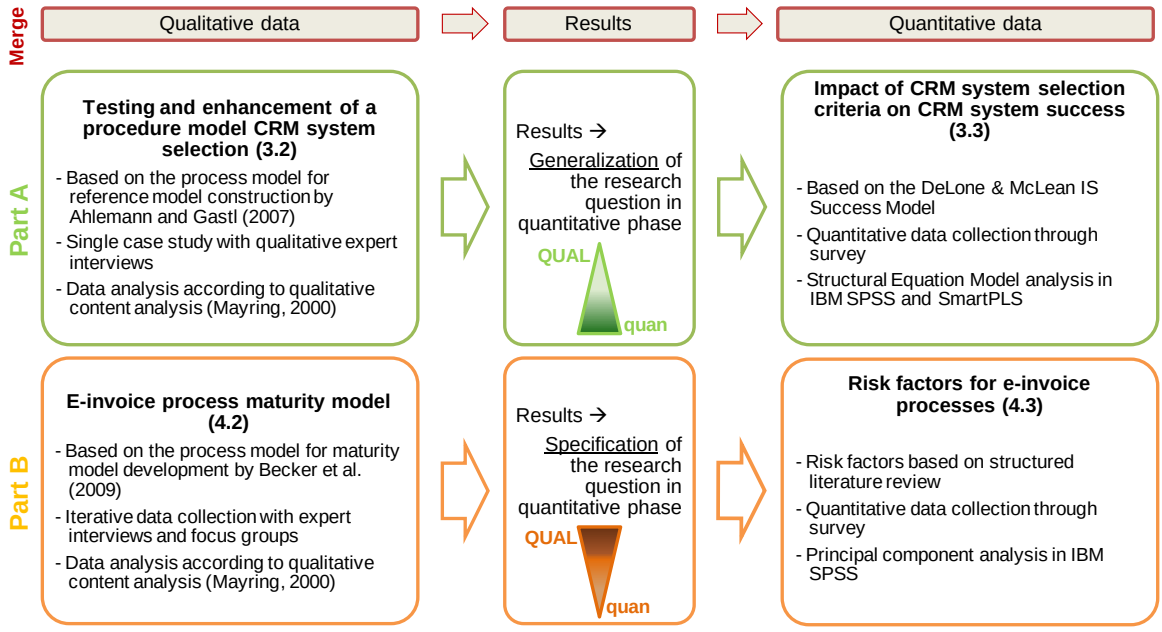


Figure 9. Classification of presented research

The theoretical model as well as qualitative and quantitative methods of data collection and analysis will be briefly presented in the following chapters of this section.

2.1. Applied meta models

The methodology of the qualitative studies presented in this thesis is based on two scientific process models. These models will be briefly summarized in this section.

Process model for reference model development. A reference model in IS research is “an information model used for supporting the construction of other models“ (Thomas, 2006). A reference model is an abstraction from enterprise or project specific characteristics and can be characterized by its reusability and recommendatory character (Thomas, 2006, Ahlemann and Gastl, 2007).
The process model for reference model construction by Ahlemann and Gastl (2007) used in section 3.2. serves the purpose structuring the process of reference modeling itself. They seek to give guidance on how to rigorously develop specific reference model which correspond with the above stated specifications.
Ahlemann and Gastl (2007) suggest a process model with five phases as follows:

Phase 1: Planning the reference modeling project

In this phase the model domain needs to be precisely defined as well as the problem domain and its practical relevance. Existing standards and norms need to

be closely monitored and considered throughout the model development process to ensure compliance of the resulting reference model. An important part of the planning is also the method and possible tools supporting the development process. In the sense of classic project planning, responsibilities, deadlines and deliverables need to be determined.

Phase 2: Model construction

Next to the collection of domain knowledge, a deductive problem-solving approach should be utilized to structure the problem domain. Clear, adequate, comprehensive categories serve as frame of reference. At the same time, these categories need to be practically relevant and theoretically grounded. The resulting categories need to be empirically tested through case studies and/or expert interviews for their completeness, disjoint vs. overlapping elements, and intuitive comprehensibility. The initial reference model is then assembled based on five data sources: interview results, standards and norms, prior research, own domain knowledge and other source, such as commercial software etc. Continuous coding and documentation thereof are an important building block of transparency and rigor.

Phase 3: Validation

The second empirical inquiry is recommended to take place with the same experts who participated in the first interviews. A Delphi study can be suitable here. The model is then refined based on these new insights and feedback. The challenge here is to distinguish between universally valid comments and the ones that are only true for a specific instantiation of the model. Configurability of the reference model can be incorporated for these aspects.

Phase 4: Practical testing

Applying the entire reference model or parts of it to a real-world situation gives the first opportunity for evaluation and further refinement based on the practical insights and the comments of the first users. At this stage first hints to create a process model can be incorporated. This gives users guidance on how, in which order and with which milestones a model can be applied.

Phase 5: Documentation

This final phase serves as an accumulation of knowledge gained throughout the model development. The rigorous model construction process need to be described transparently. Each model element is presented in detail. Case studies from the validation and/or practical testing should be presented and critically discussed.

The process model for reference model development is applied in section 3.2. The publication presented in that section refers to the Phase 4: Practical testing and refinement of the CRMSS model.

Process model for maturity model development. In IS research maturity is referred to as a state in an evolutionary progress concerning a specific capability from an initial stage towards a desired stage (Mettler et al., 2010). Modern maturity models in most cases follow the potential performance perspective rather than a life-cycle approach. The latter prescribes an evolution while the potential performance perspective suggests stages of growth where for each individual case the appropriate stage is defined (Wendler, 2012). Higher maturity levels are therefore not necessarily better than lower ones for every measured company alike. Wendler (2012) summarizes the benefits of maturity models as follows: they generate awareness of the aspect at hand, they serve as a guide to systematically implement an approach for improvement, and they give a benchmark of one's capabilities. Independently from its domain and focus, maturity models are structured in a grid-like approach to show a number of levels or stages which are hierarchical in nature and present capabilities, problem domain, organizational process, and their possible measurement (Mettler, 2010; Becker et al., 2009; Wendler, 2012). Maturity models can be descriptive (as-is), prescriptive (to-be) or comparative (Pöppelbuß and Röglinger, 2011). A comprehensive maturity model should be capable to fulfill each of the characteristic functions alike.

According to the meta-research by Wendler (2012), most maturity models presented describe a model development process and are conceptually designed. Empirical studies and model evaluation do not dominate the research field. The second highest number represent design-oriented development articles where the majority of proposed models have been evaluated. Evaluation methods range from qualitative case studies and action research, interview and quantitative survey to a very low number of mixed methods evaluation studies.

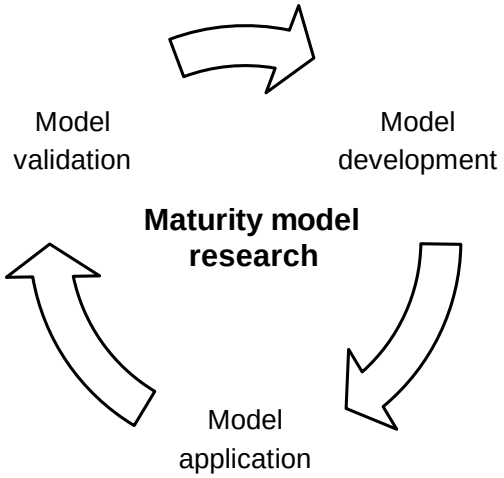


Figure 10. Research framework (simplified illustration from Wendler, 2012)

The derived meta-research framework defined a cycle of maturity model research (see Figure 10). Wendler (2012) suggests that coverage of the three steps is

unbalanced in research literature. The disadvantage of this representation is that it sharply separates the three areas of maturity model research. The process model for maturity model development by Becker et al. (2009) suggests a structured development process with an iterative main phase of model development which in parts also incorporated the model application and model validation steps within their process model (see Figure 11). Beck et al. (2009) postulate that maturity model development as a sub-domain of design science research needs to be consistent with the guidelines for rigorous design research by Hevner (2004). Therefore, they map the guidelines in form of requirements to be met to the steps of their process model. The presented model itself contains of eight phases. The first three phases serve the planning and preparations, the fourth phase is the main development phase and the last four phases serve the model documentation and presentation including an optional model rejection.

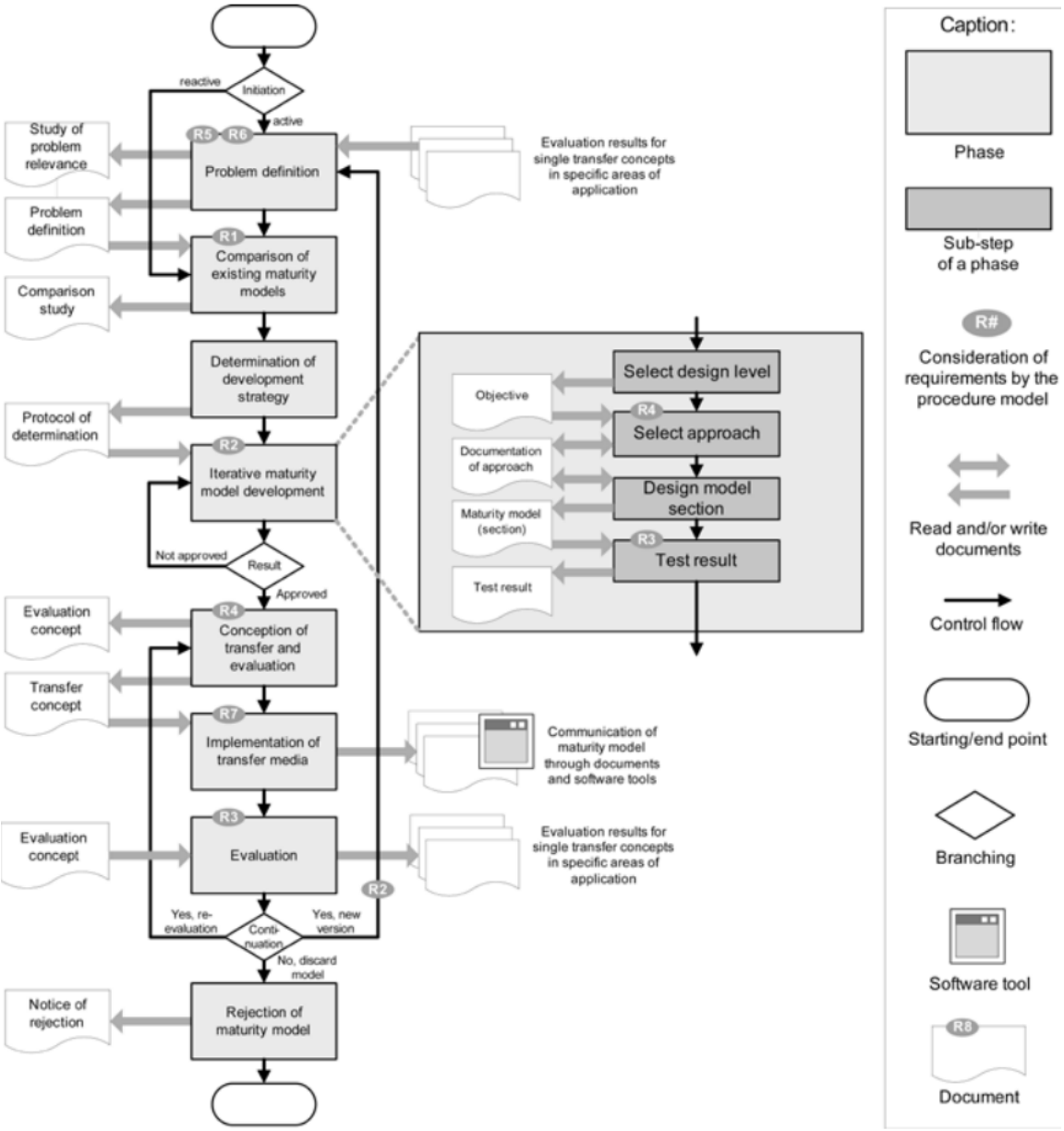


Figure 11. Process model for maturity model development by Becker et al. (2009)

The research problem is localized and structured in the *problem definition* phase to ensure its practical relevance. In *comparison of existing maturity models* available maturity models are compared to make sure no arbitrary research results will be produced. Later a decision about adopting an existing model or developing a new one needs to be taken in *determination of development strategy*. The modeling of the maturity model takes place in the *iterative maturity model development* which rotates multiple times before the model is finalized. This is closely linked to the requirements of iterative design a stated by Hevner et al. (2004). This main phase contains four sub-phases where the design level is defined, the approach is selected, and a predefined model section is designed. The last phase refers to testing the model. In the next four steps the developed model presentation to the various stakeholder groups needs to be planned

(*conception of transfer and evaluation*) and transfer material such as software tools or self-questionnaires have to be made available to the public in the *implementation of transfer media phase*. The evaluation in the real-world situation takes place through practical testing and application of the model in many contexts in the *evaluation phase*. The final optional stage *rejection of maturity model* depicts that a completely developed maturity model can be rejected after field testing if it is not accepted by the stakeholder groups and therefore lacks eligibility.
Becker et al. (2009) argue that this tactic approach to maturity model development will result in better applicable and more theoretically and practically relevant maturity models compared to a more intuitive procedure. This is yet to be proven by applying this process model in as many domains and situations as possible. Another applicability proof for this process model is given by adopting it for the development of the EIPMM in section 4.2.

2.2. Qualitative Research in Information Systems

While quantitative research usually builds on predefined hypotheses and seeks to support or reject these showing a causal relation between latent variables, qualitative research helps to understand context-based human decisions and actions (Myers, 2013). Qualitative research is a strategy for empirical research that takes place in a natural setting, uses natural language data and develops categories and theory in an inductive manner to be able to understand human perceptions, behavior and causal relations between events in a specific setting or situation of research interest (Kaplan and Maxwell, 2005). For data collection qualitative methods, such as observations, interviews (within case studies) and focus groups are applied. Systematic techniques for qualitative data analysis, such as qualitative content analysis by Mayring (2000), are used to generate research results inductively.

2.2.1. Case Study Research

„A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context“ (Yin, 2013).
Qualitative case studies are a widely accepted methodology in IS research (Atkins and Sampson, 2002). Both, the positivist (Benbasat et al., 1987; Yin, 1984, Kaplan and Duchon, 1988) and interpretative researchers (Walsham, 1995, Walsham, 2006, Bygstad and Munkvold, 2011) alike, have dealt theoretically with this research method. Especially since IS research strives for rigor and relevance (see introductory text to section 2) methodically conducted case study research can ensure practical relevance and rigorous results at the same time.
According to Yin (2013), case studies are appropriate to answer research questions referring to “how?” and “why?” of current topics in their real-world context. Case studies can be qualitative or quantitative in nature, or ideally even

use triangulation, a rationale for using multiple sources of evidence (Kaplan and Duchon, 1988; Yin, 2013) which provides “stronger substantiations of constructs and hypotheses” (Eisenhardt, 1989) and “a fuller picture of the unit under study than would have been achieved otherwise” (Kaplan and Duchon, 1988). Case study research often benefits from multiple investigators who provide complementary insights from multiple perspectives (Eisenhardt, 1989). Walsham (1995, 2006) suggest choosing a team of minimum two investigators, a closely involved one and an outsider. Through this constellation advantages from both perspectives can be gained. The involved researcher obtains deep insights into the researched object. Being an integral part of the process can even be related to action research where a researcher‘s intervention helps solving immediate organizational problems (Sein et al., 2011). Walsham (2006) argues that when the researcher is personally involved with the researched case, interviewees feel that they are more likely to cooperate. Deep involvement also helps to access additional, often quantitative data, such as reporting documents, presentation, strategy papers etc. But, close involvement can lead to disadvantages when the perspective of the researcher is biased (Benbasat et al., 1987). Therefore, the data analysis needs to be approached from both perspectives, too, with the neutral position of an outsider and interpretative approach of an insider (Walsham, 2006). Bygstadt and Munkvold (2011) provide a detailed discussion on the researchers’ role in case study research.

Eisenhardt (1989) argues in favor of case studies as in her understanding confrontation with the real-world object of research counteracts stereotype thinking and subjective judgments of researchers. On the opposite, case studies are prone to provide very detailed data and can make it difficult to come up with high-level theory. The bottom-up approach generates very specific results and can lack generalizability and overall insights. Based on the specific theories developed through cases studies, more complete theories can emerge when knowledge of the researched areas deepens (Eisenhardt, 1989). Thus, the success of research results built on case studies requires a structured and rigorous approach based on distinct criteria (Radeke, 2010).

Atkins and Sampson (2002) created a list of appraisal criteria for single case study research and formulated precise questions to be posed when evaluating a publication based on a single case study. Selected criteria are presented in a shortened form in Table 4. They object to guide the research and evaluation process of qualitative case studies in a way that is comparable to evidence-based quantitative research, thus from a positivist perspective.

Table 4. Selected single case study appraisal guidelines by Atkins and Sampson (2002)

Way of	Evaluation criteria
…thinking	• appropriateness of method • acknowledgment of bias in data analysis
…controlling	• exploitation of triangulation opportunities • transparency of research process • theoretical grounding • explanation of research process and results grounded in the data
…working	• appropriateness of case • research question • transparency of data collection and analysis
…supporting	• systematic data collection and analysis • clear context of research
…communicating	• clear objectives • acknowledgment of limitations • generalizabilty • identification of issues for future research • appropriateness of presentation • practical and theoretical contribution • rigorous presentation of results • openness to scrutiny

When applying case study research, authors “need to articulate more carefully how [they] conduct [their] work, and how [they] organize and justify [their] research contribution” (Walsham, 2006). Similar to evaluation criteria for quantitative research, case studies can be planned and reviewed based on this recommended framework. Such a checklist can prove helpful to researches conducting interpretative case study research and reviewers alike.

2.2.2. Expert interviews, focus groups and qualitative content analysis

The answers to qualitative, context-related research problems often reside within the human brain in form of experiences, perceptions and concepts coded into natural language. To approach this specific knowledge qualitative researchers have to identify appropriate “experts” representing specific context-related knowledge and experiences in areas of interest (Gläser and Laudel, 2010). To extract this context-specific knowledge, expert interviews and in some cases focus groups can be used.

To tap into different perspective and individual interviewee’s context, semi-structured guided interviewees are used to collect qualitative data in a structured manner (Gläser and Laudel, 2010). The interview guideline translates theoretical hypotheses and assumptions into appropriate open-ended questions. It is an inquiry tool comparable to quantitative surveys and helps to structure the data collection process along the theoretical assumptions originating from previous research while flexibly adjusting to each individual interview, the interviewee’s

experience, knowledge and position. One or two interviewers moderate the interview by flexibly referring to the predefined guideline, skipping or adding questions if necessary. The role of multiple interviewers can differ between active and passive positions in order to balance between a familiar atmosphere and unbiased discussion (Walsham, 2006, Benbasat et al., 1987, Eisenhardt, 1989).

Next to one-on-one interviews, focus groups are a widely applied data collection instrument in social sciences that according to Stahl et al. (2009) should be applied in IS research. They state that they can be "particularly valuable in exploring and recognizing the socio-technical nature of information systems". A specific characteristic of focus groups compared to other interviewing instruments is their emphasis on collaboration between interviewees which can prompt reaction, help synthesize information and stimulate the recall of forgotten knowledge (Stahl et al., 2009). In focus groups the social interaction from real-life context can be reenacted and studied. For application in design-oriented information systems research, Hevner and Chaterjee (2010) and Tremblay et al. (2010) suggest exploratory and confirmatory focus groups and show their applicability with examples from their own design research projects. While the latter should be used for field testing of an artifact, exploratory focus groups can be used to iterate design cycles and improve an artifact based on the target and stakeholder groups' opinions.

Tremblay et al. (2010) argue that focus groups are beneficial due to:

- Flexibility of approach and topics,
- Direct interaction between respondents and with the researchers,
- Rich data which can be analyzed qualitatively and quantitatively.

As with all qualitative methods where the researcher interacts directly with the research subject, the researcher's role, potential influence on the outcome and the moderators' skills should be considered critically. Here and with several other aspects of the focus-group based research process limitation can apply. Generalizing from focus groups is a challenge, since the social dynamics within focus groups can lead to biased results, e.g. due to a strong opinion leader in a group (Hevner and Chaterjee, 2010). Also adequately determining the number of focus groups to be conducted is difficult. The saturation criterion applies theoretically but this is a challenge and a subjectively biased task to decide that the minimum number of focus groups has been reached (Hevner and Chaterjee, 2010). Considerations concerning the research practicability however require some possibility to define a cut-off.

Qualitative data generated in expert and focus group interviews needs to be rigorously analyzed (Krippendorff, 1980). Mayring (2000) suggested a qualitative content analysis as an "approach of empirical, methodological controlled analysis

of texts within their context of communication, following content analytical rules and step by step models". Four central points need to be emphasized (Mayring and Brunner, 2009):

- The research context and the aspects of data to be researched (mood, opinion, feelings etc.) need to be put into a model of communication.
- The procedure and steps of research are predefined in the *rules of analysis*.
- Deductive or inductive *category schemata* are applied and iterated throughout the research process.
- Research *validity* (triangulation and theory grounded category development), *reliability* (Cohen's Kappa for intra-coder reliability) and objectivity (Cohen's Kappa of inter-coder reliability of minimum two coders) are tested based on scientific criteria.

After qualitative data material has been transcribed, the researchers have to decide what kind of coding categories are applicable to their research topic. While deductive categories emerge from existing theory or model, inductive categories are established closed to the material analyzed by stepwise complexity reduction and abstraction. The latter is shown in Figure 12 and is the coding method applied in this thesis (sections 3.2 and 4.2, and appendices A9, A11 and A12).

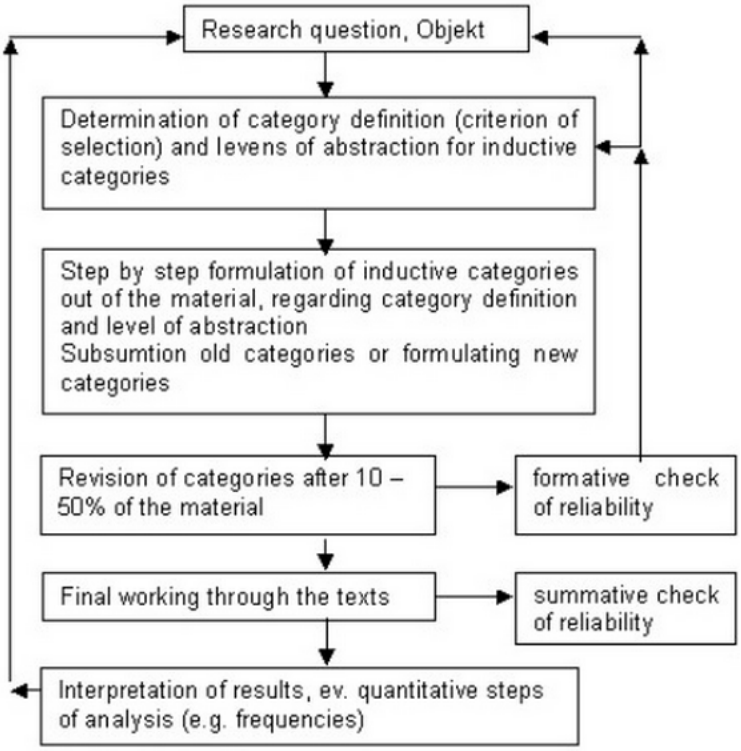


Figure 12. Inductive coding procedure (Mayring, 2000)

In the inductive coding procedure, interview and focus group material as well as literature data was openly coded, paraphrased, generalized and iteratively categorized. In each following iteration a higher level of abstraction was reached

until a category scheme with main categories and sub-category levels emerged. The structure of the category list and the number of levels depend on the topic researched.

2.3. Quantitative Research in Information Systems

Quantitative research methods stem from natural sciences and apply surveys, numerical methods and mathematical modeling (Myers, 2013). In behavioral IS research statistical methods are widely accepted to systematically analyze quantitative survey-based data and thus support or reject a predefined set of hypotheses (Frank, 2006). The main objective is to understand the research problem at hand by uncover phenomena surrounding IS implementation, management and use.

2.3.1. Survey methodology

Quantitative data is most often collected through a survey. A survey is defined as "a systematic method of gathering information from […] entities for the purpose of constructing quantitative descriptions of the attributes of the larger population of which the entities are members" (Goves et al., 2011). Some of the benefits of surveys are that they are easy to set up, allow determining the relations between variables and constructs and can be generalized to other members of the population or similar populations (Newsted et al., 1998).

Good survey design heavily relies on conceptual and statistical specifications (de Leeuw et al., 2008). Whether the survey questions actually measure what they are supposed to measure is a matter of construct validity. From the data collection perspective following error sources need to be considered:

- *Coverage error*: This error occurs when a certain part of the target population has a lower than average likelihood to be sampled. An undercoverage therefore means, that the population covered by the sample does not adequately represent the target population so that undercoverage exists (Groves et al., 2009).
- *Sampling error*: This error occurs due to the fact that based on practicability and cost issues only a subset of the population is surveyed. The two specifications of sampling error are the *sampling bias* and the *sampling variance*. The first is the zero likelihood given to certain members of the sampling frame to be included. The second is the dispersion of data across the sample and the possibility of it to be negatively biased.
- *Nonresponse error*: This error occurs when sampling entities who do not respond are in a certain way unique and differ from the ones responding. This difference makes them relevant for the study and the research results.
- *Measurement error*: Inaccuracy of responses causes deviation from the true response and therefore causes a bias to the research results.

When setting up a survey, the researchers have to counteract these error sources with their specific survey design.
For most sophisticated statistical data analysis techniques, questions based on a 5-point or a 7-point Likert-scale are still dominating the research despite various shortcomings (Ladd, 2009). The Likert-scale is an approach to measure attitudes based on items. Items are positive or negative statements with response option on an equidistant scale. The options vary between an even and an uneven number of response options which can be labeled with numbers or with natural language nuances. Specifications about the number of items used to reflect a construct and a brief overview of reflective versus formative constructs shall be given in section 2.3.2. The survey instruments developed and tested for the publications presented in sections 3.3 and 4.3 were conducted using the online survey tool www.surveymonkey.com.

2.3.2. Principal Component Analysis

Principal Component Analysis (PCA) is a widely applied and recognized dimensions reduction technique. The main objective of PCA is to replace multiple correlated variables by a smaller number of uncorrelated variables (principal components) without losing the information contained in the original set (Batholomew et al., 2002; Backhaus, 2000). The PCA method is based on orthogonal rotation is mostly used in exploratory data analysis when e.g. components have to be defined within the data. PCA answers the question regarding the number of components and their interpretation (Backhaus, 2000). The number of clusters or components is determined by the Kaiser-Meyer-Olkin criterion. It postulates that factors with an Eigenvalue <1 should be dropped as they explain less variance than a standardized variable where the Eigenvalue equally 1 (Backhaus, 2000). While the original unrotated matrix is used to determine the number of components, a rotated matrix is used for interpretation. The most commonly applied and recommended rotation method is the orthogonal right-angled rotation method VARIMAX where factors are assumed to be uncorrelated (Backhaus, 2000).
PCA can be applied as a dimension reduction and clustering method as has been done with IBM SPSS in section 4.3 or in combination with Structural Equation Modeling as happened in section 3.3.

2.3.3. Structural Equation Modeling

A widely accepted multivariate data analysis technique in behavioral IS research is Structural Equation Modeling (SEM) (Chin, 1998, Fornell and Larcker, 1981). Compared to multiple regression analysis, SEM has advantageous characteristics when analyzing a path model with latent variables (variables which can be

measured through attributed measures) (Grefen et al., 2011). SEM therefore became the most commonly used tool for hypothesis testing in IS research as they estimate two previously separated components, the structure and the measurement model (Freeze and Raschke, 2007; Grefen et al., 2011). The measurement model defines a latent variable with its measurement items which are used to operationalize the construct in a survey instrument. The structural model allows defining causal relationships between a number of exogenous and endogenous latent variables in a certain theoretical context. A prominent example is the DeLone and McLean IS success model (DeLone and McLean, 1992; 2002, 2003 and 2004) which is a theoretical model presenting the latent variable relevant to measure the success of IS and their measurement items which have been tested in a number of different application context of the model (the D&M IS success model is referred to in detail in section 3.3). According to Chin (1998), SEM has provided researchers with the ability to flexibly conduct relationship modeling among multiple predictors and variable, to establish latent variables and to statistically test theoretical models against empirical quantitative data. The complexity of this method requires stricter documentation of each research stage.
New discussions on misspecifications in the use of formative and reflective indicators (see Figure 13) arise when statistical insights have to be applied to IS theories and the definitions of theoretical latent variable of intentions, attitudes and feelings of humans in their interaction with IS. Reflective measures are in accordance with the common understanding that a change to an item will not lead to a change in the latent variable this item is attributed to (Coltman et al., 2008).

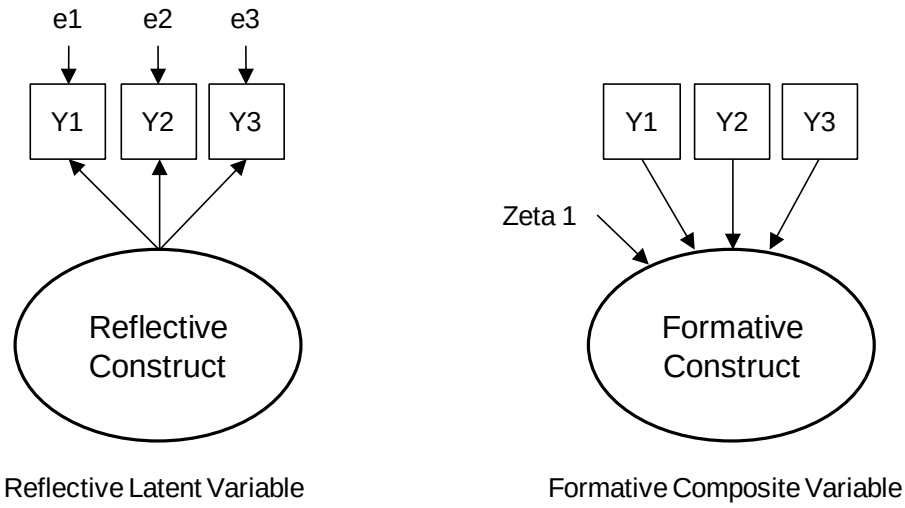


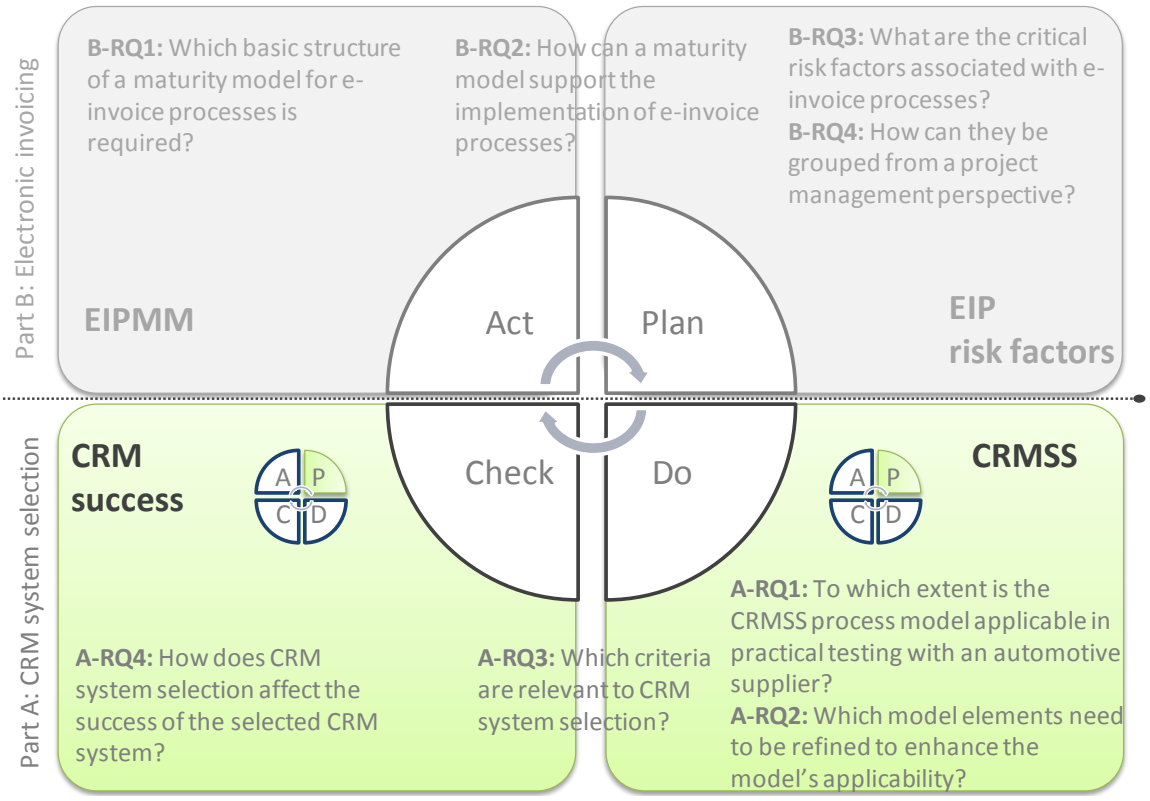
Figure 13. Reflective and formative constructs (Freeze and Raschke, 2007)

Reflective measures all represent the latent variable and are therefore interchangeable due to their high correlation (Freeze and Raschke, 2007). A less

used, but nevertheless applicable understanding of formative measures, prescribes the opposite. Formative items are causal to the latent construct they belong to, thus the latent variable changes when a formative indicator is removed (Diamantopoulos, 2011). Formative constructs are also called composites or combination variables (Freeza and Raschke, 2007). In many cases, researchers do not consider the direction of the relationship between measures and the latent variables which leads to incorrect research results (Freeze and Raschke, 2007). A measurement error indicated that part of a formative construct is not adequately explained by its formative measures.

For commonly used theoretical constructs the specification as reflective or formative latent variable has already been established by many researchers through its application. But for newly developed constructs a specification needs to be made carefully and theoretically grounded. Freeze and Raschke (2007) recommend clearly defining a new construct and its contextual domain. For statistical validation, different test and quality criteria exist for reflective and formative constructs. The application of these criteria and the SEM with SmartPLS (https://www.smartpls.com/) can be found in section 3.3. SmartPLS is based on the partial least squares structural equation modeling (PLS-SEM) by Wold and the advanced algorithms by Lohmöller (cited after Ringle et al., 2012). According to a review of PLS-SEM studies in MIS Quarterly by Ringle et al. (2012), this method has been widely applied for quantitative studies with small sample sizes and mixture of formative and reflective latent variables. The opportunities this method provides for analysis of complex theoretical model can only be realized to the fullest benefits when the recommended quality criteria and transparency requirements of research are met.

3. PART A: Customer Relationship Management systems selection criteria, selection process and IS success



3.1. Preamble

Customer Relationship Management (CRM) is a well-established management concept that is expected to yield profit and justifies high investment. Richards and Jones define CRM as business activities that are aimed at improving a company's performance in the area of customer management. These activities help supporting specific IT and process alignment with the company's strategy. CRM systems provide IT infrastructure which facilitates establishing customer relations within an organization (Hendricks et al., 2008). They serve as systematic consolidation and analysis of customer data with the aim to integrate communication channels as part of communicative, operative and analytical CRM processes (Gneisser, 2010). Through investment in master data management technologies and governance, CRM provides "a more consistent, appropriate and joined-up customer experience across multiple channels, products and functional areas" (Gartner, 2014a). Figure 14 shows the CRM research framework presented in this chapter.

Identifying and selecting the optimal CRM solution has become a multi-dimensional decision problem (Jadhav and Sonar, 2009). IT departments regularly need to make decisions on investments, required consulting support and other services (Yazgan et al., 2009). Selection is difficult due to the increasing number of available CRM solutions, the diversity of hard- and software which leads to incompatibilities, and lack of information available to decision makers (Lin et al., 2006). Due to high costs of such IT investments and application maintenance, the decision alternatives should be evaluated systematically. A CRMSS is an endeavor with many different internal and external stakeholders. Furthermore, there are business-related aspects concerning process adaptability, flexibility in terms of market and strategy changes, and IT-related aspects concerning business-IT alignment, implementation, configuration and operation issues and costs. In most cases, consulting services are integrated to supports selection and implementation of a new CRM package which further increases the investment. To balance practical experiences and research insights within a comprehensive process model, an explorative-qualitative approach was chosen in Friedrich, Kosch and Breitner (2012). Although the proposed CRMSS process model's applicability could be widely supported by the qualitative results presented in section 3.2, an interesting insight lead to a more generalized research question. In many cases CRM selection is significantly shortened or entirely skipped in favor of a preferred vendor, mostly the one already supplying other related software (e.g. ERP systems). At the same time, companies often struggle to define a clear CRM strategy (Gartner, 2014a) and to actually obtain the additional benefit associated with the implementation of a new CRM system (Freeman and Seddon, 2005).

While IT management focuses on selection the most fitting CRM solution, from the CIO perspective measuring CRM success is one of the top priorities (Gartner, 2014b).

Measuring IS success has been an important, heterogeneous and complex IS research discipline which requires a multi-dimensional perspective. A dispute between Mertens/Schumann and Urbach et al. in Buhl et al. (2010) on the research article in the Business Information Systems and Engineering journal (formally: Wirtschaftsinformatik journal) by Urbach et al. (2009) shows the explosiveness and relevance of the topic as well as its multiple facets and perspectives of research. Behavioral and design-oriented definitions of IS success exist. Cuellar (2013) points out that “product success” is a common interpretation referring to an IT project realizing the intended business benefits. At the same time, he argues that recognizing project success as a political process gives way for a multi-perspective analysis of its influencing factors. Due to its subjectivity, case and time-related and definition, IS success is rather difficult to grasp. It is therefore necessary to adapt a specific view of success as most interpretations are rather contradictory in nature (Buhl et al., 2009, Cuellar, 2013). Applying a theoretical IS success model to the specific context of CRMSS, the quantitative study aims to exploratory conceptualize CRM success in relation to the selection criteria applied during the CRMSS project (section 3.3).

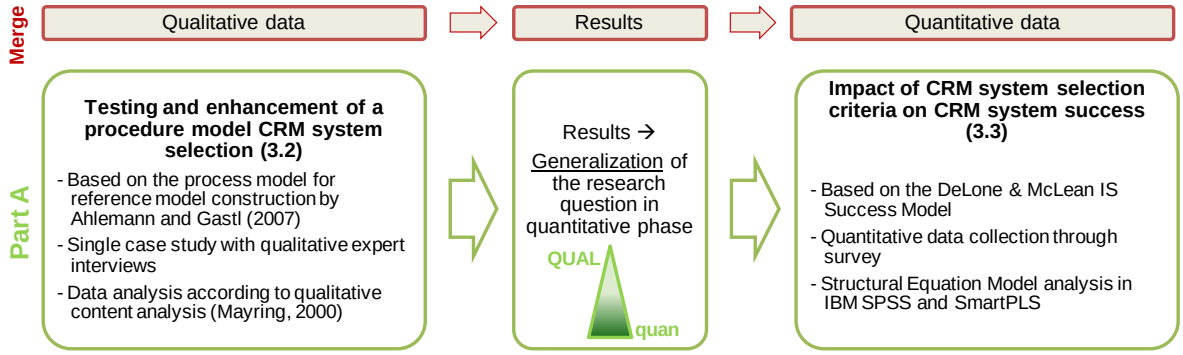


Figure 14. CRM research framework

3.2. A practical test of a process model for CRM system selection

This chapter is based on the research publication by Ina Friedrich, Lubov Kosch, and Michael H. Breitner titled “A practical test of a process model for customer relationship system selection with an automotive supplier“ which is published in the proceedings of the European Conference on Information Systems 2012 (see appendix A4).

3.2.1. Introduction

Selecting a CRM system is a part of a challenging software engineering process (Jadhav and Sonar, 2009) and the implementation of a CRM system imposes significant changes to business processes and the whole organization (Chen and Popovich, 2003; Finnegan and Currie, 2009). CRM system selection represents the structured process of comparing and evaluating a variety of CRM systems and selecting a system that shows the best fit with the company’s requirements (Friedrich et al. 2011). A CRMSS process model has been proposed in Friedrich et al. (2010) and Friedrich and Breitner (2012) to support the evaluation of a new CRM system. In the presented publication, the applicability of the CRMSS process model was tested by conducting a single case study in an automotive supplier company. The applicability test by Rosemann & Vessey (2008) is utilized. They define applicability by three categories: importance, accessibility and suitability.
The resulting research questions Friedrich et al. (2012) are:

A-RQ1: *To which extent is the CRMSS process model applicable in practical testing with an automotive supplier?*

A-RQ2: *Which model elements need to be refined to enhance the model’s applicability?*

3.2.2. Research design and methodology

The CRMSS process model is based on the methodology suggested by Ahlemann and Gastl (2007) which contains five phases (see Figure 15 for research design and section 2.1 for more detailed process model description).
The publication by Friedrich et al. (2012) presents the results and conclusions of the validation phase. The authors applied the CRMSS process model to a case study in the automotive industry using qualitative interviews.
To test acceptance and further refine the CRMSS process model a single case study was selected. Case study research is applicable to develop and test process models (Radeke, 2010). The case company is a worldwide vendor of automotive safety goods. With 43,000 employees, this company supplies all major automobile manufactures from their 80 facilities in 29 different countries. The major markets are Europe, North America and Asia Pacific. The legacy systems were implemented seven years ago. In the different European affiliates, there are

different operating systems, which are gradually being replaced by a standardized solution. In 2010, a pilot project was launched with the German affiliate to select the new system that will be rolled out in all European plants. The CRMSS process model was applied during this project. The rationale behind choosing an automotive supplier was to test the process model in a B2B environment. In the B2B context, the necessary alignment with the CRM systems of the customers can influence selection decisions due to cross-company integration requirements. The company's strategy is linked to direct customers, who are a limited number of large original equipment manufacturers (OEM). The CRM processes can be individualized for each of the large customers while functional CRM requirements can be less diversified. The automotive sector is characterized by industrialized value-adding processes which require deep supply chain integration. Despite these characteristics, the evaluation project represents a typical case for the industry (Yin, 2009).

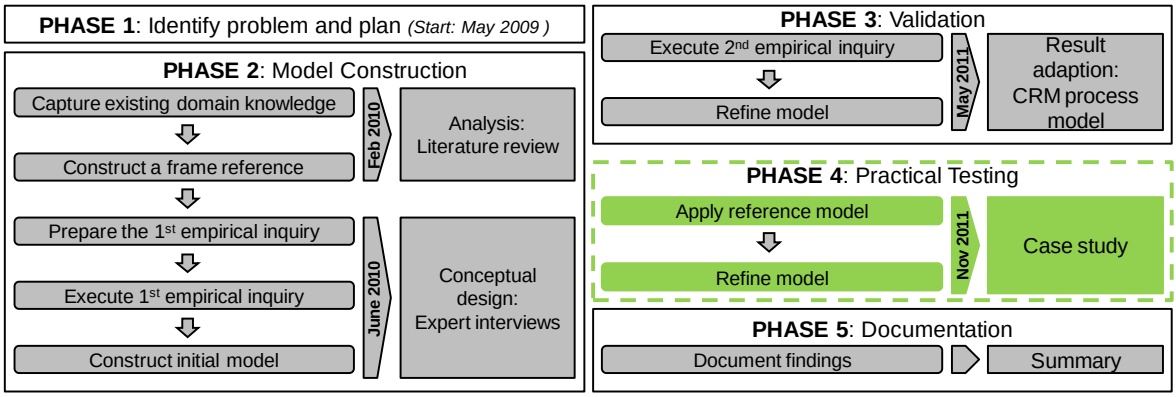


Figure 15. Approach to process model development (Adapted from Ahlemann and Gastl, 2007)

The authors conducted six focused interviews with different stakeholders from the project team (Yin, 2009; Berg 2009). In the course of introductory workshops with all project members, the accessibility of the CRMSS process model was tested by evaluating the understandability of the presented material. During the interview, a semi-structured interview guideline was used. The main part of the interview guideline was based on the different phases of the CRMSS process model (Friedrich et al., 2011) and the interviewees were asked to evaluate the applied CRMSS process model from their perspective (Ahlemann and Gastl, 2007). Individual interviews were conducted with the IT project manager, business project manager, key users from sales, controlling and IT, as well as the involved business consultant in order to ensure that all perspectives are covered (Yin, 2009). In order to mitigate negative effects (see section 1), the first and the second authors were present during the interview and the involved author took the role of

an investigator while the other author took the role of an observer (Eisenhardt, 1989). To ensure objectivity, as recommended by Yin (2009) and Eisenhardt (1989), data triangulation was applied to merge qualitative data from the focused interviews with other data sources, such as documents and presentations from the different project phases. The authors applied content analysis (see 2.2.2) to evaluate the data collected from the case study (Berg, 2009) by independently paraphrasing and deductively coding the material into the category set given by the CRMSS process model. An extended interview guideline served as the set of coding rules for matching paraphrases with categories.

3.2.3. Discussion of results

Figure 16 shows the consolidated results of all interviews that were mapped to the CRMSS process model. Each CRMSS phase is presented briefly with the general recommendations and implications for CRMSS applicability. Project specific results and activities can be found in Figure 16.

For the overall phase of *project management,* the CRMSS process model includes the establishment of a project organization in the beginning of the evaluation that remains stable also during the implementation project. The full methodology must also be set up and understood by the project management. Integrating the same people during selection and implementation has proven to be an important decision. The work load needs to be considered and leveled in advance when planning both projects. The allocation of business and IT stakeholders was important to establish mutually responsible behavior. The early involvement of all project members in the selection phase enhances understanding and acceptance. Due to limited time information flow was not optimal in practice. It needs to be addressed before the project start or early in the implementation project.

During the *demand analysis* phase, a conceptual framework must be established that includes a scope definition, critical process and system requirements identification, interface classification and vendor long list creation. The adjustment of the CRMSS process model allows simplifying the selection project. Customization takes place based on past experiences with legacy systems. The process model supported the project team in identification of critical factors and accelerated project initiation. The generation of a vendor long list and the subsequent reduction to a vendor short list in phase two was not transparent enough for the project members. Due to organizational reasons, the vendor long list was predominantly formed by IT. Later it became apparent that a business perspective and transparent communication with project stakeholders is crucial.

During the *detailed requirements specification* phase*,* mandatory functional criteria and target processes are derived and specified to narrow the list of potential vendors. The defined scope has been sufficient to obtain the selection of vendors

for the workshops. Although part of the CRMSS process model, a detailed evaluation of costs was restricted by time. CRM selection projects usually have a specifically restricted timeline due to smaller budgets. This fact needs to be acknowledged by risk management. A detailed evaluation of costs and benefits is an important deliverable for an informed decision in the decision phase.

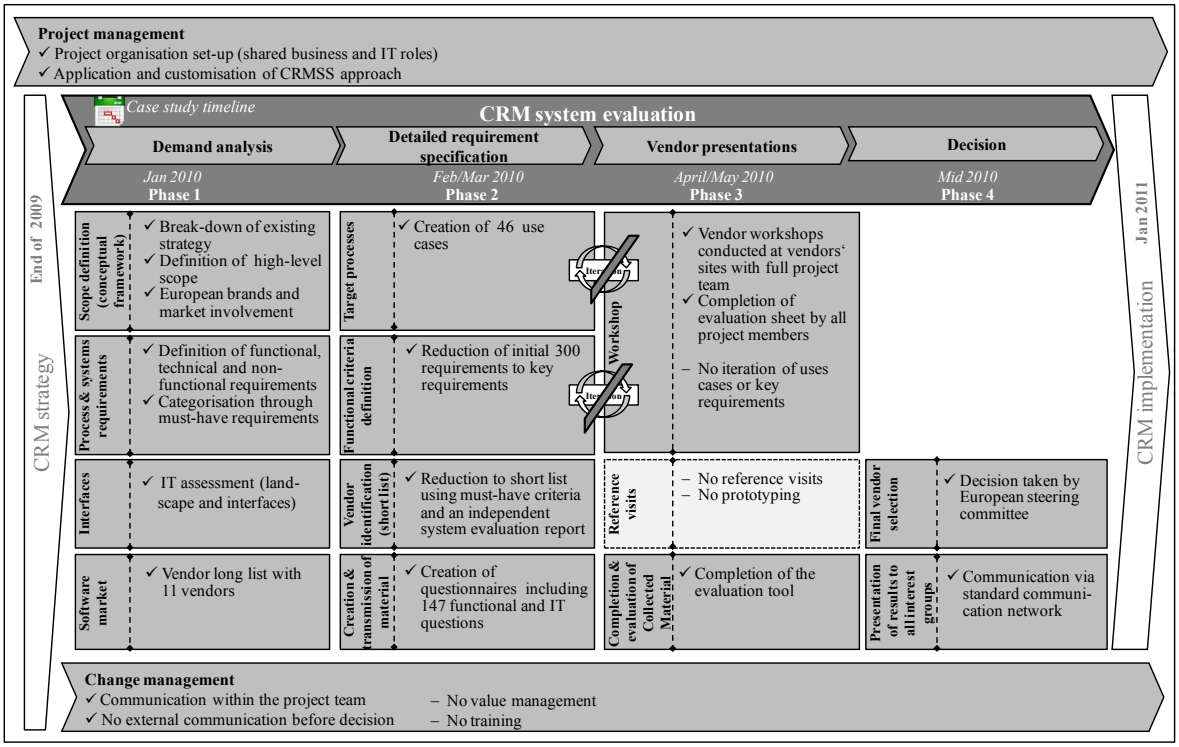


Figure 16. Consolidated results of the applied CRMSS Process Model (result of practical testing)

During the *vendor presentations* phase, three workshops that focus on obtaining a deeper insight on the degree of scope coverage are scheduled with vendors to present their solutions. The thorough preparation of the vendor workshops is a decisive milestone. The quality of transmission material and prior communication with vendors is critical for workshop efficiency and project members' acceptance. The company size and the international context of the project were supported by the project organization considering national representatives. In the B2B context of the case study with all major OEMs as customers, reference visits were irrelevant due to the competitiveness of the market. The decision is highly influenced by the requirements and operating systems of the customers. The CRMSS methodology helped to meet initial uninformed vendor preferences.

During the *decision* phase**,** results are summarized and documented before they are presented to the interest groups. Using this approach the decision is justified and demonstrated before the negotiation process with vendors begins. The missing cost calculation in detailed requirements specification phase can lead to

unnecessary long negotiations with vendors. Not all employees received the details about the decision through the usual communication channel of the case company. A detailed communication via other channels could improve transparency and acceptance.

During the overall *change management* phase, communication, business transformation, training and organization enablement are addressed. Missing **c**hange management aspects in the selection project lead to disadvantages in implementation. For example, user training was identified as critical during implementation and planning had to be outsourced to consultants. Key users confirmed that system training could improve their ability to later judge the vendors (fit-gap analysis). It is a challenge to offer further system training in the selection project because various systems are still uncompleted. Value management including business readiness was not regarded as critical as CRM processes were already well established. Project management has to evaluate the risk associated with neglecting certain areas of change management and identify critical issues for selection while shifting less critical aspects to implementation.

The practical application has confirmed the CRMSS process model. Model refinement including roles and deliverables is shown in Table 5.

Table 5. Overview of roles and deliverables derived from the case study

Phase	CRMSS Task	CRMSS selected activities	Roles	Deliverables	Additional deliverables
Phase 1: Demand analysis	Scope definition	Definition of functional high-level scope , system portfolio and IT architecture, available budget, time planning and economic demands, risk management, exit strategies	Steering committee, project management	✓Business and IT strategy documents ✓Categorization criteria	+ Exit strategies
	Process & system requirements	Define main functionality, create business processes, non-functional requirements	Template keeper (per business unit)	✓ High level process definition ✓ Initial requirements list ✓ Selection criteria	+ Business operations plan + Roll-out plan
	Interfaces	Analysis of all affected systems, technical requirements and restrictions	IT project manager	✓ Architectural Assessment	
	Software market	Standard and industry solutions, consulting support	IT project manager	✓ Vendor long list	+ Vendor assessment
Phase 2: Detailed requirement specification	Target process	Define high level target processes	Template keeper, business experts, IT and business key users	✓ Key requirements ✓ Decision criteria and weights	
	Functional criteria definition	Account management, call centre, campaign management, contact & customer management, customer service, field service, industry specifics, internet, lead & opportunity management, relationship management, reporting, sales management	Template keeper, business experts, IT and business key users	✓ Evaluation sheet	
	Vendor identification	Company and CRM project overview, requirement specifications, total cost calculation	Business project manager, IT project manager	✓ Criteria for vendor short list ✓ Vendor short list	
	Creation & transmission of material	Functional fit list, questionnaire for stakeholders	Business project manager, IT project manager, template keeper, business experts, IT and business key users	✓ Use cases ✓ Questionnaire ✓ Prototype	+ Company and project overview + Detailed standardized scope of expectations
Phase 3: Vendor presentation	Workshops	Workshop planning and organization	Business project manager, IT project manager, template keeper, business experts, IT and business key users	✓ Evaluation sheet (filled out)	+ Interview guideline for reference visits
	Completion & evaluation of collected material	Collection of relevant material	Business project manager, IT project manager	✓ Evaluation tool	+ Cost calculation
Phase 4: Decision	Final vendor selection	Stakeholder management	Steering committee		
	Presentation of results to all interest groups	Stakeholder communication	Project management	✓ Presentation	
Change management		Initiating IT and business transformation, communication, value management, training	Business project manager	✓ Communication package	+ Stakeholder analysis + Business assessment
Project management		Project organization, implementation methodology set up	Business project manager, IT project manager	✓ Project plan ✓ Project organisation chart	+ Resource plan + Business case

3.2.4. Conclusions, limitations and further research

The purpose of this research was to test the applicability of the CRMSS process model with a case study from the automotive industry. The research includes valuable contributions to the area of software evaluation. A detailed process model for CRM system selection is presently not available in scientific literature and

therefore contributes to knowledge in this field and IT system selection. The research question can be answered as follows:

A-RQ1: *To which extent is the CRMSS process model applicable in practical testing with an automotive supplier?* According to the categories of applicability by Rosemann and Vessey (2008) the CRMSS process model is applicable to CRM system selection:

- The level of *importance* was judged as high and reflects the existing needs of practice. The process model helped the project members consider the critical factors throughout the different project phases.
- All project participants were able to comprehend the model based on the presented material thus supporting *accessibility*. A lesson learned was that it was not sufficient to only give detailed instructions to the project managers, but also to provide the big picture to other project members
- The proposed methodical approach fulfilled their needs. Therefore *suitability* is given. Due to the level of detail provided by CRMSS process model, it can be adjusted for individual requirements.

A-RQ2: *Which model elements need to be refined to enhance the model's applicability?* Major refinements of the model included adding roles matching the tasks of the model phases and enhancing the deliverables catalogue.

Following limitations apply: A single case study cannot generalize the findings of a process model but it is useful to evaluate the applicability in a practical setting. Because the process model was tested from the procedural and not from the functional perspective, the limitation of industry-specific focus is mitigated. At the same time, as functional criteria were not investigated in detail, conclusions cannot be drawn as to whether the criteria in the process model are complete. This research study can serve as input for subsequent case studies to compare CRMSS application and contrast differences. Further case studies should focus on functional selection criteria for CRM system evaluation.

3.2.5. Classification of publication

The research paper "A practical test of a process model for customer relationship management system selection with an automotive supplier" by Friedrich, I., Kosch, L., and Breitner, M.H. (2012) was accepted in a double-blind peer review process and accepted for presentation after one revision at the European Conference on Information Systems (ECIS).

The ECIS was first established in 1993 and has been held annually ever since to welcome both, European and non-European researchers. It is the largest and most prestigious European conference on IS and is also an affiliated conference of the Association for Information Systems (AIS). The acceptance rates of the ECIS

have decreased steadily over the years and are roughly about 30 percent each year. The ECIS 2012 acceptance rate for full research papers was 29 percent.
The research paper was published in the proceedings of the 20th ECIS online at AIS Electronic Library (AISeL), http://aisel.aisnet.org/ecis/. The conference proceedings are assigned the ranking “A” of the WKWI and GI-FB WI (Wissenschaftliche Kommission Wirtschaftsinformatik im Verband der Hochschullehrer für Betriebswirtschaftslehre e.V., 2008). The rating in VHB-JOURQUAL3 by Henning-Thurau, T. & Sattler, H., (VHB-JOURQUAL3, 2015) is “B”.

3.3. Impact of selection criteria on CRM system success

This chapter is based on the research publication by Lubov Kosch, Halyna Zakhariya, and Michael H. Breitner titled “Beeinflussen Auswahlkriterien den Erfolg eines CRM- Systems? – eine Strukturgleichungsmodellierung basierend auf dem DeLone und McLean IS-Erfolgsmodell (in German)“ which is published in the proceedings of the International Conference on Wirtschaftsinformatik 2013 (see Appendix A3).

3.3.1. Introduction

Measuring the success of CRM activities is a significant aspect of strategic decision support for responsible managers. Its implementation often fails due to lacking definition of CRM value drivers and the adequate measurement thereof (Richards and Jones, 2008). Due to the high investments in CRM systems (Thompson et al., 2011, Gartner, 2015), identification of valid and measurable drivers is a relevant agenda for researchers and managers from practice alike. It is therefore justified to ask for a general a priori and a posteriori estimation of the value proposition of CRM systems, especially concerning the specific criteria contributing to its success.

It is undoubted that CRM systems need to be selected carefully in a structured approach to be effective in supporting organizational CRM processes. Friedrich et al. (2012) showed the necessity and the possible implementation of such a selection project. Freeman and Seddon (2005) and King and Burgess (2008) have addressed issues around critical success factors for CRM system success. But research on the complex relationship between CRM system selection and later CRM systems success is still lacking.

Kosch et al. (2013) seek to develop a theoretical framework for testing whether CRM selection criteria have any influence on system, information and service quality of the chosen and implemented CRM system and its success. The resulting research questions are:

A-RQ3*: Which criteria are relevant to CRM system selection?*

A-RQ4*: How does CRM system selection affect the success of the selected CRM system?*

3.3.2. Research Design and Methodology

The D&M IS success model (1992) describes the causal relationship between quality dimensions of an IS, the user perceptions of the IS and user behavior comprehensively in relation to individual and organizational benefits of the IS. Based on the application of this model in many different research contexts, the D&M IS success model was developed further in DeLone and McLean (2003) to now reflect the relationship between system, information and service quality and

the resulting user perspective. The latter shows the interdependency between the intention to use and actual use as well as the user satisfaction. The user perspective influences the net benefits which now combine individual and organizational IS success. The D&M IS success model has undergone manifold empirical tests in different domains (Urbach et al., 2009) and is an acknowledged model in IS research (Neumann et al., 2011).

Figure 17 shows the proposed extended D&M IS success model which serves as the structure model for empirical testing. The three quality dimensions *SysQ, InfQ* and *SerQ*, the simplified construct *UseP* and the success indicating construct *NetB* originate from the D&M IS success models in their empirically validated relationship.

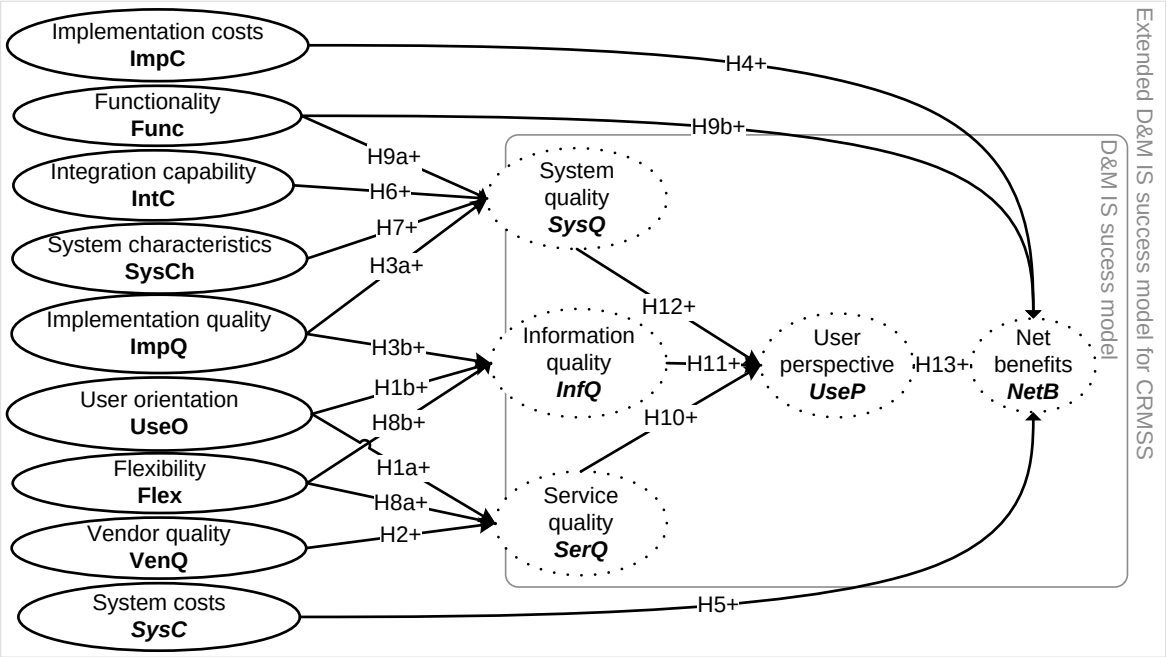


Figure 17. Proposed research model with clustered CRM system selection criteria as latent exogenous variables in an extended D&M IS success model for CRMSS

CRM selection criteria were identified through a structured literature review. From 20 relevant scientific publications a list of 33 criteria emerged though independent coding by two researchers. As a result four main categories *quality, cost, technology* and *functionality* and eight sub-categories were derived (see Figure 18).The sub-categories *ImpC, Func, IntC, SysCh, ImpQ, UseO, Flex, VenQ* and *SysC* were adapted as latent exogenous variables within the proposed research model (see Figure 17). The thirteen hypothesis presented in the research model are all assumed positive correlations between latent variables. They shall be discussed briefly:

- The higher the priority of *user orientation* during CRMSS, the better the *service* **(H1a)** and the *information* **(H1b)** *quality* of the selected CRM

system. This hypothesis is justified by the documentation and training offered for the CRM system (Chau, 1995; Parasuraman et al., 1988; Tsai et al., 2011) which influence service quality. Information quality is influenced through the trained personnel who work with the system (King and Burgess, 2008).

- The higher the priority of *vendor quality* during CRMSS, the better the *service quality* of the selected CRM system **(H2)**. Vendor quality is defined through vendor and product characteristics (Colombo and Francalanci, 2004; King and Burgess, 2008) such as reputation, specific industry focus and maturity of the product in the product lifecycle. Personnel resources are represented through availability and experience of external consultants as well as internal know-how about the product which influences vendor quality evaluation (Kemper et al., 2006; Wybo et al., 2009).
- The higher the priority of *implementation quality* during CRMSS, the better the *system* **(H3a)** and *information* **(H3b)** *quality* of the selected CRM system. The minimum implementation period as stated by the vendor (Kemper et al., 2006; McCalla et al., 2002) and the security standards of the CRM system at hand comprise the implementation quality. Another important aspect is the interoperability with the IT infrastructure of the implementing company (King and Burgess, 2008). Interoperability is associated with greater usability, efficiency and reliability of the system. The data extracted is more relevant and comprehendible (Colombo and Francalanci, 2004; Franch and Carvallo, 2003).
- The higher the priority of *implementation costs* during CRMSS, the higher the *net benefits* (**H4**). The higher the priority of *system costs* during CRMSS, the higher the *net benefits* of the selected CRM system (**H5**). In contrast to purchasing costs of licenses and hardware, personnel and installation costs are difficult to estimate. Misjudgments in the area will directly influence IS success (Sohn and Lee, 2006).
- The higher the priority of *integration capability* during CRMSS, the better the *system quality* of the selected CRM system **(H6)**. From the technical perspective, additional programming, data integration, compatible standards and estimation of installation effort are critical to system quality (Kemper et al., 2006).
- The higher the priority of *system characteristics* during CRMSS the better the *system quality* of the selected CRM system **(H7)**. Reliability and robustness, system performance and scalability (DeLone and McLean, 2004; Kemper et al., 2006; King and Burgess, 2008) influence the reliability

and efficiency of the CRM system (Khaddaj and Horgan, 2004; Tsai et al., 2011).

- The higher the priority of *flexibility* during CRMSS, the better the *service* **(H8a)** and *information* **(H8b)** *quality* of the selected CRM system. Technical flexibility in form of easy customizing, programming, and reporting plays an important role for late IT-support and data quality. Mobile features increase timeliness and relevance of information (Colombo and Francalanci, 2004).
- The higher the priority of *functionality* during CRMSS, the better the *system quality* **(H9a)** and the higher the *net benefits* **(H9b)** of the selected CRM system. Functional criteria are closely related to the unique requirements of the CRM system and a high impact on system quality can be expected. Call center functionality (Tsai et al., 2011, Wang et al., 2009), for example, include complain and inquiry management, call logging and resulting churn management. These features need to be prioritized and evaluated. Otherwise net benefits can be negatively influenced as customer services cannot be entirely fulfilled (Jadhav and Sonar, 2009; McCalla et al., 2002; Tsai et al., 2011).
- The quality dimensions of the CRM system are positively correlated with the *user perspective* **(H10-H12)**. The user perspective is positively correlated with the *net benefits* of the CRM system **(H13)**. The D&M IS success constructs and their relations are assumed to remain stable in this context (DeLone and McLean, 2004; Gemlik et al., 2010). Functional and cost criteria can have direct influence on net benefits. The influence of the other criteria is moderated by the quality dimensions.

Quality								Cost						Technology									Functionality *Func*									
Vendor quality *VenQ*			Implementation quality *ImpQ*			User orientation *UseO*			Implementation costs *ImpC*				System cost *SysC*		Integration capability *IntC*				System characteristics *SysCh*			Flexibility *Flex*										
Vendor and product characteristics	Project Management	Human resources	Interoperability	Security	Imlementation period	Training & support	User friendliness	User acceptance	Maintanance costs	Installation costs	Personalkosten	Costs for training & support	Purchasing costs	Costs of upgrade	Data integration	Operation	Integration & infrastructure	Technical compliance	Performance	Reliability & robustness	Scalability	Mobility	Modifiability & maintainability	Call center	Campaign management	Kontaktmanagement	Customer service	Field service	Internet	Lead & opportunity management	Relationship management	Reporting	Sales management

Figure 18. Category list of CRMSS criteria

For the measurement model and operationalization of the constructs from the D&M IS success model existing items from literature were utilized (see Table 6). The eight exogenous constructs representing the CRMS selection criteria were

operationalized with the help of the 33 single criteria identified from the literature review (see Figure 18).

Table 6. Items of the D&M IS success model and their operationalization

Source	Item of the D&M IS Sucess model	
ISO/IEC 9126, Nicolaou 1993, Delone and Mclean 2004	**Functionality**	**SyQ1:** The functions and features of the CRM system are highly useful to the employees in their work with the CRM system.
ISO/IEC 9126, Gorla and Lin 2010, Belardo et al. 1982, Dromney 1995, Offutt 2002, Swanson 1974, Haekkinen and Hilmola 2008, Gable and Sedera 2008	**Reliability**	**SyQ2**: The CRM system functions reliably.
ISO/IEC 9126, Molla and Licker 2001, Gorla and Lin 2010, Offutt 2002	**Usability**	**SyQ3**: The CRM system is easy to learn and use for the employees.
ISO/IEC 9126	**Efficiency**	**SyQ4**: The CRM system responds quickly
Peppers and Rogers 1997, Gable and Sedera 2008; Haekkine and Hillmola 2008	**Relevance**	**IQ1**: The CRM system provides output that seems to be exactly what is needed.
Molla and Licker 2001; Tsai et al 2003; Gable and Sedera 2008	**Understandability**	**IQ2**: Information from the CRM system is easy to understand.
Livari 2005; Haekkine and Hillmola 2008; Xu et al 2010	**Currency**	**IQ3**: Information from the CRM system is always timely.
SERVQUAL	**Reliability**	**SerQ1**: The CRM system users requests are addressed accurately and are reliable
SERVQUAL	**Responsiveness**	**SerQ2**: The request for changes regarding the CRM system are handled promptly.
SERVQUAL	**Assurance**	**SerQ3**: The IT support is knowledgable and trustworthy
Haekkinen and Hilmola 2008	**Quality of work**	**UseP1**: The CRM system is fully accepted in daily work.
Avlontis and Panagopoulos 2005	**Perceived Usefulness**	**UseP2**: The CRM system improved the quality of the daily work
Delone and Mclean 2001	**Increased sales**	**NB1**: To which extent do you know or perceive that the following areas have improved/worsened since the CRM system was implemented?
Delone and Mclean 2001	**Market share**	**NB2**: To which extent do you know or perceive that the following areas have improved/worsened since the CRM system was implemented?
Wang and Sedera 2009	**Improved responsiveness**	**NB3**: To which extent do you know or perceive that the following areas have improved/worsened since the CRM system was implemented?
Wang and Sedera 2009	**Improve service levels**	**NB4**: To which extent do you know or perceive that the following areas have improved/worsened since the CRM system was implemented?

Data was collected in a survey with 105 CRM (response rate: 10 percent, complete questionnaires: ~6 percent) experts from relevant internet portals. A PCA was conducted with IBM SPSS 19 for dimension reduction applying the Kaiser-Meyer-Olkin criterion of Eigenvalue > 1. Data analysis was conducted in a PLS-SEM with SmartPLS2. D&M IS success constructs were assumed as reflective (DeLone and McLean, 2003). The exogenous constructs were defined as

formative. The quality criteria for reflective and formative constructs are summarized in Table 7.

Table 7. Quality criteria of the reflective and formative constructs

	Construct reliability		Convergent reliability	Discriminant validity/ Fornell-Larcker criterion						VIF	Communality
Construct	α > 0,8	CR >0,7	AVE >0 ,5	SysQ	InfQ	SerQ	UseP	NetB		< 10	< 0,9
SysQ	0,84	0,89	0,68	**0,82**	*square root of AVE in diagonal				UseO	1	0,56
InfQ	0,81	0,89	0,73	0,64	**0,85**				VenQ	1	0,41
SerQ	0,86	0,91	0,78	0,60	0,66	**0,88**			ImpQ	1	0,43
UseP	0,80	0,91	0,83	0,62	0,57	0,59	**0,91**		ImpC	1	0,38
NetB	0,82	0,88	0,64	0,60	0,43	0,53	0,52	**0,80**	SysC	1	0,67
									IntC	1	0,41
									SysCh	1	0,67
									Flex	1	0,74
									Func	1	0,27

3.3.3. Discussion of results

A structured CRMSS is often neglected or significantly shortened due to existing vendor preferences or a limited budget (Friedrich et al., 2012). But results of this empirical study show that some of the CRM selection criteria have a significant impact on CRM system success. The significant relations of the structure model, their path coefficients, R^2- values of the endogenous constructs and the factor loadings of the formative latent variables are presented in Figure 19. Hypothesis H2, H4, H7, H8a-b, H9a-b, H10-13 were not rejected. Factor loadings of the measurement items of the D&M IS success model are highly significant at p<0,001. Relations between the latent variables of the D&M IS success model are significantly positive. *InfQ* is positively influenced by *Flex* (β=0,26; p<0,01). *SerQ* is positively influenced by *Flex* (β=0,2; p<0,01) and *VenQ* (β=0,27; p<0,01). *SysQ* is positively influenced by *SysCh* (β=0,26; p<0,01) and *Func* (β=0,34; p<0,01). CRM experts perceive scalability (n=43), system performance (n=39) and modifiability & maintainability (n=39) as most important. *NetB* is directly and positively influenced by *ImpC* (β=0,22; p<0,01) and *Func* (β=0,31; p<0,001). It is therefore recommendable to invest the necessary time and effort into consideration of the cost and functional criteria. Within the latter, the most important criteria are contact management (n=66), relationship management (n=45) and lead & opportunity management (n=43). Functional features can only be changed with high financial investment and significant efforts in form of human resources. This explains the direct effect on *NetB* which is also moderated by *SysQ*. Interestingly, the expected effect of *SysC, UseO, ImpQ, IntC* on the quality dimensions and NetB was rejected. *SysC* can be estimated very well and can therefore be compared

between vendors. *UseO* includes user friendliness of the system, acceptance of the users and available training material. Although the first two were attributed with high priority by the surveyed experts (n=56/46) no positive effect on *InfQ* and *SerQ* is measurable.

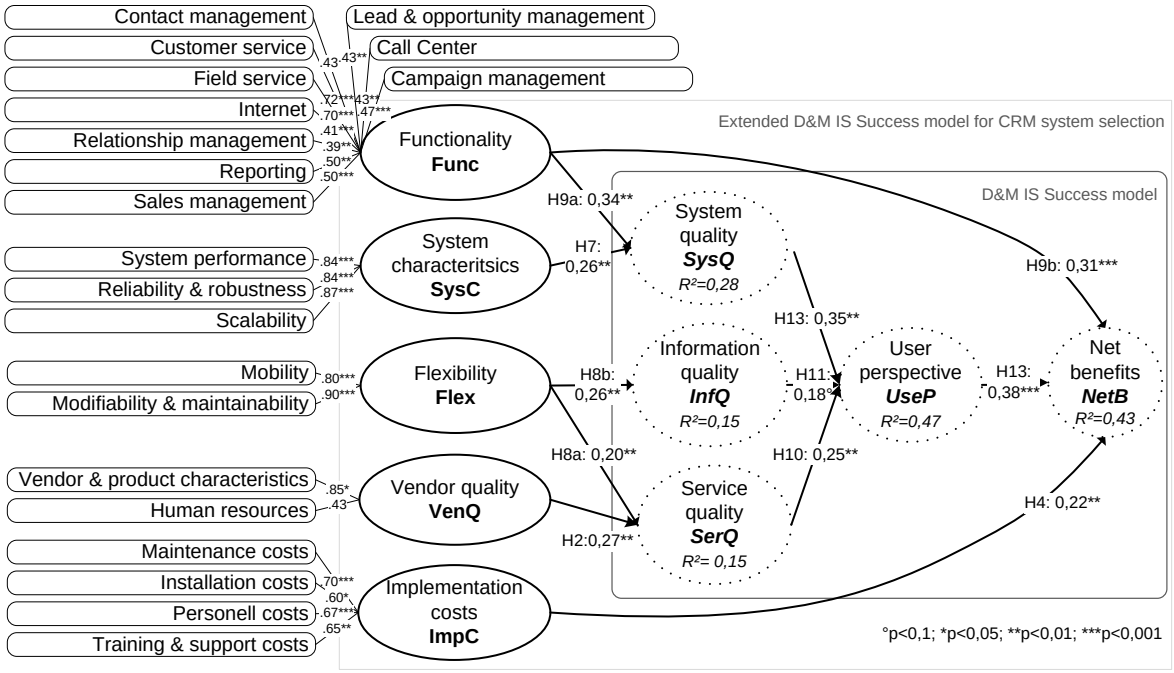


Figure 19. PLS-SEM results

These “soft” factors are often neglected (Tsai et al., 2011) or interpreted differently (Jadhav and Sonar, 2009). Although initially a certain priority level is assigned to these factors, the actual consideration of *UseO* stays behind the expectations.
As part of *ImpQ*, implementation period and security were rejected for ERP system selection by Tsai et al. (2011), too. The influence of *ImpQ* on *SysQ* and *InfQ* is not detectable as the vendor-induced implementation period is not a reliable prediction. Thus, even in case of deviation a good *SysQ* and *InfQ* can be reached.
The IT infrastructure is often not sufficiently analyzed before a CRMSS takes place (Friedrich et al, 2012). This is a possible reason for the non-significant path between *SysQ* and *IntC*.

3.3.4. Conclusions, limitations and further research

The research objective of the presented topic was to derive CRM selection criteria from literature and to test subsequently whether the criteria have causal relations within the D&M IS success model. The connection to system, service and information quality and to CRM system success represented by the latent variable net benefits was evaluated empirically. The initial research questions can be answered as follows:

A-RQ3*: Which criteria are relevant to CRM system selection?* The structured literature review revealed 33 CRM selection criteria grouped into eight sub-categories and 4 main categories (functionality, quality, cost, and technology).

A-RQ4*: How does CRM system selection affect the success of the selected CRM system?* The results of the SEM show that the D&M IS success model can be applied to the context of CRMSS. The statistical analysis results show that the five variables *Func, SysCh, VenQ,* and *ImpC* have a positive effect on at least one of the quality dimensions of the D&M IS success model or directly on *NetB.* An influence of the CRMSS on CRM success can therefore be reasoned.

Further research should incorporate the implementation phase or other possible influencing factors, such as CRM strategy, project-specific or industry-specific factors, into the structure model. Additionally, a qualitative study with CRM experts is advisable. About 30 per cent of the currently surveyed experts have expressed willingness to participate in expert interviews. During a qualitative inquiry the CRM selection criteria catalog should be challenged again to uncover further criteria or/and eliminate irrelevant ones based on expert opinion. Further, the rejected causal relations should be discussed as to be able to interpret them correctly from a practical perspective. Industry-specific extensions or adaptations should be checked.

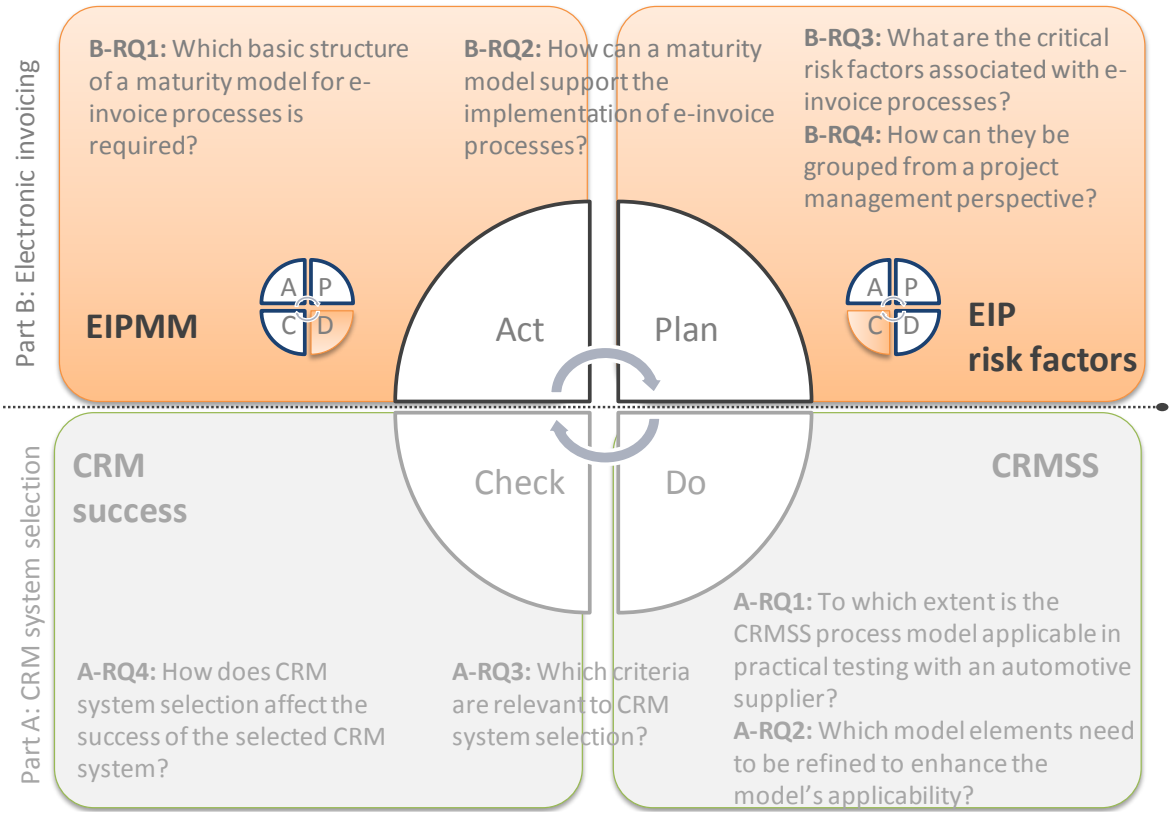
3.3.5. Classification of publication

The International Conference on Wirtschaftsinformatik (WI) is the largest conference of the German-speaking IS community with a history of 21 years.

The 11th International Conference on Wirtschaftsinformatik (WI 2013) has taken place with a total of 800 participants at the University of Leipzig between February, 27 and March 1, 2013. The program comprised 106 research presentations, four panels, five tutorials and five keynotes/invited talks. Out of the 415 submissions received for WI2013 in the eleven research tracks this yielded an acceptance rate of 25%. Proceedings of the WI are published via AIS Electronic Library of the Association for Information Systems.

The publication for the WI 2013 was written in co-authorship with Halyna Zakhariya and Prof. Michael H. Breitner.

4. PART B: Electronic invoice processes: diffusion, maturity and risk factors



4.1. Preamble

The Digital Agenda for Europe is aimed at creating “a digital single market in order to generate smart, sustainable and inclusive growth in Europe” by, among others, enhancing interoperability and standards (European Commission, 2015). An integral part of this endeavor is the “removal of the regulatory and technical barriers that prevent mass adoption of e-invoicing” (European Commission, 2010). The invoice is a core element of the European value-added taxation system (Kaliontzoglou et al., 2006) entitling pre-tax deduction based on the Council Directive 2010/457EU.

Although invoice processes usually do not create added value, the migration from paper invoices to e-invoices within the EU “will generate savings of around EUR 240 billion over a six-year period” according to the European Commission (2010). E-invoicing decreases the total cost in comparison to paper-based invoices, and improves the efficiency of business processes “through eliminating manual data entries, automatically matching purchase orders to invoices, invoice reconciliation and account assignment” (Legner and Wende 2006). Expected saving from e-invoices relate to the reduction of manual work, input errors, printing, and transport costs (Expert Group 2009; European Commission 2010; Sandberg et al. 2009). This is especially the case when e-invoices include structured data for automated processing. But in the EU, only 22 percent of SME and 42 percent of large companies exchange e-invoices (European Commission 2010). Market penetration of e-invoices in the EU is only about five percent for business-to-business (B2B) transactions (European Commission 2010). Some of the barriers to participation are manifold: lack of awareness, business strategy, and adequate IS for process optimization, as well as high investment costs, legal uncertainty, lack of standard e-invoice processes, and heterogeneous demands of the business partners (Haag et al. 2013; Legner and Wende 2006; Sandberg et al. 2009; Tanner et al. 2008). Next to these technical and organizational barriers legal concerns exist (Kreuzer et al. 2013).

Pre-tax deduction for paper and electronic invoices is legally based on the authenticity of the origin, the integrity of the content, and the legibility of the invoice from the point of creation until the end of the storage period (European Union 2010). Many solutions for e-invoice processes exist, but their functional scope, level of process integration, and technical capabilities are very diverse (Kabak and Dogac 2010; Legner and Wende 2006). From the organizational perspective, business model (direct, seller or buyer-direct or consolidator) and process-related decisions (e.g. automation level, outsourcing etc.) need to be considered. Technical considerations include, among others, transmission media (e.g. Email, EDI, service provider or portal) and data formats (EDIFACT, XML etc.). The complexity of the topic makes it difficult for companies with little know-how and/or

resources for process automation to identify their actual situation in terms of invoice processing and to evaluate opportunities and risks in this area.

The research objective to address these practical challenges was to develop a comprehensive maturity model for e-invoice processes. This qualitative study is presented in 4.2. As a specification of the research question, risk management is identified as an important discipline and is further evaluated in a quantitative study of e-invoice risk factors in section 4.3.

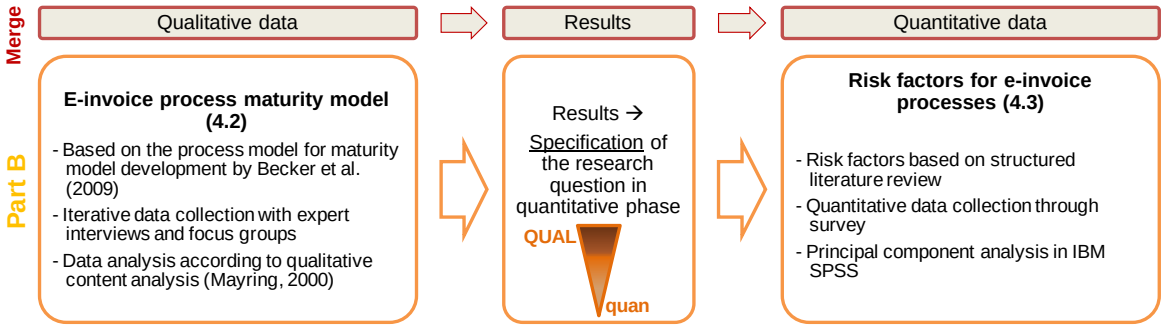


Figure 20. E-invoices research framework

4.2. Design and Discussion of a Maturity Model for Electronic Invoice Processes

This chapter is based on the research publication by Angelica Cuylen, Lubov Kosch, and Michael H. Breitner titled “Development of a Maturity Model for Electronic Invoice Processes“ which is published in the Electronic Markets Journal (see Appendix A8).

4.2.1. Introduction

Companies need tools to assess possible benefits, risks and to identify recommended activities for implementing and operating optimized and compliant e-invoice processes. Maturity models support companies to identify their as-is situation, to derive an improvement path and to control the progress of optimization (Becker et al. 2010). They evaluate and compare the maturity within a selected discipline (de Bruin et al. 2005; Mettler et al. 2010), e.g. software engineering (Paulk et al. 1993), e-business (Prananto et al. 2001), business processes (Weber et al. 2008), business process management (de Bruin et al. 2005), and knowledge management (de Bruin and Rosemann 2005). Maturity models suggest a certain number and sequence of maturity levels (de Bruin et al. 2005) and define desired characteristics, competencies and capabilities within a certain application domain (Becker et al. 2010). In the discipline of e-invoices, maturity can be defined as the level of capability to design, establish and perform e-invoice processes. A maturity model for e-invoice process is lacking that addresses the whole electronic invoice process and considers process integration issues. The research objective is to rigorously develop an EIPMM based on an acknowledged reference model. The following research questions are addressed:

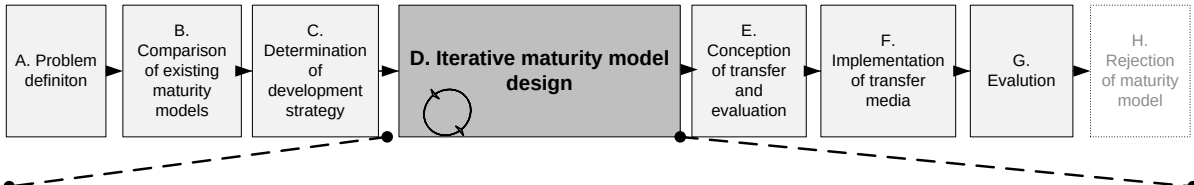
B-RQ1*: Which basic structure of a maturity model for e-invoice processes is required?*

B-RQ2*: How can a maturity model support the implementation of e-invoice processes?*

4.2.2. Research design and methodology

Figure 21 summarizes the research process completed which is based on Becker et al. (2009). The eight-stage procedure model for the development of maturity models is presented in more detail in section 2.1. The four initial stages (A-D) of the procedure model are completed. The final four stages refer to future final evaluation. The actual development takes place in the fourth phase (D) which was iterated four times so far (sub-steps D.1.-D.4.). Literature and interview analysis in iterations1, 2 and 4 was conducted with the help of qualitative content analysis as explained in section 2.2.2.In the latest EIPMM iteration 4 exploratory focus interviews were applied. Three focus groups were completed within organizations,

two in a company setting and one in a public administrations setting. Each focus group consisted of 3-4 participants since smaller focus groups require a greater participation of each member (Tremblay et al. 2010).



	Iteration 1	Iteration 2	Iteration 3	Iteration 4
D.1. Select design level	Category level of initial EIPMM	Sub-category level of initial EIPMM	Revised EIPMM	EIPMM with detailed categories
D.2. Select approach	Literature review	Expert interviews	Logical reorganisation	Focus groups
D.3. Design model section	Category list	Sub-category list	Category and sub-category list	Detail category list
D.4. Test results	Qualitative expert interviews	Internal deductive argumentation	Evaluation and enhancement with focus groups	Deductive literature review
Model structure	Maturity level: 1 through 5 Categories: 5 strategy, IS/IT and automation, internal and external acceptance, standardization, compliance	Maturity level: 0 through 4 Categories:3 strategy, acceptance, technology Sub-categories: 7	Maturity level:0 through 4 Categories: 3 strategy, acceptance, technology Sub-categories: 9	Maturity levels: 0 through 4 Categories: 4 Sub-categories: 15
Changes	–	• Maturity levels renamed to reflect the level 0 (non-existent) • Categories: all categories but *strategy* adapted • Sub-categories: *automation, technical standards, trading partner on-boarding, user acceptance, policies and legal requirements, cost-benefit analysis, responsibility and accountability*	• Sub-category *strategic alignment* added to *strategy* • Sub-category *information systems added to technology* • Sub-category *automation* in *technology* extended to *integration and automation*	• Category *processes and organization* added • Sub-categories extended significantly • Detailed categories developed
Data collection	Literature research time frame: May through July 2012 and ongoing in later iterations Search terms: e-invoice and synonyms and/or maturity model Databases: AISeL, ScienceDirect, IEEE Xplore, KIT, EBSCO, Google Scholar Selection criteria: year >1990	Interview time frame: July through September 2012 Interview length: ~50-80 min. Demographics: 7 e-invoice experts from 6 EU states: ○ 4 country information managers from CEN/ISS e-invoice gateway ○ 1 CEO of service provider ○ 1 project head from private company ○ 1 e-invoice researcher	Literature research time frame: January through July 2013 Reassesment of other related and non-related maturity models and literature update Preparation for evaluation with focus groups	Time frame: 3 focus groups á ~90 min., November 2013 through January 2014 Demographics: ***FG1:*** ○CEO in SME, >20 years experience in accounting ○team leader accounting software development for SME ○project manager, experience with maturity models ***FG2:*** ○team member development of e-invoicing solutions ○member of NGOs for e-invoicing as representative for SMEs ○e-payment, experience in NGOs for e-invoicing for large companies ***FG3:*** public administration ○head of accounting ○key user accounting ○accounting clerk ○senior financials consultant

Figure 21. Research design according to Becker et al. (2009)

4.2.3. Discussion of results

The focus of the EIPMM is the electronic invoicing and incoming invoice processing including the e-invoices and the paper-based invoices alike. To support the dispersion of e-invoices should, benefits of automated processes are presented and the companies including SME are encouraged to optimize their

invoice processes. However, each company is able to decide for themselves whether the optimization of the process is efficient for them. Consequently, the EIPMM provides a map of relevant e-invoice process issues as a basis for decision-making. The target users of the EIPMM are all stakeholders of e-invoice processes (EU Expert Group 2009).

The current EIPMM (iteration 4) includes four main categories: strategy, acceptance, processes & organization, and technology. These categories represent the critical success factors for implementation and operation of e-invoice processes. Further, the complexity of the e-invoice topic could be explained by these categories. At the current stage, each category contains sub-categories and detailed categories that are measured by five maturity levels (see Figure 22).

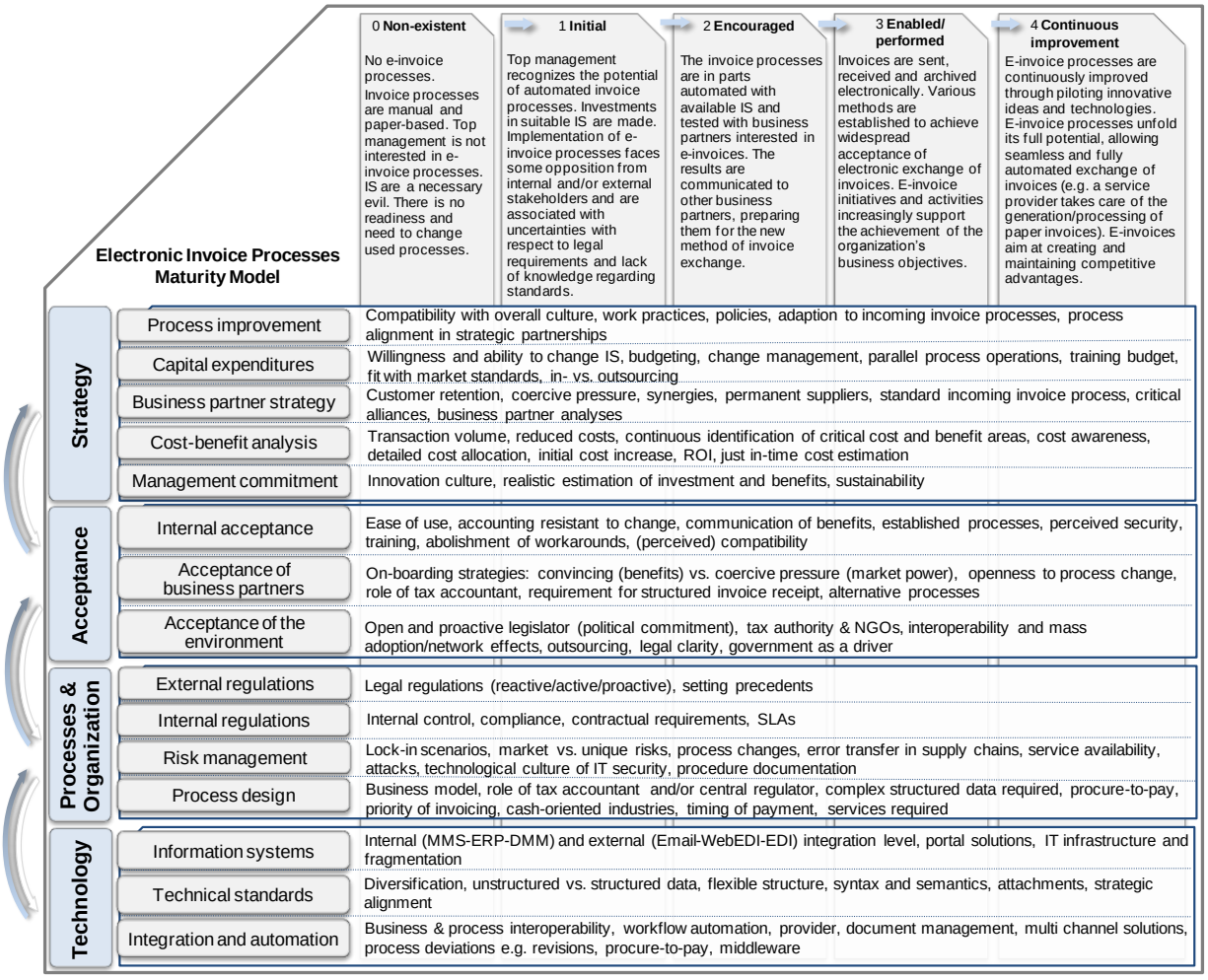


Figure 22. The current Electronic Invoice Processes Maturity Model (EIPMM)

Technology Category. The *technology* category measures the use and the progressiveness of IS during implementation and operation of invoice processes, to what degree the human interaction can be excluded, and to what extent companies apply technical standards. Some experts think of it as a key factor

because without suitable IS, companies are not able to benefit from reduced expenses. For others it is not decisive because there are sufficient service providers offering suitable solutions. The standardization effort for exchanging e-invoices with business partners is considerable. It is also difficult to manage fragmentation and integration of IS within a company. According to Kreuzer et al. (2013) technological readiness is a critical factor in the context of e-invoice processes and it also affects the adoption of e-invoice solutions.

The sub-category *information systems* assesses the IS infrastructure for e-invoice processes and determines whether the current IS are capable of transmission, receiving, and processing of e-invoices. It evaluates whether there is a system to archive documents electronically or whether there is a workflow system for electronic approval and circulation of documents within a company. Security aspects result from the invoice transmission based on “authentication and non-repudiation of origin and receipt, confidentiality and privacy” (Hernández-Ortega, 2012) and from “technological culture” (Hernández-Ortega, 2012) of a company.

The sub-category *technical standards* describes to what extent companies apply technical standards like message standards of e-invoices and standards for the transmission. Standards are essential for the exchange of business documents between companies and higher automation levels require standardized structured data (EU Expert Group 2009). This sub-category supports the identification of suitable standards for internal decisions, as well as for the discussion with business partners.

The sub-category *integration and automation* measures the level of automated exchange and processing of e-invoices and describes the cross-linking to other processes. According to the experts, the whole procure-to-pay cycle should be considered.

Direct processing of invoice data in payment and accounting systems is the objective of the receiving party (Cuylen et al. 2013; Kivijäri et al. 2012). There are different maturity steps for processing e-invoices, starting with manual processing, moving through IS support for capturing invoice data from PDF invoices, and ending with full automation.

Processes & Organization Category. The category *processes & organization* assesses to what extent regulations ensuring e-invoices processes have been adopted and defined, risks considered, and processes designed. Methods and instruments to facilitate the integration of business partners and roles to enable the exchange and processing of invoices need to be defined (EU Expert Group 2009).

The sub-category *external regulations* deals with legal implications of invoices and the fact that the legal uncertainty appears to be one of the major barriers for implementation of e-invoice processes (EU Expert Group 2009). The lowest maturity levels represent companies with a reactive position according to external

regulations. SME are either not aware of legal issues or they are unsure about the interpretation of laws. They confirm with the laws and expect more precisely formulated laws. At the middle maturity levels are the companies that have an active position with regard to external regulations. These companies maintain the laws and document their processes. The highest maturity levels represent proactive companies that make use of the legal scope. Depending on the company's business relations, international laws and different external regulations must also be considered (Keifer 2011).

The sub-category *internal regulations* implies responsibility and accountability to all relevant stakeholders, compliance and policies of the company. The processes and the division of tasks with service providers such as tax consultants or solution providers are determined. Service level agreements are concluded and determined (EU Expert Group 2009). Companies have to reduce risks and maximize chances (Kivijäri et al. 2012), therefore the sub-category *risk management* assesses to what extent the lock-in effects, the effects of integration, and other risks are considered. Market risks include the lock-in with a service provider (creating switching costs) (Penttinen et. al 2008). Unique risks result from technical complexity of e-invoice processes (Kivijäri et al. 2012) or the question of reliability of transmission

The sub-category *process design* assesses the level of support and the quality of basic processes of the whole purchase-to-pay cycle. There are companies that have no payment process because all their invoices are paid by debit credit. Others write no invoices because all their customers pay in cash. Another important aspect in the organization of internal processes is the absence of parallel processes. The relationships with business partners including the organizational integration of service providers and tax consultants are considered. A company can have different service providers for incoming and outgoing invoices (Kivijäri et al. 2012). Some a central regulator is employed. Up to now, the supplier sends a paper invoice to the customer and header and footer invoice data in EDIFACT to the central regulator. Kivijäri et al. (2012) separate short-term contracting relationships from collaborative long-term partnerships.

Acceptance Category. The *acceptance* category measures to what extent the e-invoice processes have been accepted by internal stakeholders and by business partners, as well as how mature the environment is according to e-invoice processes. The sub-category *internal acceptance* refers to being aware of the benefits and using electronic documents for document exchange within the company, as well as understanding the complexity of the topic. Sales managers are able to promote the electronic exchange of invoices to the customers. But they are also aware of expenses and costs for implementing e-invoice processes since not for all companies initial benefits can be expected from e-invoices. But

companies could consider that the benefits of e-invoices processes are not derived from the first use but from continuous use because companies that habitually use e-invoices perceive efficiency, security and trust more often (Hernandez-Ortega and Jimenez-Martinez 2012).

The *acceptance by the business partner* is required by law and cannot be expected as given (Haag et al. 2013). This sub-category assesses the willingness for exchanging e-invoices by the company's business partners including the acceptance by their tax consultants, sponsors of public organizations or other service providers.

The sub-category *acceptance of the environment* examines whether the environment of a company fulfills the requirements for e-invoicing, meaning the expectations of the companies towards legal regulations. Legal requirements need to be easy to understand and clearly formulated so that no interpretation is necessary (Cuylen et al. 2013, EU Expert Group 2009). The maturity of the environment depends on the level of mass adoption, and the commitment and behavior of the government and the public administrations. The critical mass of e-invoice adopters is essential because the absence of potential exchange partners impairs the adoption and results in higher costs (Haag et al. 2013).

Strategy Category. The s*trategy* category assesses the business IT alignment of the e-invoice issues and describes strategic implementation decisions for e-invoice processes. It is essential for the management to have a clear direction and be willing to use e-invoices.

The sub-category *process improvement* deals with process alignment in strategic relationships, compliance with the overall strategy, the culture of the organization, and internal policies. The invoice processes are more efficient when the invoice data is in a structured electronic format (Kivijäri et al. 2012; Legner and Wende 2006) and when it is compatible with the companies' business processes, policies, and culture (Hernández-Ortega 2012).

In the context of *capital expenditure management* companies must determine the profitability of the investment in e-invoice processes. Decision processes for investments have to be examined. Companies usually have to decide between an in-house solution and outsourcing. A one-to-one connection with a business partner already causes significant process changes (Kivijäri et al. 2012).

The sub-category *business partner strategy* addresses alignment with strategic decision making on partnerships. In a persuasion strategy business partners are argumentatively convinced to participate. The EIPMM could support the discussion with a partner whether an e-invoice process might be more cost-saving. Through the company's market power a more pressure-oriented strategy is applied.

The sub-category *cost-benefit analysis* assesses the company's cost awareness. E-invoice processes cause monetary costs, e.g. implementation and operation

costs and intangible costs, e.g. losing a customer. Some companies have no benefits from e-invoice processes because the number of exchanged invoices is too small so that implementation, operation and maintenance costs are not compensated (Penttinen et al. 2009; Haag et al. 2013).

The sub-category of strategy *management commitment* assesses the involvement of top management and to what extent the top management has an innovative culture. Top management needs instruments to evaluate the potential benefits of e-invoice processes and to identify the real costs, so that relevant investments are not overestimated (Haag et al. 2013).

4.2.4. Conclusions, limitations and further research

Maturity models support companies to identify strengths and weaknesses of a specific domain, and to develop and improve this domain. The research questions can be answered as follows:

B-RQ1*: Which basic structure of a maturity model for e-invoice processes is required?* The maturity of e-invoice processes is evaluated by the categories technology, processes & organization, acceptance, and strategy. Each category has sub-categories that are evaluated by five maturity levels. These categories of the EIPMM are critical success factors for the implementation and operation of e-invoice processes. They also represent a systematic process for decision making. Although strategy is the basis for decisions and change management, in the discussion with business partners it can be easier to start discussions with the actual situation based on technology used and established processes.

B-RQ2*: How can a maturity model support the implementation of e-invoice processes?* All experts confirmed the usefulness of such a model. They highlighted that it is a suitable tool for management and research to understand the complexity and the different possibilities for e-invoice processes. The EIPMM serves as a framework of terms and issues that have to be considered and shows that the e-invoice participation is a process with different levels of integration and automation. Not all companies benefit from having fully automated invoice processing. There are various stages of process integration, depending on the invoice type. The benefits for a company depend on the starting point of maturity and the planned level of maturity. Invoice processing is a complex process with a lot of stakeholders and critical success factors to be considered.

The research is limited by the small number of experts interviewed. But, due to their representativeness, the survey has revealed that a maturity model for e-invoice processes is useful and worthwhile to pursuit. Further empirical evaluation is necessary to perform the next iterations. Being a model, it is possible that the reality is oversimplified and that “the potential existence of multiple equally advantageous paths” are neglected (Pöppelbuß and Röglinger 2011). Therefore

maturity models focus on factors for development and improvement (Pöppelbuß and Röglinger 2011) and demonstrate the characteristics for deploying high-performance processes (Hammer 2007). A number of critical success factors influence the widespread dispersion of e-invoices. The maturity of e-invoices processes is only one of them. So, the EIPMM is not the solution for the widespread diffusion of e-invoices, which is the aim of the EU commission (European Commission 2010).

Further research shall determine descriptions, metrics and maturity levels for each sub-category. The objective of each sub-category shall be provided, together with the possibility of better determining the company's status quo. Best practices and practicable examples shall be presented to explain the maturity levels of each sub-category and how the metrics might be applied. The EIPMM should be evaluated against achievements of the previously defined objectives (Becker et al. 2009). Further research will conduct detailed interviews of experts of the different target groups.

4.2.5. Classification of publication

The research paper "Development of a Maturity Model for Electronic Invoice Processes" by Angelica Cuylen, Lubov Kosch, and Michael H. Breitner (2015) was first submitted to Electronic Markets (EM) journal on May 23rd, 2014. The paper was accepted for publication on October 1st, 2015 after five revisions.

EM is a quarterly, scholarly journal edited at the University of St.Gallen, Switzerland and the Leipzig University, Germany. Published by Springer, EM has emerged as one of the premier journals in the area of electronic and networked business (http://www.electronicmarkets.org/). EM welcomes research on diverse aspects of networked business with quantitative and qualitative methods.

The EM journal is assigned the ranking "A" of the WKWI and GI-FB WI (Wissenschaftliche Kommission Wirtschaftsinformatik im Verband der Hochschullehrer für Betriebswirtschaftslehre e.V., 2008). The rating in VHB-JOURQUAL3 by Henning-Thurau, T. & Sattler, H., (VHB-JOURQUAL3, 2015) is "B".

4.3. Empirical analysis and discussion of risk factors for electronic invoice processes

This chapter is based on the research publication by Angelica Cuylen, Lubov Kosch, and Michael H. Breitner titled “Why are Electronic Invoice Processes Risky? - Empirical Analysis and Discussion of Risk Factors“ which is published in the proceedings of the European Conference on Information Systems 2015 (see Appendix A7).

4.3.1. Introduction

Next to agreements and standards for automated invoice exchange, the European Commission (2010) is also calling for risk management. With the lack of interoperable e-invoice solutions, there is a risk that companies need to invest in a number of solutions, causing unnecessary expenses (European Commission 2010). Another risk is being dependent on a service provider that generated switching costs by customizing the service being used (Penttinen et al. 2008). According to Hernández-Ortega (2012), companies “with a strong fear of the unknown will perceive less risk if they consider that e-invoicing is compatible with their business activities”. However, each company faces uncertainty and has to decide how much uncertainty they are willing to accept. In order to improve their efficiency and provide competitive advantages, companies need to be aware of potential opportunities and risks of e-invoice processes before they decide to change both their business processes and their IS architecture.

All risk definitions have in common that “risk is concerned with the probability that something unfavorable will occur mostly followed by a loss” (Rommel and Gutierrez, 2012). Risk management combines risk assessment and risk control techniques (Boehm, 1991). The assessment of risks is a pivotal process of risk management (Ghadge et al. 2013) and it covers risk identification, risk analysis, and risk evaluation (Boehm 1991; Coyle and Conboy 2009). The identification of risks is the initial step of efficient risk management (Ghadge et al. 2013). This step produces a list of risks that have a negative impact on the companies’ outcome. Then, the risk analysis “assesses the loss-probability and loss magnitude for each identified risk item, and it assesses compound risks in risk-item interactions” (Boehm 1991). The probability of risks measures the likelihood that an uncertain event will occur (Coyle and Conboy 2009). The consequences of risk can be described trough a qualitative (terms like ‘low’ and ‘high’) or a quantitative (e.g., monetary units) analysis (Coyle and Conboy 2009). The risks items are prioritized (Boehm 1991) and evaluated (Coyle and Conboy 2009) in order to decide which risks must be avoided and which risks can be accepted (Rommel and Gutierrez 2012). The risks of e-invoice processes can be described as uncertain events that can have a negative impact on the business processes and on compliance with

legal regulations. The exchange of e-invoices among organizations is still low (European Commission 2010). Some companies are afraid of losing their right to take pre-tax deduction and still insist on paper-based invoices (Haag et al. 2013). In addition, companies are concerned about security issues such as the authenticity and integrity of invoices (Haag et al. 2013). Other risks for companies are technological in nature or from lock-in effects when the change of a standard used or of a service provider is associated with unbearable costs (Gómez-Pérez et al. 2012). Prior research on e-invoice processes does not specifically focus risk factors but mostly concentrates on the identification of success factors, drivers and barriers affecting the diffusion of the exchange of invoices (e.g. Arendsen and Wijngaert 2011; Kreuzer et al. 2013; Penttinen and Hyytiänen 2008). The risk factors are developed in this paper based on barriers, critical success factors or challenges mentioned by the analyzed research papers on e-invoice processes. The following research questions are addressed:

B- RQ3: *What are the critical risk factors associated with e-invoice processes?*
B-RQ4: *How can they be grouped from a project management perspective?*

4.3.2. Research design and methodology

A structured literature review based on scientific papers that are written in English and German was conducted. A total of 75 published papers were analyzed, applying qualitative content analysis (see section 2.2.2.). Barriers, critical success factors, and challenges mentioned in 27 of these papers were extracted to 215 text passages. These passages were then categorized inductively and the suitability of the content for identifying risks was checked. The authors identified 48 potential risk factors for e-invoice processes. The result is presented in Table 8. In order to confirm, analyze, and explore critical risk factors of e-invoice processes in a standardized approach with a large population of experts, the survey methodology is applied (Groves et al. 2011). A web-based survey that focused on experts with comprehensive knowledge of e-invoice processes was conducted. In the survey, the experts assessed the probability of occurrence and the risk value (potential loss) based on their subjective experience (Coyle and Conboy 2009) using a 5-point Likert scale from 1 (very low) to 5 (very high). After a pre-test, the questionnaire addressed 48 potential risk factors roughly grouped into the dimensions “strategy”, “process” and “technology”. The survey consisted of five main sections with a total of 21 questions. The questionnaire can be accessed at http://www.iwi.uni-hannover.de/survey0.html.

Table 8. Concept-centric Categorization of Risk Factors from Literature Review based on Webster and Watson (2002)

Risk dimension	Risk Factor	Angeles and Nath 2007	Arendsen and Wijngaert 2011	Beck et al. 2002	Edelmann and Sintonen 2006	EU Expert Group on e-Invoicing 2009	European Commission 2010	European Union 2010	Fairchild 2004	Gómez-Pérez et al. 2012	Haag et al. 2013	Haq 2007	Hernández-Ortega 2012	Hernandez-Ortega and Jimenez-Martinez 2012	Kabak and Dogac 2010	Kelfer 2011	Kivijärvi et al. 2012	Kreuzer et al. 2013	Legner and Wende 2006	Lumiaho and Rämänen 2011	Netter and Pernul 2009	Netter et al. 2010	Penttinen and Hyytiänen 2008	Penttinen and Tuunainen 2011	Penttinen et al. 2008	Salmony and Harald 2010	Sandberg et al. 2009	Tanner et al. 2008
Strategy	Disruption or contravention due to legal ignorance					x	x				x																	
	Disruption or contravention due to different international legal regulations										x					x		x	x						x			
	Not acting in accordance to law due to a lack of knowledge within the company										x																x	x
	Master data which is relevant for invoices is lacking quality																											x
	Lack of knowledge of additional costs (implementation, operation,...)	x	x		x					x									x					x			x	x
	Dependency upon customer																							x			x	
Process organisation	Too few business partner are using electronic invoices				x				x		x									x								
	Lack of willingness by suppliers to change process																x		x									x
	Additional expenses due to parallel invoice processes (entry of invoice data in web portals, paper-based and electronic invoices,...)											x								x								
System	Electronic archive is lacking or is not conforming with the law																				x							
	Lack of adequate information systems within the company (slow internet	x									x													x	x			x
	Sunk costs (e.g. printing of electronic invoices, operating parallel processes,...)	x									x									x								
	Error proneness due to lack of experience of service provider																x											
	Lack of functionality in service offers	x																	x									
Standard	Adoption of too many standards						x																				x	x
	Use of different service offers due to lack of interoperability of service systems (web portals,...)															x							x			x		
	Use of parallel systems due to lack of interoperability of information systems	x				x	x			x								x	x						x			x
	Dependency upon used standard																								x			
	Selection of a standard that is not future-proof	x					x				x								x							x		
Security	Loss of invoice (spam filter, errors in archiving...)										x		x	x														
	External threat to invoice (spying out of content, deletion of invoice file, falsified sender or receiver...)																				x	x						
	Lack of data integrity in invoice processes (falsified data)										x		x	x							x							
	Lack of readability in invoice processes (visual representation of invoice)							x																				
Environment	Reputation loss due to non-adaption of electronic invoices																							x				
	Not exploiting competitive advantage due to non-adaption of electronic				x										x	x											x	
	Adaption due to external pressure of business partners or government																	x										
Process execution	Error proneness of financial accounting					x																		x				
	Error proneness of the control procedure of the payment process					x																						
	Error proneness of the control procedure of the inbound invoice process					x																						
	Incomplete adaption of the business processes										x									x								
Acceptance	Lack of acceptance by top management										x														x		x	
	Lack of willingness for internal and external process changes inside the										x		x						x							x		
	Lack of acceptance of new processes by staff	x									x							x										
Change management	More difficult cash payment process																							x				
	Irreversibility of process changes				x																							
Project management	Lack of comprehensive process and IT know-how of consultant	x																										x
	Lack of strategic planning																										x	
*Risk Factors excluded after principal component analysis	*Lack of acceptance regarding electronic invoices by tax authorities		x																									
	*Lack of process ownership and responsibility																					x	x					
	*More difficult error tracing due to process complexity																							x				
	*Underestimated adaption costs (process, information systems,...)			x							x																	
	*Dependency on service provider (system, standard, network of																		x				x					
	*Dependency on supplier									x														x				
	*Expected benefits are missing or are not measurable				x						x		x															x
	*Lack of willingness of customers to change process					x																						
	*Selection of a inadequate information system										x								x									x
	*Too low transaction volumes result in higher costs			x							x															x	x	
	*Lack of adaptability of used information system									x																x		

*Risk Factors excluded after principal component analysis

In total, 282 experts were approached due to the specific profile of the target group. For the German survey, 102 responses were received and for the English survey 22 responses were received. The assessment of risk probability was answered by 106 experts (38% return rate). The assessment of risk value was answered by 88 experts (31% return rate). The relatively high quit rate resulted from a long questionnaire. A PCA with VARIMAX rotation was conducted in IBM SPSS 21 to reduce the dimensions of the risk factors. The measure of adequacy (MSA) values of the suggested risk factors were above 0.6 for all factors except for one. This factor was excluded from further analysis. The sample is adequate and valid in terms of the factor analysis (KMO=0.811). The Bartlett's test of sphericity is

significant. Applying the criteria of Eigenvalue greater than one and coefficient value greater than 0.5, the initial was reduced to 37 risk factors in ten dimensions (Table 8 and Table 9). The rotated factor loading of the included risk factors based on the measurements for risk probability are presented in Table 9. The values explain at least 50 percent of the variance of the associated item. The cut-off is chosen slightly higher than the usual (0.3 or 0.4) in order to improve interpretation. The solution with ten resulting risk dimensions achieves a good fit by reaching approx. 70 percent of total variance explained. Since the last two risk dimensions "change management" and "project management" have low values of α (0.539 and 0.511). The low internal consistency associated with low α can still be accepted in this case as both risk dimensions represent a set of multiple topics. Acknowledging that both dimensions contain of merely two factors, more factors can be included in future research.

4.3.3. Discussion of results

The resulting risk factors and the risk dimensions are shown in Table 9.

Table 9. Risk Dimensions and Factors – Rotated Factor Loadings and Descriptive Statistics

Reliability-Cronbach's Alpha	One-way ANOVA mean	Risk Dimension	Included Risk Factor	Rotated Factor Loadings	Risk Probability		Risk Value		One-way ANOVA mean
					Mean	SD	Mean	SD	
0.838	2.738	**Strategy**	Disruption or contravention due to legal ignorance	.713	2.604	1.084	2.563	1.097	2.738
			Disruption or contravention due to different international legal regulations	.637	2.848	1.026	2.721	1.081	
			Not acting in accordance to law due to a lack of knowledge within the company	.633	2.654	.993	2.655	1.066	
			Master data that is relevant for invoices is lacking quality	.558	2.733	1.059	2.724	1.117	
			Lack of knowledge of additional costs (implementation, operation,...)	.544	2.865	1.053	2.828	.955	
			Dependency on customer	.521	2.781	1.028	2.759	.976	
0.752	3.079	**Process Organization**	Too few business partner are using electronic invoices	.805	3.198	1.125	3.080	1.059	3.079
			Lack of willingness by suppliers to change process	.742	3.057	.984	3.011	1.006	
			Additional expenses due to parallel invoice processes (entry of invoice data in web portals, paper-based and electronic invoices,...)	.601	2.981	1.215	2.908	1.007	
0.836	2.614	**System**	Electronic archive is lacking or is not legally compliant	.691	2.781	1.209	2.977	1.198	2.614
			Lack of adequate information systems within the company (slow internet connection, software solutions do not suit electronic invoices,...)	.598	2.566	1.121	2.402	1.005	
			Sunk costs (e.g. printing of electronic invoices, operating parallel processes,...)	.566	2.705	1.055	2.709	1.016	
			Error proneness due to lack of experience of service provider	.542	2.467	1.029	2.558	1.001	
			Lack of functionality in service offers	.534	2.538	.968	2.494	1.031	
0.853	2.835	**Standard**	Adoption of too many standards	.737	2.868	1.155	2.647	1.088	2.835
			Use of different service offers due to lack of interoperability of service systems (web portals,...)	.635	3.125	1.146	2.871	1.044	
			Use of parallel systems due to lack of interoperability of information systems	.629	2.875	1.077	2.885	1.028	
			Dependency on standard being used	.542	2.781	.980	2.694	1.012	
			Selection of a standard that is not future-proof	.524	2.575	1.014	2.698	1.085	
0.778	2.250	**Security**	Loss of invoice (spam filter, errors in archiving...)	.818	2.226	1.035	2.345	1.055	2.250
			External threat to invoice (spying out of content, deletion of invoice file, falsified sender or receiver...)	.741	2.094	.921	2.345	1.087	
			Lack of data integrity in invoice processes (falsified data)	.642	2.133	.889	2.483	1.109	
			Lack of readability in invoice processes (visual representation of invoice)	.517	2.115	1.008	2.161	.951	
0.774	2.833	**Environment**	Reputation loss due to non-adaption of electronic invoices	.805	2.743	1.092	2.644	1.000	2.833
			Not exploiting competitive advantage due to non-adoption of electronic invoices	.785	2.876	1.053	2.713	.939	
			Adoption due to external pressure from business partners or government	.726	2.885	1.036	2.871	.910	
0.810	2.296	**Process Execution**	Error proneness of financial accounting	.814	1.991	.834	2.198	.892	2.296
			Error proneness of the control procedure of the payment process	.671	2.067	.862	2.310	.968	
			Error proneness of the control procedure of the inbound invoice process	.655	2.264	.939	2.287	.875	
			Incomplete adoption of the business processes	.620	2.857	.945	2.802	.905	
0.772	2.615	**Acceptance**	Lack of acceptance by top management	.802	2.619	1.095	2.655	1.098	2.615
			Lack of willingness for internal and external process changes inside the company	.558	3.198	1.099	3.035	.951	
			Lack of acceptance of new processes by staff	.545	2.802	1.018	2.793	1.058	
0.539	2.123	**Change Management**	More difficult cash payment process	.781	1.971	.955	2.128	.968	2.123
			Irreversibility of process changes	.526	2.283	.778	2.400	.928	
0.511	2.755	**Project Management**	Lack of comprehensive process and IT know-how of consultant	.626	2.613	1.065	2.701	.990	2.755
			Lack of strategic planning	.533	2.896	1.112	2.897	1.012	

The results of the ANOVA for risk probability values revealed that the risk dimension *process organization* ranks highest. This dimension includes the usage rate of e-invoices by business partners, the suppliers' willingness to change processes and the necessity for parallel invoice processes. The first two risk factors represent issues that are difficult to control or influence. A large percentage of companies claim that business partners are not ready to adopt electronic invoices (Haq 2007, Lumiaho and Rämänen, 2011). This often results in reluctance to implement e-invoicing or at least results in parallel processing of paper and electronic invoices. The higher operational costs can well explain the high perceived riskiness of these factors. The risk dimension *standard* is ranked second on the risk probability scale. The experts perceive issues regarding selecting the "right" standard and a lack of interoperability of IS as potentially significant threats to e-invoice processes. The necessity to support multiple standards and the associated efforts in adequate mapping of transmitted message content triggers the experts risk perception (European Commission 2010). The lock-in effects can be another reason to consider this dimension to be high risk, as the transition from one standard to another can be difficult and costly (Penttinen and Hyytainen 2008). Standard selection is an important and complex project, as the risk of choosing a standard that is not future-proof is relatively high. The risk dimension *environment* deals with external pressure facing companies that affects their reputation or the achievement of competitive advantages through e-invoice processes. Without a strategic approach to e-invoice adoption, companies risk being left behind while competitors make progress in their operative processes (Keifer, 2011). The risk dimension *project management* includes risks that concern the lack of strategic, process and technological know-how of the project manager and consultant. However, the statistical reliability of this risk dimension is rather poor (α=0.511). Because this dimension comprises only two risk factors, it can be concluded that further aspects are lacking to complete it. However, the factor analysis identified this risk dimension as being statistically significant, and due to the high mean values this dimension was not removed. The risk dimension *strategy* combines all risks that relate to both legal and strategic questions and to the detailed process cost analysis. Management must decide which procedures are adopted to ensure compliant e-invoice processes on a national and international level (Kreuzer et al., 2013). They determine whether the laws are maintained strictly or whether the legal scope is fully utilized. Master data quality is another risk factor stemming from underestimated strategic importance (Tanner et al. 2008). The relationship with regular customers needs to be analyzed to uncover dependencies (Sandberg et al., 2009). The risk dimension *acceptance* deals with the willingness toward internal and external process change within a company. That includes involvement of both top management and staff. Sandberg

et al. (2009) argues that innovativeness and risk appetite are strongly correlated when it comes to e-invoice adoption. The risk dimension *system* is another technological aspect. This dimension includes risk factors that concern IS within the company, the established range of services and technological processes with service providers. Further, risks related to the unexpected costs of poor performing IS and technological processes are also included in this dimension. Often adoption costs cannot be precisely estimated as paper-based and electronic processes are run parallel (Lumiaho and Rämänen, 2011). Not being able to add attachments to e-invoices is an example of an inadequate IS (Penttinen et al., 2008). The risk dimension *process execution* combines all risk factors that relate directly to the execution of the e-invoice processes such as financial accounting, the payment process and the inbound invoice process. The major risks arise from the receivers' systems and their internal control procedures (EU Expert Group on e-Invoicing 2009). Larger companies perceive fewer risks as they better understand the impact of invoicing to the process of e-procurement (Haag et al. 2013). Additionally, respondents argued that only deeply integrated and automated e-invoice processes are superior to paper-based processes in term of risk. The risk dimension *security* is remarkably not perceived as being very risky by the respondents. Security related risks are not rated as high by the experts. However, technical manipulations to e-invoices cannot be detected as easy by the responsible accounting personnel. Insecure transmission channels, such as the internet, may make e-invoice processes vulnerable if no countermeasures are implemented (Netter et al., 2009). Risks include the possibility of loss, the threat of external criminal attack, and the lack of data integrity and readability. Currently, success of e-invoice processes does not fully depend on compliance, but on an adequate level of process integration. The risk dimension *change management* includes risk factors that relate directly to process changes. The irreversibility of investments (Edelmann and Sintonen, 2011) and the difficult transition for cash payment processes (Penttinen and Tuunainen, 2011) are two examples. However, the statistical reliability of this risk dimension is rather poor as measured by Cronbach's Alpha and it includes only two risk factors. As change management is a multifaceted discipline, internal consistency cannot be expected in this risk dimension. But, further risk factors can be included which will increase the reliability of this dimension. This dimension is identified as statistically significant by the factor analysis.

Due to its commercial and legal impact, the invoice is a pivotal document with strategic and operational consequences for companies. The most obvious risks are the legal consequences. But the study revealed that process organization risks are considered to be the highest. Companies are recommended to prove and determine their internal and external processes. For example, they are supposed

to analyze how many of the business partners already use e-invoice processes and whether the supported processes align to their internal processes. Despite the obvious benefits of e-invoice processes, business partners must often be convinced to participate. In order to persuade and support the business partners, companies must be conscious of potential risk factors of e-invoice processes.
Companies have to decide whether they accept parallel processing of paper and electronic invoices. It is recommended that they try to handle paper and electronic invoices similarly as soon as possible in their processing by converting into a single standard at an earliest possible process step. This includes the determination of responsibilities. Not only companies but also politicians, organizations, committees and other stakeholder in a leading position need to be aware of risks and opportunities of the different solutions of e-invoicing. It is recommended that they support companies in their decision to implement and use e-invoice processes. Providing best practices of established e-invoice solutions can also be helpful. In this context, both the risks and the opportunities need to be compared with each other. Recommendations for business are to be presented. Tax authorities are supposed to provide reliable suggestions for the procedure documentation, so that all participants understand it and are assured to act compliant with law. Selection, implementation, and use of standards, as well as external pressure are regarded as topics of high risk. In order to not to lose a business partner, companies are forced not only to implement e-invoice processes, but also to use a specific standard. As many standards exist for data structure and transmission, companies have to implement multiple standards simultaneously. Although they can outsource to a service provider, there are other risks and questions to be considered. In order to measure the benefits of e-invoice processes, companies are recommended to perform process cost analysis. This is not only important for process optimization and redesign but also to involve top management. Risk assessment is a continuous process. New technologies, laws and other business environment change the situation so that identification of new risks and a reassessment of existing risk factors are necessary.

4.3.4. Conclusions, limitations and further research

B- RQ3: *What are the critical risk factors associated with e-invoice processes?*
Based on a literature review the potential risk factors of e-invoice processes were identified and assessed empirically in an online survey. The statistical analysis revealed that 37 risk factors are valid and reliable.
B-RQ4: *How can they be grouped from a project management perspective?*
The risk factors were grouped into ten dimensions by factor analysis. The analysis with the one-way ANOVA prioritized the ten dimensions: process organization, standard, environment, project management, strategy, acceptance, system,

process execution, security, and change management. At this preliminary stage of research, the focus is solely on the identification of critical risk factors and on an appropriate risk assessment method.

The research is limited by a small sample size. Due to the unknown population and their distribution the sampling error cannot be estimated (Groves et al., 2011) and thus generalizability of this research is limited. The community's interest is reflected by the high response rate to the survey. Most interviewees are from German-speaking countries. Since about a third of respondents are from large companies, the international perspective is reflected in their responses.

This research concentrates on a specific set of risk factors identified in prior theoretical and practical studies on e-invoicing with an European focus. Although the variance explained by the PCA indicated a good fit with the underlying data set further risk factors need to be identified to complete the picture. In this context of the EIPMM, case studies with companies can be suitable for assessing and evaluating the critical risk factors and applying them to real data and values. That is supported by the fact that, although the selection of the interviewees was mainly focused on experts for e-invoice processes, not all experts were able to answer questions of the assessment of the risk value and quit at this point the survey. This is also reflected in the narrow corridor of mean value for risk and value between 2 and 3 as shown in Table 9.

Future research should further investigate critical risk factors of e-invoice processes in different countries, in order to make a cross-border comparison and to identify intercultural and national differences. It is recommended that this expansion of the survey supports also the analysis of dependencies on company sizes and industries. Various risk factors affect the success of IS projects mentioned in literature (see Rommel and Gutierrez, 2012). These findings can be applied to the implementation of an e-invoice solution. It is necessary to undertake more empirical research to confirm and expand these results and put the assessment in concrete terms such as case studies can reveal. Recommendations to control, to handle and to mitigate also risks need to be developed.

4.3.5. Classification of publication

The research paper "Why are Electronic Invoice Processes Risky?-Empirical Analysis and Discussion of Risk Factors" by Cuylen, A., Kosch, L., and Breitner, M.H. (2015) was accepted in a double-blind peer review process and accepted for presentation without revision at the European Conference on Information Systems (ECIS).

The ECIS was first established in 1993 and has been held annually ever since to welcome both, European and non-European researchers. It is the largest and

most prestigious European conference on IS and is also an affiliated conference of the Association for Information Systems (AIS). The acceptance rates of the ECIS have decreased steadily over the years and are roughly about 30 percent each year. The ECIS 2015 acceptance rate for full research papers was 31 percent.
The research paper was published in the proceedings of the 23rd ECIS online at AIS Electronic Library (AISeL), http://aisel.aisnet.org/ecis/. The conference proceedings are assigned the ranking “A” of the WKWI and GI-FB WI (Wissenschaftliche Kommission Wirtschaftsinformatik im Verband der Hochschullehrer für Betriebswirtschaftslehre e.V., 2008). The rating in VHB-JOURQUAL3 by Henning-Thurau, T. & Sattler, H., (VHB-JOURQUAL3, 2015) is “B”.

5. Critical Appraisal, Limitations and Future Research

5.1. Contributions to research and practice

This chapter summarizes the overall contribution of the conducted research and the limitations associated with it. All four presented research papers were accepted for publication in acknowledged scientific outlets after passing the peer review process with three or more anonymous reviewers. The two papers presented in chapter 3 were accepted after revision. The paper presented in section 4.3 was accepted as-is without revision. And the paper presented in section 4.2 is currently conditionally accepted in the third revision. The scientific peer review process is a necessary but not a sufficient quality indicator. It has been continuously criticized in terms of its reliability and possible bias through prejudice, competitive effects, and argumentation in favor of colleagues (Neidhardt, 2010). Laudel (2006) calls the peer review process as “idiosyncratic, shaped by personal interests and power constellations”. Nevertheless, it can be assumed that peer-reviewed publications adhere to specific quality measures imposed by the organizing committee of a conference or by a journal’s editor in chief (Laudel, 2006). It is acceptable to value the research quality of peer-reviewed publications in terms of relevance, adequate research method and logical argumentation. But, critical appraisal and discussion of results and their limitation is an important internal process to further one’s own research.

The presented thesis recapitulates four selected research publications from two distinct research areas, namely CRM system selection criteria, process, and IS success, and electronic invoice process maturity and risk. The topics share a mutual research design based on the merger of results from a model-based qualitative study with survey-based quantitative results. Applying this approach it was possible to uncover aspects in exploratory research which could be further examined with the help of quantitative methods.

In the research area on CRMSS the following research questions were addressed:

A-RQ1: *To which extent is the CRMSS process model applicable in practical testing with an automotive supplier?*

A-RQ2: *Which model elements need to be refined to enhance the model’s applicability?*

A-RQ3*: Which criteria are relevant to CRM system selection?*

A-RQ4*: How does CRM system selection affect the success of the selected CRM system?*

Research results of the single case study with an automotive supplier showed that the CRMSS process model is practically applicable. An applicability check by

Rosemann and Vessey (2008) was conducted to evaluate practical applicability of the model. Rosemann and Vessey (2008) argue that “applicability checks could be conducted on emerging IS research outcomes” and “improve future research by incorporating learnings into revisions to theories or models”. According to the three applicability categories (importance, accessibility, and suitability) the CRMSS model was judged positively by the interviewed project representatives in the case company. Enhancements to the model were introduced. The CRMSS process model contributes to IS research by applying the methodology by Ahlemann and Gastl (2007), thus proving its feasibility and effectiveness in terms of the research results. It shows how their meta model can be applied in the research discipline by following the recommended phases and customizing them to meet the specific requirements of the topic. In practical terms, this research gives guidance for systematically selecting CRM systems and presents a portfolio of IT project-oriented phases, roles, and deliverables (see section 3.2).

Based on the insights from the case study a more general research question arose concerning the effect of the CRM selection criteria on the CRM system success. The CRM selection criteria were incorporated into the widely acknowledged D&M IS success model (DeLone and MCLean, 2004). Thus, this research contributes to the evaluation of this theoretical model in the context of CRMSS. DeLone and McLean (2003) have called for their model to continuously “be tested and challenged”. The extended D&M IS success model adheres to the postulate that “selection of IS success dimensions and measures should be contingent on the objectives and context of the empirical investigation, but, where possible, tested and proven measures should be used” (DeLone and McLean, 2003). Quantitative data was surveyed among CRM experts. Although the original model paths could be again supported, new insights were obtained on the relationship between CRM selection criteria and their possible impact on CRM system success. The study showed that a certain selection criteria have an impact on the quality dimension and some directly on net benefits (see section 3.3). This is a practically relevant research result as it gives an idea which phases and aspects of the CRMSS process model are of higher importance for a sustainably positive IT project outcome. It is therefore decisive to individually adapt the CRMSS process model and correctly interpret the selection criteria for the specific case at hand. For example, the task *functional criteria definition* as part of *phase 2: detailed requirements specification* in the CRMSS process model has direct and highly significant impact on net benefits. These activities (functional criteria), the associated roles (template keeper and business experts), and the deliverable (evaluation sheet) have to be regarded as key issues and have to attributed sufficient budget, time and organizational priority within the CRMSS project.

In the research area on e-invoice processes the following research questions were addressed:

B-RQ1*: Which basic structure of a maturity model for e-invoice processes is required?*

B-RQ2*: How can a maturity model support the implementation of e-invoice processes?*

B- RQ3: *What are the critical risk factors associated with e-invoice processes?*

B-RQ4: *How can they be grouped from a project management perspective?*

In a research design based on a Becker et al. (2009) the EIPMM model was developed iteratively. Becker et al. (2009) argue that their procedure model provides "a methodologically well-founded development and evaluation of maturity models".

For the time being, the last iteration included qualitative, explorative focus group interviews resulting in a maturity model with four main categories (technology, process and organization, acceptance, and strategy), 15 sub-categories and detailed categories which should be measured by five maturity levels from *0:non-existent* to *4:continous improvement*. These categories represent a systematic process for the implementation and operation of e-invoice processes and for decision making. From the theoretical perspective and similar to the earlier argumentation on meta model application, the EIPMM contributes to the objective of rigorous maturity model design (Becker et al., 2009) by showing the applicability of the suggested process model in a specific domain. At the same time, in comparison to the available best-practice maturity models (see Appendix A8), the EIPMM development process is documented in a transparent and reproducible manner supporting the hypothesis that a structured model-based result leads to "more profitable results than an intuitive procedure without recourse to a reference manual" (Becker et al., 2009).

From the practical point of view, the EIPMM helps to provide the overall picture of the issue around e-invoicing. As most benefits occur when the procure-to-pay process is fully automated with seamlessly integrated e-invoice processes (European Commission, 2010), it makes sense to examine the maturity-oriented concept. The EIPMM shall provide information whether all possible and convenient opportunities for them are implemented and used. The EIPMM raises awareness for the e-invoice processes and shows how processes can be improved. It presents critical success factors affecting the decision as to how invoice processes should be managed. The e-invoice issue is not only a question between paper-based and electronic invoice but more of how processes are designed. The EIPMM is a valuable tool, not only for evaluation of internal capabilities, but also for discussions with partners.

As part of the EIPMM *risk management* within the *processes and organization* dimension was considered an especially important issue. Risk management for e-

invoice processes, according to the conducted structured literature review, is the first study to identify and analyze critical risk factors of e-invoice processes. A quantitative study surveying experts on e-invoicing was conducted to evaluate theoretically developed risk factors. The analysis revealed ten dimensions of risk factors that need to be considered. The 37 identified and statistically significant factors are an initial approach for the practical risk management for e-invoice processes. This research provides support especially for companies that are starting to implement e-invoice processes. However, companies that decline e-invoice process can use these results as a starting point to reconsidering their decision. Further, this research can support companies that are trying to convince their business partners to implement e-invoice processes. Finally, the results can be used as basic frameworks for consultants, organizations or other stakeholders to analyze and design e-invoice processes and solutions. The analysis of risk factors is relevant because as the adoption rate of e-invoicing is rather low (European Commission 2010). Further, this research highlighted the importance of a risk assessment for e-invoice processes due to the fact that nearly half of the contacted experts taking part in the survey were interested in the results of the study.

5.2. Limitations and further research

The relevance of the research topics and the rigorous methodology leading to the presented research results have been described in detail. As with every research project, certain methodic and structural limitations apply and should be summarized in this section.

As to the general research design presented in section 2, despite the mentioned advantages, the use of meta models restricts the approach and procedure taken to achieve the research results. It is self-evident that the choice to structure the research process along a meta model and the choice of the model itself is a major delimitation, but a necessary one. In both research streams, the decision for a specific meta model was taken after considering possible alternatives and reflecting on the applicability and practicability of the model's use.

For the research on CRMSS, a major limitation is the chosen single case study approach. Although case study research is a well understood and widely acknowledged method in IS research (Yin, 1987; Atkins and Sampson, 2002), a single case study is a potential source of bias and lack of generalizability. Finding a suitable company which is willing to adapt a newly designed approach to their CRMSS project and actually implement it in practice for research purposes is a challenging endeavor. Therefore, although generally advisable, a field study is not realistic. Adhering to the critical appraisal guidelines by Atkins and Sampson (2002, see section 1), the authors made sure that certain quality criteria are met to the best possible extent. Among these are the triangulation postulate by Yin (1984) and a

recommended level of involvement and skeptical scrutiny towards the CRMSS process model's implementation and applicability (Walsham, 1995). For this purpose different stakeholders and sources of data were consulted to obtain an in-depth view. Performing an applicability check as recommended by Rosemann and Vessey (2002) was a necessary decision to overcome these limitations and at the same time satisfy the requirements set by the meta model for the validation phase.

The process model was evaluated in terms of its procedural applicability. The selection criteria were not tested in detail as these results would not be generalizable. Therefore, selection criteria were part of the following quantitative study.

The subsequent quantitative study applying the D&M IS success model is subject to further limitations. Some important limitations originate from the different definitions for IS success and the criticism of the D&M IS success model itself. A challenging aspect is defining the relationship and possible interdependencies between system and project success (Rosemann and Vessey, 2008; Buhl et al., 2010, Cuellar, 2013). Mertens and Schuhmann argue in Buhl et al. (2010), that the understanding of IS success conveyed by DeLone and McLean (2003) is at least incomplete. They turn to the classic distinction between behavioral and design-oriented IS research and criticize the D&M IS success model for its inability to measure cost-effectiveness of the project. According to them, the effort necessary to achieve the successful IS as defined by DeLone and McLean is lacking. Mertens and Schuhmann state that this goal conflict facing system architects are neither sufficiently discussed by Urbach et al. (2009) nor in the D&M IS success model and the research applying it.

Another aspect of criticism are the potentially different and contradicting views on IS success by different stakeholders of the system. The role of stakeholders to evaluate success is decisive (Rosemann and Vessey, 2008), since it is assumed that "net benefits are a proxy for success for all social agencies, which is not necessarily so" (Cuellar, 2013). Cuellar (2013) argues further that "the analytical methodology […] may not be powerful enough to discriminate between those who perceive the project as a failure and those who perceive it as a success. What is captured is the average response across all agencies". Overall, the D&M IS success model in its original form does not distinguish sufficiently between project and system success and does not consider possible different interpretation of system success by all stakeholders of the system at hand. Utilizing the D&M IS success model despite this criticism is a delimitation well considered, since our exploratory approach to conceptualize the relationship between CRMSS criteria and the CRM system success required a practical and widely evaluated approach. The model is accepted in the IS community and can be easily applied in quantitative studies. The promise to obtain first results weighs higher for the explorative nature of our research, then the justified concerns.

Along with these structural limitations, IS success has to be adapted to the individual case by choosing adequate measures. DeLone and McLean (2003) recommend the

number of measures should be reduced to the minimum in order to be able to compare and validate findings. The measures chosen in this study can be seen as delimitations, although they have been extracted from other similar studies on IS success.

A core limitation lies in the structure of the extended model. Although many paths were supported, the results cannot be fully explained due to the time gap between CRM system selection, CRM system implementation and later CRM system operation. The numerous influencing factors that can occur during the project and later during system use are very likely to change the perception of the CRM system success. Possible influences are the many project-related and organizational and strategic factors and the market dynamics as external factors. Incorporating these factors into the structure model will increase the model complexity significantly making it impossible to be measured quantitatively.

Future research on CRMSS should focus following aspects:

- Applying the CRMSS process model to other settings, e.g. different company sizes, industries, and role of CRM processes etc., will further improve generalizability of research results and indicate further enhancements and extensions to the model and its defined roles and deliverables.
- Qualitative research in form of interviews or focus groups needs to be conducted to further examine the role of stakeholders and their different understanding of CRM success. As part of the qualitative approach, supported and non-supported paths of the extended D&M IS success model should be discussed.
- Influencing factors during selection, implementation and operation of the CRM system need to be determined and evaluated qualitatively and/or quantitatively.
- Functional criteria of the CRM system need to be further investigated, possibly in a quantitative manner. Here, industry-specific criteria may exist.

For the research on e-invoice processes, especially the small number of experts interviewed throughout the iterative research process can lead to biased results. Adhering to the saturation cut-off and by considering different stakeholder groups in a representative manner, the authors have mitigated this limitation to the best of their knowledge. In the quantitative study on risk factors for e-invoice processes the major limitation relates to the surveyed experts, too. Although they are all knowledgeable in the e-invoice topic, their experience with risk management is self-reported and may not be equally profound. The results showed that the difference between probability and risk value was not clear or that experts had no experience in estimating the risk value. This research focus of this survey was on risk assessment and is based on

subjective estimation. Cox (2008) argues that the constraint of weak consistency, which he interprets as the existence of quantitative measures in risk evaluation, is crucial to the practical usefulness of a risk matrix. It was not yet possible to establish a risk matrix for e-invoice processes based on this data as risk probability and risk value are linearly correlated according to the experts` estimation.

Further research on e-invoice processes should focus following aspects:

- The EIPMM need to be further iterated to classify the detailed categories and provide suitable practical examples for each of the detailed categories. A web-based tool can be created for individual evaluation and for benchmark purposes. Additionally, this tool can then be utilized for field studies where the EIPMM can be further enhanced and extended for specific context, such as industry-specific requirements, country versions or company size-related aspects.
- Case studies can be suitable to analyze the risks comprehensively and quantitatively. This is also mentioned by Boehm (1991), who suggests that methods such as prototyping, benchmarking, and simulation provide more accurate estimates. Further, the results of this study help to investigate risk management of e-invoice processes as a comprehensive process.
- Risk factors should be analyzed and assessed with individual measurements and derivations for their handling. Perhaps there are already solutions within the companies to mitigate some of the mentioned risks. Based on the established processes and IS being used, companies need to investigate whether other risk factors have to be analyzed.

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Overview of Appendices

Appendix 1 (A1): Optimal Sustainable CRM System Selection – A Decision Support Approach
Appendix 2 (A2): Towards a multi-criteria decision support framework for customer relationship management selection
Appendix 3 (A2): Beeinflussen Auswahlkriterien den Erfolg eines CRM- Systems? – eine Strukturgleichungsmodellierung basierend auf dem DeLone und McLean IS-Erfolgsmodell
Appendix 4 (A4): A practical test of a process model for customer relationship management system selection with an automotive supplier
Appendix 5 (A5): Evaluating Customer Relationship Management in the Context of Higher Education
Appendix 6 (A6): Requirements Analysis for a Student Relationship Management System – Results from an Empirical Study in Ivy League Universities
Appendix 7 (A7): Why are Electronic Invoice Processes Risky? - Empirical Analysis and Discussion of Risk Factors
Appendix 8 (A8): Development of a Maturity Model for Electronic Invoice Processes
Appendix 9 (A9): Will XML-Based Electronic invoice standards succeed? – an explorative study
Appendix 10 (A10): Initial Design of a Maturity Model for Electronic Invoice Processes
Appendix 11 (A11): Voraussetzungen und Anforderungen für die Verbreitung der elektronischen Rechnungsabwicklung – Ergebnisse einer Expertenbefragung
Appendix 12 (A12): Quo vadis elektronische Rechnung? – Forschungsstand, -lücken, -fragen und –potenziale
Appendix 13 (A13): Elektronische Drittmittelakte in der Hochschulverwaltung – Erkenntnisse aus Fallstudien
Appendix 14 (A14): Critical success factors for adoption of integrated information systems in higher education institutions – a meta-analysis
Appendix 15 (A15): Sinnhafte Vollautomatisierung nach Mertens: Konzepte, Prozesse und Technologien

Appendix 1 (A1)

Optimal Sustainable CRM System Selection – A Decision Support Approach

Halyna Zakhariya

Lubov Kosch

Michael H. Breitner

Abstract

Selecting an optimal sustainable customer relationship management (CRM) system is a decision problem with functional, economic, social, environmental and technical aspects. It is mandatory to base this type of IT investment decision not only on best practice experiences, but on robust and reliable data in order to base the final choice on concrete arguments. CRM solutions range from simple address and activity management applications to integrated software packages that link front office and back office functionality. Therefore, selecting the appropriate CRM system can be described as a multi-criteria decision making (MCDM) problem, which implies that selecting a particular CRM system requires methodological support. Taking specific requirements of a sustainable CRM system selection into account, Weighted Scoring Method (WSM) and Fuzzy Technique for Order Preference by Similarity to Ideal Solution (FTOPSIS) are both selected and implemented. Classic and fuzzy multi-criteria decision making are compared. A CRM system selection tool is presented and discussed within the context of the MCDM framework.

Keywords

Sustainability, evaluation, CRM, system selection criteria, multi-criteria decision making, fuzzy TOPSIS

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Appendix 2 (A2)

Towards a multi-criteria decision support framework for customer relationship management selection

Halyna Zakhariya

Lubov Kosch

Ina Friedrich

Michael H. Breitner

Abstract

Selecting suitable customer relationship management (CRM) systems is a decision problem with economic, behavioural, technical and functional aspects. It is mandatory to base this type of IT investment decision not only on best practices experience, but primarily on robust data so that the final choice is based on concrete arguments. A CRM system selection framework is presented and discussed that specifically focuses on attributes for CRM evaluation with multi-criteria decision support. This framework is based on findings from a literature review of evaluation techniques for system selection and three subsequent CRM expert evaluations defining the CRM system evaluation criteria. A process is suggested on how to apply this framework to CRM system selection projects.

Keywords

CRM system selection, CRM software selection, CRM system evaluation tool, CRM system selection framework, multi-criteria decision support, weighted scoring method, literature review.

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Appendix 3 (A3)

Beeinflussen Auswahlkriterien den Erfolg eines CRM- Systems? – eine Strukturgleichungs-modellierung basierend auf dem DeLone und McLean IS-Erfolgsmodell

Lubov Kosch

Halyna Zakhariya

Michael H. Breitner

Abstract

Die strukturierte Auswahl von Customer Relationship Management (CRM) Systemen gilt als eine kritische Voraussetzung für den Implementierungserfolg. Ein indirekter Zusammenhang zwischen Auswahlkriterien und dem Systemerfolg lässt sich u.a. basierend auf dem Modell zur Erfolgsmessung von Informationssystemen nach DeLone und McLean darstellen. Im vorliegenden Beitrag wird das Modell modifiziert, um Auswahlkriterien für CRM-Systeme erweitert und empirisch überprüft. Für die Datensammlung werden Experten aus dem Umfeld von CRM-Systemen identifiziert und mittels eines standardisierten Fragebogens befragt. Aus einer Stichprobe von 105 Datensätzen wird ein Strukturgleichungsmodell generiert. Die Auswertung des Strukturgleichungsmodells unterstützt die Annahme, dass die Berücksichtigung und Priorisierung bestimmter CRM-Auswahlkriterien einen positiven Einfluss auf die drei Dimensionen System-, Informations- und Servicequalität sowie den Nettonutzen eines CRM-Systems haben. Die Zusammenhänge zwischen den Auswahlkriterien und den einzelnen Komponenten des DeLone und McLean IS-Erfolgsmodells sind dabei unterschiedlich stark ausgeprägt.

Keywords: Customer Relationship Management, Systemauswahl, Systemerfolg, DeLone und McLean IS-Erfolgsmodell, Strukturgleichungsmodellierung

Kosch, Lubov; Zakhariya, Halyna; and Breitner, Michael H., "Beeinflussen Auswahlkriterien den Erfolg eines CRM-Systems? - eine Strukturgleichungsmodellierung basierend auf dem DeLone und McLean IS-Erfolgsmodell" (2013). *Wirtschaftsinformatik Proceedings 2013.* Paper 15, pp. 229-243. http://aisel.aisnet.org/wi2013/15

Appendix 4 (A4)

A practical test of a process model for customer relationship management system selection with an automotive supplier

Ina Friedrich

Lubov Kosch

Michael H. Breitner

Abstract

Selecting suitable customer relationship management systems (CRM) is a decision problem with economic, behavioural, technical and functional implications. It is important to methodically identify an appropriate solution with regard to the various aspects of the decision. In this paper, a practical test of the previously developed customer relationship management system selection (CRMSS) process model is conducted in a case study with an automotive safety goods supplier. The process model used was constructed based on a literature review and further refined by expert interviews and two international online surveys. To test the models applicability and align phases, tasks, roles and deliverables with practical experiences, qualitative interviews were conducted with the different stakeholders in the evaluation project. The CRMSS process model was then further refined according to the conclusions drawn from the presented case study. The first application of the process model suggests that it is considered as relevant for practice and can be understood and applied successfully for a CRM selection and evaluation. In the context of the case study the model was customised to meet the needs of the project.

Keywords: CRM, system selection, system evaluation, automotive industry, case study research, process model.

Friedrich, Ina; Kosch, Lubov; and Breitner, Michael H., "A Practical Test of a Process Model for Customer Relationship Management System with an Automotive Supplier" (2012). *ECIS 2012 Proceedings.* Paper 21. http://aisel.aisnet.org/ecis2012/21

Appendix 5 (A5)

Evaluating Customer Relationship Management in the Context of Higher Education

Lubov Kosch

Ina Friedrich

Michael H. Breitner

Abstract

The current economic climate has its effect on the higher education sector as less money is provided by governments and increasing number of students with higher demands and expectations intensify competition among universities. Customer relationship management (CRM) has become a key instrument in attracting paying students as retaining a long-lasting relationship provides financial and other benefits. This paper presents a structured literature review to analyze requirements for a student relationship management system (SRMS) as discussed in literature and analyzes the findings with results gained through an online survey which was conducted with students and alumni from four Ivy League universities. The results of this preliminary study show that universities need to focus on perceived service quality, satisfaction and trust of their students to enhance student and alumni retention. Preferred communication channels vary by communication partner and topic. In regard to student-university communication, university administrations need to improve their relationship and communication habits as student satisfaction with administrative services is lowest in comparison to lecturers and mentors. Current SRMS revealed gaps for student life support, class selection and financial aid.

Keywords: CRM, student relationship management system, universities, higher education institution, relationship quality

In: Kosch, L., Friedrich, I., Breitner, M.H. (2012). Evaluating Customer Relationship Management in the Context of Higher Education, International Journal of Social and Organizational Dynamics in IT (IJSODIT), Volume 2, Issue 1, pp. 32-52. DOI: 10.4018/ijsodit.2012010103

Appendix 6 (A6)

Requirements Analysis for a Student Relationship Management System – Results from an Empirical Study in Ivy League Universities

Lubov Lechtchinskaia

Ina Friedrich

Michael H. Breitner

Abstract

The higher education sector encounters increasing number of students with more diverse attributes, expectations, and demands. In times of sinking budgets and severe competition among universities, student relationship management (SRM) has become a key instrument in attracting paying students and retaining a long-lasting relationship, which in turn provides financial benefits and enhances the reputation of the university. In this paper, a structured literature review revealed a lack of requirement analysis for a student relationship management system (SRMS) from the target group perspective. An online survey was conducted with students and alumni from four Ivy League universities. The survey showed that university administration needs to improve their relationship and communication habits with the target groups. Because modern communication channels such as social network, blogs and apps are not yet wide-spread in this context, SRMS need to be further enhanced to include them.

In: Lechtchinskaia, L.; Friedrich, I.; Breitner, M.H., "Requirements Analysis for a Student Relationship Management System-Results from an Empirical Study in Ivy League Universities," *System Science (HICSS), 2012 45th Hawaii International Conference on* System Science, pp.5132,5141, 4-7 Jan. 2012. DOI: 10.1109/HICSS.2012.502

Appendix 7 (A7)

Why are Electronic Invoice Processes Risky? - Empirical Analysis and Discussion of Risk Factors

Angelica Cuylen

Lubov Kosch

Michael H. Breitner

Abstract

Electronic invoice processes are characterized by various software solutions, legal uncertainty, heterogeneous demands, lack of know how, and information system infrastructure incompatibilities. Due to this complexity and the uncertainty that companies face, a holistic map of risk factors of e-invoice processes is required. Companies must be conscious not only about potential opportunities but also about potential risks before they change their business processes and their information systems' architecture. Potential risk factors are identified theoretically and empirically evaluated with a quantitative expert survey that investigates risk probabilities and potential losses associated with these factors. The empirical analysis reveals that the investigated factors are valid and reliable. After conducting an explorative factor analysis, 37 statistically significant risk factors are grouped into ten risk dimensions: process organization, standard, environment, project management, strategy, acceptance, system, process execution, security, and change management.

Keywords: e-invoice, electronic invoice processes, risk factors, risk probabilities

In: Cuylen, Angelica; Kosch, Lubov; and Breitner, Michael, "Why Are Electronic Invoice Processes Risky? - Empirical Analysis and Discussion of Risk Factors" (2015). ECIS 2015 Completed Research Papers. Paper 34. ISBN 978-3-00-050284-2,http://aisel.aisnet.org/ecis2015_cr/34

Appendix 8 (A8)

Development of a Maturity Model for Electronic Invoice Processes

Angelica Cuylen

Lubov Kosch

Michael H. Breitner

Abstract

The digitalization of invoice processes provides a good opportunity for companies to pare down expenses, optimize administrative tasks, and increase efficiency and competitiveness. But the digitalization is limited by a variety of software solutions, legal uncertainties, heterogeneous demands, lack of know-how, and information system infrastructure incompatibilities. A holistic map of electronic invoice processes is mandatory, especially to demonstrate different levels of process integration and optimization. A maturity model puts this into practice and provides companies with a tool to identify their current situation and to derive recommendations to optimize that situation. In this paper, a maturity model for electronic invoice processes will be developed using exploratory data from focus groups. A theoretical approach that is based on a procedure-model for developing maturity models is applied. Four categories (strategy, acceptance, processes & organization, and technology) are identified and enriched by sub-categories. Future research requires the development of detailed maturity metrics.Keywords: e-business, e-invoicing, e-invoice processes, maturity model

In: Cuylen, A., Kosch, L., Breitner, M.H. Discussion of a Maturity Model for electronic Invoice Processes, Electronic Markets (online first 14.11.2015),pp..1-13, DOI:10.1007/s12525-015-0206-x

Appendix 9 (A9)

Will XML-Based Electronic invoice standards succeed? – an explorative study

Kathrin Kühne
Lubov Kosch
Angelica Cuylen

Abstract

The digitalization of business processes is a crucial method for cutting down administrative costs, improve productivity in business processes, and achieving process transparency. Since invoices are some of the most important documents exchanged between business partners, it makes sense that invoices be sent and received electronically. There are no formal rules that determine the format of electronic invoices. However, companies benefit most when invoices contain structured data that can be processed automatically. The acceptance and adoption of structured electronic invoicing is generally rather low in the European Union, but it differs significantly among European countries. The electronic data interchange with the invoice standard EDIFACT is most favored by larger companies. An XML-based invoice could fill the gap between EDIFACT invoices and unstructured invoices like PDF and paper invoices. Some European countries have already established a national XML-based invoice standard. This paper addresses critical success factors to the adoption of XML-based standards. In an explorative study with experts, various aspects of acceptance were derived, and the results adapted to the Technology-Organization-Environment framework.

Keywords: electronic invoicing, XML-based standard, adoption, technology-organization-environment model.

In: Kuehne, Kathrin; Kosch, Lubov; and Cuylen, Angelica, "Will XML-based Electronic Invoice Standards Succeed? - An Explorative Study" (2015). ECIS 2015 Completed Research Papers. Paper 113. ISBN 978-3-00-050284-2, http://aisel.aisnet.org/ecis2015_cr/113

Appendix 10 (A10)

Initial Design of a Maturity Model for Electronic Invoice Processes

Angelica Cuylen
Lubov Kosch
Valentina Böhm
Michael H. Breitner

Abstract

Dematerialization and automation of invoice processes are an essential opportunity for companies to pare down expenses, optimize administrative tasks, and in turn, increase efficiency and competitiveness. But electronic invoices are characterized by various software solutions, legal uncertainty as well as heterogeneous demands, know how, and information system infrastructure incompatibilities. A holistic map of electronic invoice processes must be presented, especially to demonstrate different levels of process integration and optimization. A maturity model for electronic invoice processes puts this into practice and provides companies with a tool to identify the current situation and derive recommendations for optimizing it. In this paper, such a model is designed theoretically and then evaluated with an explorative expert survey. The key dimensions are strategy, acceptance, and technology.

Keywords: e-invoicing, e-business, maturity model, business process management, e-invoice processes

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Appendix 11 (A11)

Voraussetzungen und Anforderungen für die Verbreitung der elektronischen Rechnungs-abwicklung – Ergebnisse einer Expertenbefragung

Angelica Cuylen

Lubov Kosch

Michael H. Breitner

Abstract

Trotz hoher erwarteter Einsparpotentiale bleibt die Verbreitung der elektronischen Rechnungsabwicklung hinter den Erwartungen der Europäischen Kommission und der Marktteilnehmer zurück. Gesetzesvereinfachungen auf europäischer und nationaler Ebene sowie Standardisierungsbestrebungen zahlreicher Organisationen haben bisher die Einführung der elektronischen Rechnung, insbesondere bei kleinen und mittleren Unternehmen, nicht in ausreichendem Maße fördern können. In diesem Aufsatz sollen die Anforderungen der Praxis an die elektronische Rechnungsabwicklung und die Voraussetzungen für die Etablierung der elektronischen Rechnung erörtert werden. Es werden qualitative, leitfadengestützte Interviews mit Experten aus den Gruppen Unternehmen, Steuerberatung und Lösungsanbieter für elektronische Rechnungsabwicklung durchgeführt. Aus den Ergebnissen werden Handlungsempfehlungen abgeleitet und die Rechnungstaxonomie als Erfolgsfaktor für die Verbreitung der elektronischen Rechnungsabwicklung identifiziert. Die kritischen Erfolgsfaktoren einer Rechnungstaxonomie werden aus der Expertenbefragung abgeleitet.

Keywords: Elektronische Rechnung, Expertenbefragung, Standardisierung, Taxonomie

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Appendix 12 (A12)

Quo vadis elektronische Rechnung? – Forschungsstand, -lücken, -fragen und –potenziale

Angelica Cuylen
Lubov Kosch
Michael H. Breitner

Abstract

Die elektronische Rechnungsverarbeitung gewinnt in Europas Unternehmen, staatlichen Verwaltungen und Organisationen an Bedeutung. Die internen Geschäftsprozesse und die Prozesse unter Geschäftspartnern ändern sich signifikant. Die elektronische Rechnungsverarbeitung besitzt enorme Einsparpotenziale in Milliardenhöhe: trotzdem ist der Anteil elektronisch versendeter B2B oder B2G Rechnungen in Summe in vielen Staaten Europas vergleichsweise gering. Dieser Aufsatz hat das Ziel, den aktuellen Stand der Forschung im Umfeld der elektronischen Rechnungsverarbeitung zu analysieren. Die Ergebnisse und Erkenntnisse zeigen, dass die Forschung diverse Themen und Fragen untersucht, allerdings existieren bisher aber weder eine einheitliche und integrative Sicht, noch befriedigende Theorien, Modelle oder Handlungsempfehlungen für Europa.

In: Cuylen, A., Kosch, L., Breitner, M.H. (2012). „Quo vadis elektronische Rechnung? - Forschungsstand, -lücken, -fragen und –potenziale“, Dirk Christian Mattfeld; Susanne Robra-Bissantz (eds.), Tagungsband der Multikonferenz Wirtschaftsinformatik 2012, S. 1921 – 1932, http://www.digibib.tu-bs.de/?docid=00048475

Appendix 13 (A13)

Elektronische Drittmittelakte in der Hochschulverwaltung – Erkenntnisse aus Fallstudien

Halyna Zakhariya,
Lubov Kosch
Michael H. Breitner

Abstract

Die durch die Veränderungen in der Hochschullandschaft notwendig gewordenen Effizienzbestrebungen der universitären Verwaltung, führen auch zur Prozessreorganisation und Automatisierung des Drittmittelverwaltungsprozesses. Im Rahmen des Einsatzes von Records Management an Hochschulen soll die elektronischen Drittmittelakte etabliert werden. Hierbei gilt es den papierbasierten Prozess der Aktenführung für den speziellen Fall der Drittmittelverwaltung in eine entsprechend strukturierte, elektronische Form zu überführen, ohne die durch Gesetzgebung und organisatorische Vorschriften geregelten Anforderungen zu verletzen. In diesem Beitrag werden vier Fallstudien mit dem Ziel der ordnungsgemäßen Referenzmodellierung für den Prozess der elektronischen Drittmittelakte beschrieben sowie das daraus resultierende, validierte Referenzmodell vorgestellt. Der Prozess der Drittmittelverwaltung variiert stark in Bezug auf Geldgeber und hochschulspezifische, organisatorische Gegebenheiten. Ein Referenzmodell ist durch den Wiederverwendungscharakter, insbesondere für die stärker regulierten Verwaltungsprozesse und vor allem für die elektronische Drittmittelverwaltung von Vorteil, da die anzuwendenden Regularien hochschulübergreifend vergleichbar oder identisch sind. Daher bietet das vorgestellte Referenzmodell bei der Implementierung der elektronischen Drittmittelakte trotz möglicher, zusätzlich notwendiger Anpassungen eine gute Basis.

In: Zakhariya, H., Kosch, L., Breitner, M.H. (2102). „Elektronische Drittmittelakte in der Hochschulverwaltung – Erkenntnisse aus Fallstudien“, INFORMATIK 2012: Was bewegt uns in der/die Zukunft?, 16-21. September 2012 in Braunschweig, GI-Edition - Lecture Notes in Informatics (LNI), P-208, S. 613-626.

Appendix 14 (A14)

Critical Success Factors for Adoption of Integrated Information Systems on Higher Education Institutions – A Meta-Analysis

Lubov Lechtchisnkaia
Jörg Uffen
Michael H. Breitner

Abstract

Integrated information systems continuously develop into a strategic instrument for higher education institutions. In contrast to private companies, specific characteristics of higher education institutions in regards to their organizational structure as well as their management and operations require a tailored project management approach. There is need for thorough research and practical recommendations for implementation of integrated information systems in higher education institutions. This paper provides a systematic meta-analysis and a state of the art overview of critical success factors for selection and implementation of integrated information systems based on the characteristic of the higher education sector. A qualitative content analysis is applied to receive a comprehensive list of critical success factors for higher education institutions. The mostly named critical success factors are stakeholder participation, business process reengineering and communication which align well with the peculiarities of the higher education sector.

Keywords: Project management, critical success factors, CSF, state of the art analysis, higher education institutions, university, ERP systems, campus management system, CMS, integrated information system

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Appendix 15 (A15)

Sinnhafte Vollautomatisierung nach Mertens: Konzepte, Prozesse und Technologien

Angelica Cuylen
Christian Fischer
Lubov Lechtchinskaia

Im Jahre 1995 unterzog Peter Mertens mit seinen Mitarbeitern die Zeitschrift Computerwoche einer inhaltsanalytischen Untersuchung mit dem Ziel Schlagworte der Wirtschaftsinformatik zu identifizieren sowie deren Häufigkeit im Zeitverlauf zu bestimmen. Als Ergebnis dieser Untersuchung stellte sich heraus, dass die Forschungsdisziplin Wirtschaftsinformatik in hohem Ausmaß von kurzfristig aktuellen Themen, oft mit Modecharakter, dominiert wird. Dieses Ergebnis wurde in einer Folgeuntersuchung aus dem Jahr 2006 bestätigt und führt zu der Frage nach den Ursachen für diese Fokussierung sowie der Frage nach potentiellen Lösungskonzepten. Im Kontext der allgemeinen Frage nach dem Forschungsschwerpunkt der Wirtschaftsinformatik fällt stets der Begriff der Rationalisierung als eine der ersten Antworten. Integrativer Bestandteil und wesentliche Voraussetzung für dessen Realisierung und Optimierung ist die Automatisierung, was gemäß DIN 19233 den Einsatz künstlicher Mittel und damit den selbständigen bzw. autonomen Ablauf betrieblicher Vorgänge und Prozesse bezeichnet.

Vor diesem Hintergrund ist es das Ziel dieser Arbeit den von Mertens entworfenen Lösungsansatz für das Auftreten von Modethemen zu erläutern und kritisch zu diskutieren. Um die Nachvollziehbarkeit und Bedeutung dieses Lösungsansatzes zu gewährleisten, werden der Erkenntnisgegenstand, die Forschungsperspektiven sowie die generelle Bedeutung von Leitzielen in der Wirtschaftsinformatik vorgestellt. Schließlich erfolgt im vierten Kapitel, anhand des konkreten Beispiels der Finanzbuchhaltung, der Versuch einer Verifizierung dieses Ansatzes von Mertens, indem die betrieblichen Vorteile einer fortschreitenden Automatisierung beschrieben werden. Das Rechnungswesen hat bereits frühzeitig fortschreitende Automatisierung durch den Einsatz von Informationssystemen erfahren und eignet sich deshalb besonders zur Demonstration der praktischen Realisierbarkeit und der Grenzen einer Vollautomatisierung.

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Abstract: Selecting an optimal sustainable customer relationship management (CRM) system is a decision problem with functional, economic, social, environmental and technical aspects. It is mandatory to base this type of IT investment decision not only on best practice experiences, but on robust and reliable data in order to base the final choice on concrete arguments. CRM solutions range from simple address and activity management applications to integrated software packages that link front office and back office functionality. Therefore, selecting the appropriate CRM system can be described as a multi-criteria decision making (MCDM) problem, which implies that selecting a particular CRM system requires methodological support. Taking specific requirements of a sustainable CRM system selection into account, Weighted Scoring Method (WSM) and Fuzzy Technique for Order Preference by Similarity to Ideal Solution (FTOPSIS) are both selected and implemented. Classic and fuzzy multi-criteria decision making are compared. A CRM system selection tool is presented and discussed within the context of the MCDM framework.

Optimal Sustainable CRM System Selection – Discussion of a Decision Support Approach

Abstract

Selecting an optimal sustainable customer relationship management (CRM) system is a decision problem with functional, economic, social, environmental and technical aspects. It is mandatory to base this type of IT investment decision not only on best practice experiences, but on robust and reliable data in order to base the final choice on concrete arguments. CRM solutions range from simple address and activity management applications to integrated software packages that link front office and back office functionality. Therefore, selecting the appropriate CRM system can be described as a multi-criteria decision making (MCDM) problem, which implies that selecting a particular CRM system requires methodological support. Taking specific requirements of a sustainable CRM system selection into account, Weighted Scoring Method (WSM) and Fuzzy Technique for Order Preference by Similarity to Ideal Solution (FTOPSIS) are both selected and implemented. Classic and fuzzy multi-criteria decision making are compared. A CRM system selection tool is presented and discussed within the context of the MCDM framework.

Keywords

Sustainability, evaluation, CRM, system selection criteria, multi-criteria decision making, fuzzy TOPSIS

1 Introduction

The market for software packages and diverse IT solutions has significantly increased in recent years, covering both vertical solutions and integration topics. Identifying and selecting the most suitable solution for an individual company has become a complex multi-criteria decision problem. The main decision parameters include adaptability of the business processes, flexibility in terms of market and strategy changes, and IT architecture fit. The importance of sustainability for companies and its impact on the future business success are increasing steadily. The consideration of environmental, social, and economic objectives in corporate decisions is among the key success factors in the transformation towards sustainability (Müller and Pfleger 2014). Multi-criteria decision making (MCDM) describes the evaluation of a - often restricted - number of alternatives, considering multiple criteria (Yoon and Hwang 1995). It also supports a decision-making process if those criteria are unmanageable and difficult to rank, helping users choosing the best alternative (Le Blanc and Jelassi 1989). Evaluation methods that translate information into comparable numbers provide a mathematical bridge for the underlying qualitative problem. Especially fuzzy based techniques, which are handling with unquantifiable and often incomplete information, are making a high contribution (Mentes and Helvacioglu 2012).

The scope of customer relationship management (CRM) processes is constantly increasing as customers demand the integration of new communication channels (e.g. mobile), new CRM processes are being established (e.g. social CRM) and more data needs to be processed and mined (e.g. in terms of cloud computing and analytics) (Thompson et al. 2011). The vendor landscape for CRM systems shifts further towards more focused vendors who target specific industries. According to Thompson et al. (2011), the established suite vendors also continue to extend their market into front-office applications. The CRM system sourcing decision needs to cover the span between the large vendors who support end-to-end processes and specialized vendors who support industry and niche requirements. Furthermore, the companies are forced to take into account and integrate the issues of sustainability at various levels, also with respect to the CRM systems in use. And the reasons for this development "not only scarce resources and the emerging social problems, but also expectations of stakeholders of a company like its customers, investors, employees, suppliers or society in general. Companies need to manage these challenges to benefit from the transformational power of the development and thus make ''sustainability'' a key success factor" (Hahn and Scheermesser 2006, Müller and Pfleger 2014). Making an allowance for sustainability issues in CRM strategy and in the CRM processes leads to differentiation from competitors and helps ensure the continuity of business operations, as the ecological and societal limits are considered (Ruhwinkel 2013). Therefore, selecting the appropriate sustainable CRM system can be described as a complex MCDM problem.

CRM solutions range from simple address and activity management applications to integrated software packages that link front office and back office functions (Chen and Popovich 2003). This means that there is a multitude of different characterizations for CRM, which in turn implies selecting a particular one requires methodological support. General selection criteria

need to be tailored to reflect the specific requirements of a CRM system selection. In order to create the structured criteria catalogue an overview of criteria, extracted from literature and verified with CRM practitioners in an international survey, is presented. These criteria are then discussed in terms of sustainability. Afterwards, a brief overview of MCDM, classic and fuzzy methods as well as a literature review on the MCDM methods used in the field of system selection are presented. Weighted Scoring Method (WSM) and Fuzzy Technique for Order Preference by Similarity to Ideal Solution (FTOPSIS) are both selected for the purpose of comparison between classic and fuzzy MCDM and are therefore presented in detail. Although a number of approaches to MCDM have been discussed in different areas of information system research (ISR), a MCDM framework for selection of a sustainable CRM system which includes a calculation tool has not been proposed yet. The aim of this paper is to answer the following research questions:

(1) Which criteria should be taken into account while selecting a sustainable CRM system?

(2) Which evaluation method, classic or fuzzy, is more suitable for the specific multi-criteria decision making problem of sustainable CRM system selection?

The paper is structured as follows: In Section 2 a summary of current "selection criteria" research with focus on sustainable CRM is provided. Section 3 presents an overview of common MCDM methods, defines the fuzzy set theory and a suggested MCDM framework for sustainable CRM system selection. In Section 4 WSM and FTOPSIS are introduced in detail and applied in a tool within the context of the MCDM framework. The paper closes with a discussion and summary of the results.

2 Criteria for CRM System Selection and Sustainability

The challenges of IS system selection result from e.g. the non-uniform definition of system functionality and requirements which can vary depending on industry and may therefore be interpreted differently. CRM is a cross-functional and integrated business process management strategy (Chen and Popovich 2003) and CRM system selection criteria need to be individually tailored to fit a company's requirements. According to Vlahavas et al. (1999), the definition of selection criteria is the most important step of the evaluation process.

In order to generate an overview of current research for CRM system selection criteria a literature review according to Webster and Watson (2002) was conducted considering the major research databases in the field of ISR (AISeL, IEEE Xplore, ScienceDirect, Springerlink, EBSCOhost etc.). As a result (Tab. 1) 33 selection criteria from categories "quality", "cost", "functionality" and "technical" were extracted from academic literature and verified with CRM practitioners within an international online survey (citation blinded for review). Since most experts recommended that none of the suggested criteria be deleted, all of them should be incorporated into a CRM system selection criteria catalogue, which would allow company-specific assessment. The criteria need to be adapted in a tool that enables companies to customize their evaluation according to their preferences. Quality criteria cover the requirements that measure the quality of the vendor and its product; functional criteria determine the functional fit; costs include all software-related expenses (incl. implementation costs); and tech-

nical requirements reflect technical characteristics from hard- and software to data integration. Additionally, the criteria can be differentiated due to their type. The decision maker strives to maximize the "benefit" criteria and minimize the criteria of type "cost" (Caterino et al. 2009).

Tab. 1 Criteria for CRM System Selection

Quality criteria		
Popularity	q1	Reputation, credentials, market share, lifecycle, industry focus
Resources	q2	Experience and availability of external consultants and internal staff
Portability	q3	Compatible platforms, available interfaces
Security	q4	Security levels (data and/or functional), resisting unauthorized access
Timeliness	q1	Implementation time and duration
Training & Support	q2	Training material, documentation, services, available tools
Usability	q3	Usefulness, user friendliness (ease of use)
User Acceptance	q4	Acceptance of system by user
Functionality criteria		
Account Management	f1	Sales support, contract management
Campaign Management	f2	Design, implement and monitor campaigns for marketing information
Contact Management	f3	Customer data (basic and transaction), customer feedback
Customer Service	f4	After-sales-service, maintenance and repair management, SLAs
Field Service	f5	Mobility technology and options (incl. data synchronization)
Internet	f6	Customer self-service (incl. e-cash), intranet, web-based DSS, E-commerce
Lead & Opportunity Management	f7	Workflow to track and trace leads, acquisition management
Relationship Management	f8	Customer retention management, partner management, loyalty programs
Reporting	f9	Business analysis, forecasting, monitoring, data mining, business intelligence
Sales Management	f10	Quotation management, product configuration, pricing, cross-/up-selling
Cost criteria		
Maintenance	c1	Activities to keep the system up&running, retain/restore hardware/software
Preparation & Installation	c2	Required hardware components and software packages
Resources	c3	All required project personnel resources (internal, consulting, and vendor)
Training & Support	c4	Training material, training execution; support during project, after Go-live
System Purchase Costs	c5	Licenses for software and hardware applications, support contract costs
Upgrade	c6	Estimated future upgrade costs: next releases, additional system components
Technical criteria		
Data Integration	t1	Data conversion and movement; data access, actuality; information quality
Deployment	t2	Technical transformation from old hard-/software environment to the new
Integration & Infrastructure	t3	Interface definition, development, system and hardware environment
Software & Hardware Requirements	t4	Technical standards, compatibility
Mobility	t5	Possibility to use CRM system outside the company's main infrastructure
Modifiability & Maintainability	t6	Degree of configuration, availability of source code, personalization
Performance & Practicability	t7	Execution time, responsiveness, efficiency, design principles (e.g. SOA)
Reliability & Robustness	t8	Troubleshooting, reproduction of its functions over a period of time
Scalability	t9	Management of growing data and functionality requirements

The frequently quoted definition of sustainability describes sustainable development as development, which meets "the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations 1987).

To accomplish sustainability four dimensions, the environmental (human welfare improvement while protection of resources and optimization of energy usage), social (pursuing generational equity), economic (capital and (economic) value preservation) and technical (long-term use of software systems and their adaptability to continuous changes) should be in balance (Condori-Fernandez et al. 2014).

Resource-protective behavior and concentration on additional aims from the social or cultural area are vital parts of sustainable management. This indicates for companies the goal of accomplishing more than just customer need satisfaction. Assuming environmental and social

responsibility leads to an essential change of scope in marketing and particularly in CRM (Wagner vom Berg and Stamer 2012).

“If the corporate strategy includes sustainability-related goals, CRM might be an instrument to influence the customer behavior in a more sustainable direction.” (Wagner vom Berg and Stamer 2012). To apply the most effective marketing actions which are intended for different groups of customers it is important to consider the customer needs. For that reason operational CRM systems should collect sustainability-related user data. Evaluation of these data make it possible to build customer segments for those who are open for particularly sustainable offers. Those particularly sustainable offers can also be identified in in the context of an evaluation process. The information about customer segments and alternatives should be brought back to the operational CRM systems where they can be used as a basis for marketing campaigns. The response and results of the campaigns should again be proceeded to the data warehouse where they can be evaluated. These example aspects of sustainability for CRM should be taken into account in the detailed definition of functional criteria (see tab. 1) and they may differ depending on the industry. E.g. for the functional criteria “reporting” it needs to be considered which analytical data warehouse system uses methods of OLAP and data mining. The possibility of creating interfaces to extract necessary data from operational system, which then can be used as the basic information for data mining, should also be verified. In the “campaign management” the usage of sustainable communication channels e.g. E-Mail, the internet or communication via smartphone apps without using resources like paper should be ensured (Wagner vom Berg and Stamer 2012).

The idea of a sustainable CRM which affect the consumption behavior of customers in a sustainable direction is not equally valid for every industry. It should be adopted to specific industries and domains. Aspects of sustainability in the mobility domain e.g. can be implemented by offering sustainable transportation options to the customers and integrating it as a travel booking alternative or via social networks as traveling offer for customers with same interests (Wagner vom Berg and Stamer 2012).

In addition to CRM-related sustainability (functional criteria in tab. 1) the sustainability which is not related to the specific software (not only valid for CRM) needs to be investigated. The Software Sustainability Institute defines sustainability as “software you use today (that) will be available - and continue to be improved and supported - in the future” (Software Sustainability Institute).

The requirements for software sustainability were discussed by different authors and as further execution shows they reflect most of the quality and technical criteria for CRM system selection (the abbreviation of the criteria in tab. 1 are described directly by corresponding software sustainability characteristics).

Regarding to Calero et al. 2013 software sustainability can be considered from two perspectives:

1. "short-term" software sustainability:

a. Energy consumption (t4/t7). To what extent the amount of energy required in performing the functions of software is in line with sustainability expectations. Even if software itself consumes no energy, it intensely influence the consumption of hardware. The goal is to affect the direct carbon footprint of software (e.g. by reducing the energy consumption due to the CPU cycles) and the indirect influences on sustainability (i.e. the effects depending on the domain where the system is used) (Lami et al. 2012).
b. Resource optimization (t4/t5/q2/q6). To what extent the amount and types of resources used by performing of software functions meet sustainability expectations. Resources are by this means the software/hardware configuration of the system, materials (e.g. print paper, storage media).

2. "long-term" software sustainability (Perdurability):
    a. Reusability (t1/t2): To what extent is usage in more than one system, or in building other assets possible
    b. Modifiability (t6): To what extent can software be modified without impairment of existing quality
    c. Adaptability (t3): To what extent can software be adapted to different hardware, software or other operational environments

Irrespective of a short/long-term definition Venters et. al. 2014 propose that software sustainability should be considered additionally as a measure of a system's:

- Availability (t8): readiness to service correct
- Integrity (t4): avoiding of inappropriate system changes
- Maintainability (t6): possibility of modifications and repairs
- Reliability (t8): stability of correct service
- Safety (q4): avoiding of catastrophic consequences on the user(s)/environment
- Interoperability (t3): the effort needed to link software/systems
- Maintainability (t6): the effort needed to localize an error and repair software
- Portability (q3): the effort required when transferring to another environment (e.g. hardware platform);
- Scalability (t9): the degree to which software can horizontal or vertical expand.
- Usability (q5/q7/t7): the degree to which a software can be used by specified users in a specified context of use to achieve specified goals.

3 Multiple criteria decision making

MCDM problems are widespread problems that usually involve subjective judgments of multiple, occasionally conflicting criteria. There are two categories of MCDM: the first concerns the design problems called the multiple objective decision selection problems. The second category is also known as the multiple attribute decision making and is concerned with selection problems (Yoon and Hwang 1995). The latter is the focus of our research. For the sake of simplicity the selection problem should be called hereinafter MCDM. The MCDM methods are supporting management decision in selecting one from a predetermined number of alter-

natives. The alternatives are characterized by quantifiable or not-quantifiable multiple criteria. Also, the process is usually accompanied by groups of decision-makers and for that requires a compromise solution (Pohekar and Ramachandran 2004). Incorporating preferences is a key aspect of a decision making process framework (Neubauer and Stummer 2009). Hence, selecting a CRM system can be defined as a MCDM problem, where alternatives are standard software, which are rated by functional, technical, cost and quality criteria (see Tab. 1).

Requirements of decision-makers regarding the evaluation of possible alternatives are seldomly expressed on a ratio scale. More often qualitative criteria are a part of decision processes, which are always subjective and thus imprecise. At least an adequate conversion of qualitative linguistic judgment into the crisp numbers is required to apply any classical MCDM method. One of the common solutions is transformation of ordinal scale (e.g. very high, high, fair, low) into a ratio (e.g. 4, 3, 2, 1). However, while four is twice two, very high is not twice low (Caterino et al. 2009; Morisio and Tsoukias, 1997). As a conversion of the human judgments to numerical values leads to inherent uncertainties, many researchers prefer fuzzy sets regarding to multi criteria methods in order to consider the roughly estimated criteria (Ayag and Ozdemir 2007). In assigning the imprecision and vagueness characteristics, classical MCDM methods appear to be not as effective as fuzzy ones (Olcer and Odabasi 2005).

3.1 Basic Definitions of Fuzzy Set

Many real world problems have inexact information about alternatives and criteria while observable real world knowledge is rather fuzzy than precise (Mentes and Helvacioglu 2012; Olcer and Odabasi 2005). In those cases, the fuzzy set theory developed by Zadeh (1965) is useful because it accepts the ambiguity occurring during human decision making and allows the decision makers to use linguistic terms for the purpose of criteria and alternatives evaluation reflecting better the real world (Lin et al. 2007).

According to Zadeh (1965): A fuzzy set $\tilde{a}$ is characterized trough a membership function f_A described as a fuzzy subset of the real number R with member function f_A that represents uncertainty. A membership function is defined from universe of discourse to [0, 1] (see Fig. 1).

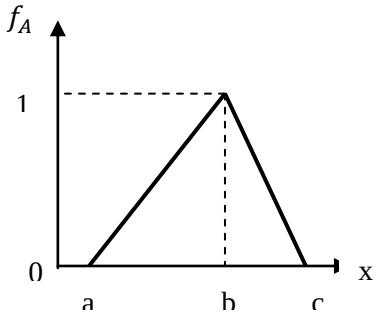

Fig. 1 A triangular fuzzy number

A fuzzy set usually uses triangular, trapezoidal or Gaussian fuzzy numbers, which convert the vague numbers to fuzzy numbers. The triangular fuzzy numbers (TFN) are used often because

they are suitable for a multiple expert judgment representations and working with TFNs simplifies fuzzy mathematical operations (Mentes and Helvacioglu 2011). In this study TFNs are used. TFN $\tilde{a}$, can be defined as a triplet (a, b, c). Then, a membership function of the fuzzy set $\tilde{a}$ defined as (1).

$$f_A = \begin{cases} 0, & x \le a \\ \frac{x-a}{b-a}, & a < x \le b \\ \frac{c-x}{c-b}, & b < x \le c \\ 0, & x > c \end{cases} \quad (1)$$

The arithmetic operations of (+), (-), (x), and (÷) on fuzzy sets $\tilde{a} = (a_1, a_2, a_3)$ and $\tilde{b} = (b_1, b_2, b_3)$ are defined as follows (2-5):

$$\tilde{a} + \tilde{b} = (a_1 + b_1, a_2 + b_2, a_3 + b_3) \quad (2)$$

$$\tilde{a} - \tilde{b} = (a_1 - b_1, a_2 - b_2, a_3 - b_3) \quad (3)$$

$$\tilde{a} \times \tilde{b} = (a_1 \times b_1, a_2 \times b_2, a_3 \times b_3) \quad (4)$$

$$\tilde{a} \div \tilde{b} = (a_1 \div b_1, a_2 \div b_2, a_3 \div b_3) \quad (5)$$

The inversion of and the multiplication with constant can be done according to (6-7):

$$\tilde{a}^{-1} = \left(\frac{1}{a_1}, \frac{1}{a_2}, \frac{1}{a_3}\right) \quad (6)$$

$$k \times \tilde{a} = (k \times a_1, k \times a_2, k \times a_3) \quad (7)$$

For calculation of a distance between fuzzy set $\tilde{a}$ and $\tilde{b}$:

$$d(\tilde{a}, \tilde{b}) = \sqrt{\frac{1}{3}[(a_1 - b_1)^2 + (a_2 - b_2)^2 + (a_3 - b_3)^2]} \quad (8)$$

3.2 Literature Review of Software Evaluation Methods

To identify the methods researched and applied for MCDM, in particular for system evaluation, the authors searched the five major research databases in the field of ISR: ACM, IEEE, Science Direct, and SpringerLink for “multiple criteria decision making”, “multiple attribute decision making”, “(software) evaluation methods” and “(system) selection techniques”. In total 64 academic articles were identified for software evaluation methods. Relevant articles (see Tab. 2) were categorized based on their focus (general or specific software selection) and the methods used. All in all the classical MCDM methods seems to be more popular for software selection than their fuzzified equivalents. Distinctive is the fact that all fuzzy publications were published after 2004 showing a trend for increasing frequency while the most classic contributions are dated earlier. It may be assumed that due to increasing complexity of software system requirements the classical methods are not adequate enough. Tab. 2 shows that the majority of articles dealing with specific software selection relate to ERP systems, while only three articles refer to CRM software. Colombo and Francalanci (2004) compared 42 CRM software packaged using AHP merely regarding quality criteria. Hong and Kim (2007) developed a criteria catalogue for CRM system selection for financial institutes and

ranked the criteria based on expert opinion. Goyal and Sharma (2010) refer to CRM only in a wider framework for the selection of data mining tools.

The preferred classical methods suggested for software selection are WSM and the Analytical Hierarchy Process (AHP). WSM is one of the oldest (developed by Fishburn in 1967) and most widespread method which is also considered to be the easiest (Caterino et al. 2009; Pohekar and Ramachandran 2004). WSM uses weighting and rating of criteria to calculate a total score for each of the evaluated alternatives. The AHP, developed by Saaty (1980), is a MDCM method that is characterized by pair-wise comparison of criteria in a hierarchical net and allows for consideration of both, objective and subjective, aspects (Jadhav and Sonar 2009). The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method, developed by Hwang and Yoon (1981), postulates the theory that the preferred alternative should be the nearest to the solution with the best criteria values (positive-ideal solution) and the farthest from the one with the worst possible (negative-ideal solution) (Olcer and Odabasi 2005). ANP is a generalization of AHP, where the hierarchy of alternatives is extended to a network to reflect the complexity of many "real-life" problems with interconnected inputs (Gürbüz et al. 2012). ELECTRE (Elimination and choice translating reality) method developed in 1966 by Benayoun presents as a result of binary outranking relations among alternatives (Caterino et al. 2009).

The examples of other classic methods - not as frequently used in the research of system selections - are DEA (data envelopment analysis) or HKBS (Hybrid knowledge based system).

In CRM system selection problems decision data of MCDM are usually fuzzy, or a combination of fuzzy and crisp. To deal with decision making problems which "have unquantifiable, incomplete, non-obtainable and partial ignorance information, fuzzy multiple attribute decision making (FMADM) techniques and methods have to be used" (Mentes and Helvacioglu 2012).

As shown in Tab. 2, the most popular fuzzy method for software selection are the fuzzy AHP (FAHP), which extends Saaty's AHP and combines it with fuzzy set theory. FAHP uses the fuzzy ratio scales with an objective of indicating the relative factor strength of the corresponding criteria. For that reason, a fuzzy expert judgment matrix can be created. The calculated final results are also characterized by fuzzy numbers. The preferable alternative can be determined by ranking fuzzy numbers by means of special algebra operators (Durán 2011).

Fuzzy TOPSIS (FTOPSIS) method which also presented a combination of classic TOPSIS and fuzzy set theory is less used for software selection so far. Nevertheless, it has been successfully applied in many other different areas and is widely discussed in the literature, e.g. Mentes and Helvacioglu (2012) as well as Wang and Elhag (2006) give an overview of the articles that applied FTOPSIS.

Tab. 2 Literature Review of Software Evaluation Methods

		Classic methods						Fuzzy methods			
Author	**Software**	AHP	ANP	ELECTRE	TOPSIS	WSM	Other	FAHP	FANP	FTOPSIS	Other
Ayağ and Özdemir 2007	ERP Software								x		
Azadeh et al. 2010	Simulation Software							x			
Braglia et al. 2006	Maintenance System Software	x									
Cavus 2010	Learning Management System										x
Cebeci 2009	ERP Software							x			
Changyun et al. 2012	Business Processes Management software							x			
Chen 2009	E-Commerce System							x			
Collier et al. 1999	Data Mining Software					x					
Colombo and Francalanci 2004	CRM System	x									
Davis and Williams 1994	Simulation Software	x									
Demirtas et al. 2011	ERP Software							x		x	
Durán 2011	Maintenance Management Systems							x			
Fu et al. 2010	Project Management Software							x			
Ghapanchi et al. 2008	ERP Software						x				
Goyal and Sharma 2010	Data Mining Software for CRM Systems					x					
Guan 2008	ERP Software	x									
Gupta et al. 2009	Simulation Software	x			x	x					
Gürbüz et al. 2012	general IS		x				x				
He and Li 2009	ERP Software							x			
Hong and Kim 2007	CRM System	x									
Hrgarek 2008	Management Software					x					
Huang 2008	general IS				x						
Jadhav and Sonar 2009	general IS	x				x	x				
Karaarslan and Gundogar 2008	ERP Software	x									
Karsak and Özogul 2009	ERP Software										x
Kontio 1996	COTS software	x				x					
Kutlu and Akpinar 2009	ERP Software										x
Lai et al. 2002	Multimedia Authoring System	x									
Le Blanc and Jelassi 1989	Decision Support System Software					x					
Lee and Wang 2007	general IS							x			
Lee et al. 2004	general IS										x
Liang and Lien 2007	ERP Software							x			
Lien and Chan 2007	ERP Software							x			
Lin et al. 2007	Date Warehouse System										x
Lingyu et al. 2009	ERP Software									x	
Mahalik 2011	E-governance Software	x			x						
Mamaghani_2002	Antivirus and Content Filtering Software	x									
Mao et al. 2009	general IS				x						
Mastalerz 2010	E-Leaning IT system			x							
Mehrjerdi 2012	RFID-based System									x	
Min 1992	general IS	x									
Miyoshi and Azuma 1993	general IS					x					
Morisio and Tsoukias 1997	general IS	x				x					
Mosley 1992	CASE tool					x					
Mulebeke and Zheng 2006	Software for Product Development		x								
Naumann and Palvia 1982	System Development Tools					x					
Ncube and Dean 2002	COTS software					x					
Neubauer and Stumme 2009	Web Services					x					
Ngai and Chan 2005	Knowledge Management Tools	x									
Nikolaos et al. 2005	ERP Software					x					
Ochs et al. 2001	COTS software	x									
Onut and Efendigil 2010	ERP Software							x			
Poston and Sexton 1992	Testing Tools					x					
Razmi and Sangari 2008	ERP Software				x		x				
Rouhani 2012	Business Intelligence for enterprise systems									x	
Sen et al. 2009	ERP Software										x
Shih 2010	ERP Software							x			
Stamelos et al. 2000	general IS			x		x					
Uysa and Tosun 2012	Maintenance Management Systems									x	
Vlahavas et al. 1999	Expert system;					x					
Wang and Lee 2008	general IS									x	
Wei et al. 2005	ERP Software	x									
Yazgan et al. 2009	ERP Software		x				x				
Ziaee et al. 2006	ERP Software						x				
Total		17	3	2	5	17	6	13	1	6	6

After excluding of AHP and FAHP methods, WSM and FTOPSIS are the most often mentioned representatives of classic vs. fuzzy methods to be compared (see Tab. 2). For this purpose a numeric example calculation will be presented in Section 4 as well as main advantages and drawbacks will be summarized in Section 5.

3.3 MCDM Framework for CRM System Selection

Irrespective of the method, the basic MCDM characteristics always apply. The least common denominator of the procedure explained in the literature (Wie et al. 2005, p. 50; Huang 2008; Gupta et al. 2009) is:

(1) Initially, a list of criteria is defined to determine the decision problem. MDCM problems deal with multiple decision criteria C_j , $j \in (1,n)$ which represent different aspects of alternatives A_i , $i \in (1,m)$. After the cross-functional project team was set up the first step is to select the relevant decision criteria in all categories. Evaluation criteria cannot exclusively focus on functional requirements, although these are critical. The criteria list presented in Tab. 1 is generally applicable, but each alternative must be rated according to the expectations of the individual case. This list must be enhanced with industry-specific criteria, as well as company-specific requirements with a special focus on sustainability.

Next, a list of alternatives for problem solving is created. The market of CRM systems packages is dominated by the vendors Microsoft CRM, SAP, Oracle Siebel and Salesforce. Depending on the individual CRM strategy, these alternatives must be expanded, e.g. automotive solutions include Detecon, Dealersocket and Autobase. This expanded list of alternative vendors needs to be shortened applying a structured approach, e.g. as presented in Friedrich et al. (2012).

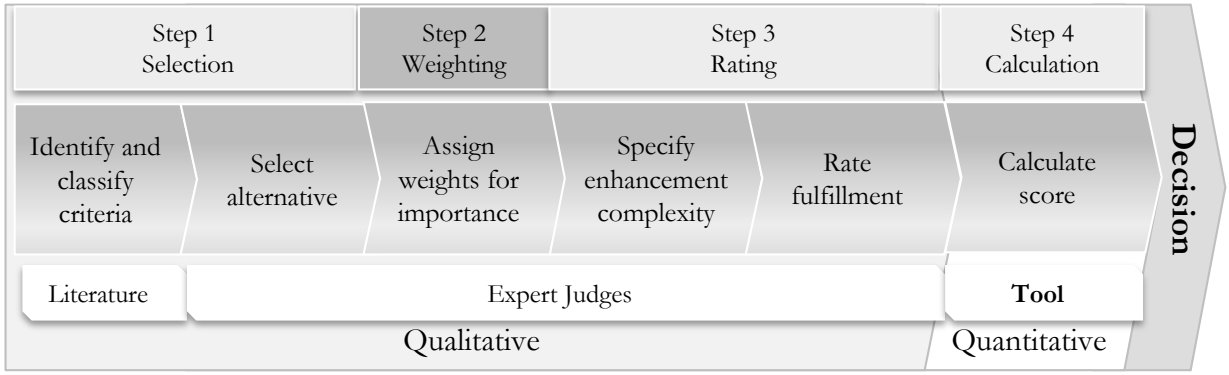

Fig. 2 MCDM Framework for CRM System Selection

(2) Then the weights are assigned to the criteria. During this step each criterion is weighted according to its individual importance. Importance in this context represents the significance of the criterion for the individual expert judge. The weights are assigned independently from the alternatives. Importance weights of various criteria are considered as linguistic variables, which can be expressed in crisp numbers for classic calculation (WSM) or in triangular fuzzy numbers for estimation by means of FTOPSIS (see Tab. 3a). The scores increase to reflect the level of importance.

(3) All alternatives are rated according to their fit to each criterion. For selection of sustainable CRM system the authors consider a further essential factor - the complexity of enhancing the feature to the expected level. According to Seacord et al. 2003 software sustainability means the ability of modifying a software system according to current needs and deploying

these modifications. That is exactly what should be measured by enhancement complexity which in this context means the effort needed to reach an expected level in the system through development or customization. The effort required for enhancement varies by CRM system software and regards only functional criteria. For example, complex enhancements in SAP result in higher efforts than in Microsoft Axapta. The implementation of a coefficient that helps to take enhancement complexity into account minimizes possible errors regarding cost and effort estimation. Weighting, rating and enhancement complexity scales are not generally defined and vary according to the decision problem. An example of the possible scales that are implemented within a numeric example in the next section provides Tab. 3 (a-c).

(4) Finally, an overall score is calculated and the alternatives are ranked.

Tab. 3 Linguistic Variables for Weighting, Rating, and Enhancement Complexity

Weighting (a)	Crisp	Fuzzy	Rating (b)	Crisp	Fuzzy	Enhancement Complexity (c)	Crisp	Fuzzy
Not Relevant (NR)	0	(0, 0, 0.1)	Very low (VL)	1	(0, 0, 0.1)	Hardly Possible (HP)	1	(0, 0, 0.1)
Medium Relevant (MR)	1	(0, 0.1, 0.3)	Low (L)	2	(0, 0.1, 0.3)	Very Difficult (VD)	2	(0, 0.1, 0.3)
Relevant (R)	2	(0.1, 0.3, 0.5)	Medium Low (ML)	3	(0.1, 0.3, 0.5)	Difficult (D)	3	(0.1, 0.3, 0.5)
Low Important (LI)	3	(0.3, 0.5, 0.7)	Medium (M)	4	(0.3, 0.5, 0.7)	Moderate (MD)	4	(0.3, 0.5, 0.7)
Medium Important (MI)	4	(0.5, 0.7, 0.9)	Medium high (VH)	5	(0.5, 0.7, 0.9)	Medium Easy (ME)	5	(0.5, 0.7, 0.9)
Very Important (VI)	5	(0.7, 0.9, 1)	High (H)	6	(0.7, 0.9, 1)	Easy (E)	6	(0.7, 0.9, 1)
Essential (ES)	6	(0.9, 1, 1)	Very high (VH)	7	(0.9, 1, 1)	Very Easy (VE)	7	(0.9, 1, 1)

In the case of CRM system selection, the authors suggest a framework described in Fig. 1 for applying the WSM. The steps are derived from the literature review on system selection. For FTOPSIS additional steps within a calculation step are necessary. (4a) Calculating the positive ideal solution; (4b) Calculating the negative ideal solution; (4c) Selecting the alternative which is next to the positive ideal solution and furthest from negative ideal solution (Gupta et al. 2009).

4 Applying WSM and Fuzzy TOPSIS to CRM System Selection

Once the values have been assigned to rating, enhancement complexity and criteria importance (weights), the CRM selection tool calculates the performance of each criterion for each alternative.

4.1 WSM Calculation

Let $A = \{A_1, A_2 ...., A_m,\}$ specify a set of alternatives. Then the score for the criteria n of the alternative A_i is calculated as follows (Nikolaos et al. 2005):

$$s_{ij} = w_j \cdot r_{ij} \cdot c_{ij}\,;\; i \in (1,m),\, j \in (1,n) \tag{9}$$

r_{ij} and c_{ij} denote rating and coefficient of enhancement complexity, respectively for the j^{th} criteria of i^{th} alternative. n and m are the numbers of criteria and alternatives. w_j describes the individual importance weight of the j^{th} criteria and is identical for all alternatives. As enhancement complexity is additionally added to the calculation, the value of the functional criteria score differs from the others. For this reason a normalized scores per category should be calculated:

$$S_i^k = \sum_{j=1}^{n} s_{ji}^k / \max_j s_{ji}^k ; i \in (1,m), k \in (1,4) \quad (10)$$

Total score per alternative (TS_i) is a sum of all category scores:

$$TS_i = \sum_{k=1}^{4} w^k s_i^k ; i \in (1,m) \quad (11)$$

Fig. 3 illustrates an example for the aggregated scoring of an individual company. In this example, the number of categories and alternatives both equal 4.

				Alternative											
				A_1: Alternative 1			A_2: Alternative 2			A_3: Alternative 3			A_4: Alternative 4		
Criteria		Weight		Rating	Coefficient	Score	Rating	Coefficient	Score	Rating	Coefficient	Score	Rating	Coefficient	Score
Quality criteria		**25%**				**4.63**			**4.27**			**3.97**			**3.97**
Popularity	(Q_1)	Low Important		Medium Low		9.00	Medium Low		9.00	Low		6.00	Low		6.00
Resources	(Q_2)	Medium Important		Medium		16.00	High		24.00	Medium		16.00	Medium high		20.00
Portability	(Q_3)	Medium Important		Medium high		20.00	Medium high		20.00	Very low		4.00	Medium Low		12.00
Security	(Q_4)	Very Important		High		30.00	High		30.00	Medium high		25.00	High		30.00
Timeliness	(Q_5)	Medium Important		Low		8.00	Low		8.00	Very low		4.00	Very low		4.00
Training & support	(Q_6)	Low Important		Medium high		15.00	High		18.00	High		18.00	High		18.00
Usability	(Q_7)	Medium Important		Medium		16.00	Very low		4.00	Medium		16.00	Very low		4.00
User acceptance	(Q_8)	Very Important		Medium high		25.00	Medium Low		15.00	High		30.00	Medium high		25.00
Functionality criteria		**25%**				**4.55**			**4.55**			**4.14**			**4.24**
Account Management	(F_1)	Essential		Medium Low	Easy	108.00	Medium Low	Easy	108.00	Medium Low	Difficult	54.00	Medium Low	Easy	108.00
Campaign Management	(F_2)	Medium Important		Medium high	Medium Easy	100.00	High	Easy	144.00	Medium	Very Easy	112.00	Medium	Moderate	64.00
Contact Management	(F_3)	Essential		Medium	Difficult	72.00	Medium Low	Difficult	54.00	Very low	Moderate	24.00	Very low	Easy	36.00
Customer Service	(F_4)	Very Important		Medium high	Medium Easy	125.00	High	Medium Easy	150.00	High	Medium Easy	150.00	High	Medium Easy	150.00
Field Service	(F_5)	Low Important		Medium Low	Hardly Possible	9.00	Low	Medium Easy	30.00	Low	Medium Easy	30.00	Low	Moderate	24.00
Internet	(F_6)	Medium Important		Very low	Easy	24.00	Very low	Easy	24.00	Low	Moderate	32.00	Medium	Easy	96.00
Lead & Opportunity Ma	(F_7)	Low Important		Low	Moderate	24.00	High	Moderate	72.00	Medium	Easy	72.00	Medium	Moderate	48.00
Relationship Manageme	(F_8)	Relevant		High	Difficult	36.00	Low	Very Easy	28.00	Very high	Very Difficult	28.00	Medium	Moderate	32.00
Reporting	(F_9)	Medium Relevant		Medium	Easy	24.00	Medium high	Easy	30.00	Medium high	Very Easy	35.00	Medium	Easy	24.00
Sales Management	(F_{10})	Low Important		Very high	Very Easy	147.00	Low	Very Easy	42.00	Medium	Very Easy	84.00	High	Difficult	54.00
Cost criteria		**25%**				**2.43**			**2.43**			**1.91**			**2.43**
Maintenance	(C_1)	Medium Relevant		Medium high		5.00	Medium high		5.00	Low		2.00	Medium high		5.00
Preparation & Installatic	(C_2)	Low Important		High		18.00	High		18.00	Medium		12.00	High		18.00
Resources	(C_3)	Very Important		Very high		35.00	Very high		35.00	Very high		35.00	Very high		35.00
Training & Support	(C_4)	Low Important		Medium		12.00	Medium		12.00	Very low		3.00	Medium		12.00
System Purchase Costs	(C_5)	Medium Important		Medium Low		12.00	Medium Low		12.00	Medium Low		12.00	Medium Low		12.00
Upgrade	(C_6)	Low Important		Very low		3.00	Very low		3.00	Very low		3.00	Very low		3.00
Technical criteria		**25%**				**4.57**			**3.14**			**4.46**			**3.43**
Data Integration	(T_1)	Essential		Medium Low		18.00	High		36.00	Very low		6.00	Medium high		30.00
Deployment	(T_2)	Low Important		Medium Low		9.00	Low		6.00	High		18.00	Very low		3.00
Integration & Infrastruc	(T_3)	Medium Important		Medium high		20.00	Low		8.00	High		24.00	High		24.00
Software & Hardware Re	(T_4)	Low Important		Very high		21.00	Medium		12.00	Very high		21.00	Very high		21.00
Mobility	(T_5)	Not Relevant		Medium		0.00	Medium		0.00	Medium		0.00	Medium Low		0.00
Modifiability & Maintai	(T_6)	Medium Relevant		High		6.00	Medium Low		3.00	High		6.00	High		6.00
Performance & Practical	(T_7)	Low Important		Very low		3.00	High		18.00	Very high		21.00	Medium		12.00
Reliability & Robustnes	(T_8)	Medium Important		Medium		16.00	Very high		28.00	Low		8.00	Very low		4.00
Scalability	(T_9)	Medium Relevant		Medium Low		3.00	Low		2.00	Medium Low		3.00	Medium Low		3.00
TOTAL SCORE						**4.05**			**3.60**			**3.62**			**3.52**

Fig. 3 Applying WSM to CRM System Selection

During step three, each criterion is weighted according to their individual importance w_j. Importance in this context represents the significance of the criterion for the individual rater. In contrast to the individual importance, the relative importance w^k indicates the overall significance of each category in comparison to the other categories. The weights (relative importance) on the level of "category" are based on the percentage scale (0 %-100%) and mirror the importance assigned to each of the categories, quality, cost, functionality and technical. For instance, if functionality is more important than cost it receives a higher percentage. The sum of all category weights must equal 100 per cent (Collier et al. 1999; Goyal and Sharma 2010). The relative importance of each criterion should not be assigned before all alternatives

are selected and rated to prevent results from affecting the rating of further alternatives. Especially when adding industry-specific alternatives, the criteria catalogue is extended, which has an impact on results and preferences. The relative importance of criteria represented by allocated weights must be hidden throughout the whole process so as not to influence the judgment of the person conducting the evaluation. In the present example all the categories receive the same weight. The tool indicates that in the present example, the best is an alternative 1.

4.2 FTOPSIS Calculation

In order to compare the calculation results of both methods the same example of an individual company which is described in Subsection 4.1 should be applied to FTOPSIS calculation. Taking alternatives A_i, $i \in (1, m)$ and criteria C_j, $j \in (1, n)$ into account the decision matrix D can be expressed as (12).

$$D = \begin{array}{c} \\ A_1 \\ A_2 \\ \cdots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \ldots & C_n \end{array} \\ \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \end{array}, \text{ where } \overline{x_{ij}} = (a_{ij}, b_{ij}. c_{ij})\text{-triangular number} \qquad (12)$$

According to the individual company example decision matrix for CRM system selection is presented in Tab. 4.

Tab. 4 FTOPSIS decision matrix for CRM system selection

	(Q_1)	(Q_2)	(Q_3)	(Q_4)	(Q_5)	(Q_6)	(Q_7)	(Q_8)	(F_1)	(F_2)	(F_3)
A_1:	(0.10;0.30;0.50)	(0.30;0.50;0.70)	(0.50;0.70;0.90)	(0.70;0.90;1.00)	(0.00;0.10;0.30)	(0.50;0.70;0.90)	(0.30;0.50;0.70)	(0.50;0.70;0.90)	(0.10;0.30;0.50)	(0.50;0.70;0.90)	(0.30;0.50;0.70)
A_2:	(0.10;0.30;0.50)	(0.70;0.90;1.00)	(0.50;0.70;0.90)	(0.70;0.90;1.00)	(0.00;0.10;0.30)	(0.70;0.90;1.00)	(0.00;0.00;0.10)	(0.10;0.30;0.50)	(0.10;0.30;0.50)	(0.70;0.90;1.00)	(0.10;0.30;0.50)
A_3:	(0.00;0.10;0.30)	(0.30;0.50;0.70)	(0.00;0.00;0.10)	(0.50;0.70;0.90)	(0.00;0.00;0.10)	(0.70;0.90;1.00)	(0.30;0.50;0.70)	(0.70;0.90;1.00)	(0.10;0.30;0.50)	(0.30;0.50;0.70)	(0.00;0.00;0.10)
A_4:	(0.00;0.10;0.30)	(0.50;0.70;0.90)	(0.10;0.30;0.50)	(0.70;0.90;1.00)	(0.00;0.00;0.10)	(0.70;0.90;1.00)	(0.00;0.00;0.10)	(0.50;0.70;0.90)	(0.10;0.30;0.50)	(0.30;0.50;0.70)	(0.00;0.00;0.10)
	(F_4)	(F_5)	(F_6)	(F_7)	(F_8)	(F_9)	(F_{10})	(C_1)	(C_2)	(C_3)	(C_4)
A_1:	(0.50;0.70;0.90)	(0.10;0.30;0.50)	(0.00;0.00;0.10)	(0.00;0.10;0.30)	(0.70;0.90;1.00)	(0.30;0.50;0.70)	(0.90;1.00;1.00)	(0.10;0.30;0.50)	(0.10;0.30;0.50)	(0.50;0.70;0.90)	(0.90;1.00;1.00)
A_2:	(0.70;0.90;1.00)	(0.00;0.10;0.30)	(0.00;0.00;0.10)	(0.70;0.90;1.00)	(0.00;0.10;0.30)	(0.50;0.70;0.90)	(0.00;0.10;0.30)	(0.70;0.90;1.00)	(0.00;0.10;0.30)	(0.00;0.10;0.30)	(0.30;0.50;0.70)
A_3:	(0.70;0.90;1.00)	(0.00;0.10;0.30)	(0.00;0.10;0.30)	(0.30;0.50;0.70)	(0.90;1.00;1.00)	(0.50;0.70;0.90)	(0.30;0.50;0.70)	(0.00;0.00;0.10)	(0.70;0.90;1.00)	(0.70;0.90;1.00)	(0.90;1.00;1.00)
A_4:	(0.70;0.90;1.00)	(0.00;0.10;0.30)	(0.30;0.50;0.70)	(0.30;0.50;0.70)	(0.30;0.50;0.70)	(0.30;0.50;0.70)	(0.70;0.90;1.00)	(0.50;0.70;0.90)	(0.00;0.00;0.10)	(0.70;0.90;1.00)	(0.90;1.00;1.00)
	(C_5)	(C_6)	(T_1)	(T_2)	(T_3)	(T_4)	(T_5)	(T_6)	(T_7)	(T_8)	(T_9)
A_1:	(0.30;0.50;0.70)	(0.70;0.90;1.00)	(0.00;0.00;0.10)	(0.30;0.50;0.70)	(0.10;0.30;0.50)	(0.50;0.70;0.90)	(0.70;0.90;1.00)	(0.90;1.00;1.00)	(0.30;0.50;0.70)	(0.10;0.30;0.50)	(0.00;0.00;0.10)
A_2:	(0.30;0.50;0.70)	(0.10;0.30;0.50)	(0.70;0.90;1.00)	(0.90;1.00;1.00)	(0.00;0.10;0.30)	(0.50;0.70;0.90)	(0.70;0.90;1.00)	(0.90;1.00;1.00)	(0.30;0.50;0.70)	(0.10;0.30;0.50)	(0.00;0.00;0.10)
A_3:	(0.30;0.50;0.70)	(0.70;0.90;1.00)	(0.90;1.00;1.00)	(0.00;0.10;0.30)	(0.10;0.30;0.50)	(0.00;0.10;0.30)	(0.30;0.50;0.70)	(0.90;1.00;1.00)	(0.00;0.00;0.10)	(0.10;0.30;0.50)	(0.00;0.00;0.10)
A_4:	(0.10;0.30;0.50)	(0.70;0.90;1.00)	(0.30;0.50;0.70)	(0.00;0.00;0.10)	(0.10;0.30;0.50)	(0.00;0.10;0.30)	(0.70;0.90;1.00)	(0.90;1.00;1.00)	(0.30;0.50;0.70)	(0.10;0.30;0.50)	(0.00;0.10;0.30)

With given weightings vector $W = (w_1, w_2, \ldots, w_m)$ and decision matrix D the goal is to rank the alternatives. Before the provided data can be used a normalized decision matrix should be developed:

$$R = [r_{ij}],\ i = 1, \ldots, m; j = 1, \ldots, n, \qquad (13)$$

$$r_{ij} = \left(\frac{a_{ij}}{c_j^+}, \frac{b_{ij}}{c_j^+}, \frac{c_{ij}}{c_j^+}\right) \qquad (14)$$

j stand for an index of corresponding benefit criteria. and $c_j^+ = \max_i(c_{ij})$ (15)

$$r_{ij} = \left(\frac{a_j^-}{c_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{a_{ij}}\right) \qquad (16)$$

j stand for an index of corresponding cost criteria. and $a_j^- = \min_i(a_{ij})$ (17)

Now having a normalized decision matrix the weighted normalized decision matrix can be constructed:

$$V = [v_{ij}]\ i = 1, \dots, m; j = 1, \dots, n; v_{ij} = x_{ij} \times w_{ij}\ , \tag{18}$$

v_{ij} is triangular number $(v_{ij\ 1}, v_{ij\ 2}, v_{ij\ 3})$

According to the individual company example weighted normalized decision matrix is presented in Tab. 5.

Tab. 5 Weighted normalized FTOPSIS decision matrix

	(Q_1)	(Q_2)	(Q_3)	(Q_4)	(Q_5)	(Q_6)	(Q_7)	(Q_8)	(F_1)	(F_2)	(F_3)
A_1:	(0.20;0.60;0.20)	(0.20;0.60;0.20)	(0.00;0.20;0.00)	(0.00;0.20;0.00)	(0.30;0.50;0.30)	(0.70;0.90;0.70)	(0.30;0.50;0.30)	(0.50;0.70;0.50)	(0.56;0.78;0.56)	(0.56;0.78;0.56)	(0.00;0.00;0.00)
A_2:	(0.20;0.60;0.20)	(0.20;0.60;0.20)	(0.20;0.60;0.20)	(0.50;0.70;0.50)	(0.70;0.90;0.70)	(0.30;0.50;0.30)	(0.30;0.50;0.30)	(0.43;0.71;0.43)	(0.14;0.43;0.14)	(0.00;0.00;0.00)	(0.00;0.00;0.00)
A_3:	(0.56;0.78;0.56)	(0.33;0.56;0.33)	(0.90;1.00;0.90)	(0.00;0.10;0.00)	(0.30;0.50;0.30)	(0.70;0.90;0.70)	(0.10;0.30;0.10)	(0.70;0.90;0.70)	(0.00;0.00;0.00)	(0.50;0.70;0.50)	(0.10;0.30;0.10)
A_4:	(0.30;0.50;0.30)	(0.30;0.50;0.30)	(0.90;1.00;0.90)	(0.00;0.10;0.00)	(0.00;0.00;0.00)	(0.20;0.60;0.20)	(0.00;0.20;0.00)	(0.20;0.60;0.20)	(0.20;0.60;0.20)	(0.56;0.78;0.56)	(0.56;0.78;0.56)
	(F_4)	(F_5)	(F_6)	(F_7)	(F_8)	(F_9)	(F_{10})	(C_1)	(C_2)	(C_3)	(C_4)
A_1:	(0.11;0.33;0.11)	(0.70;0.90;0.70)	(0.70;0.90;0.70)	(0.50;0.70;0.50)	(0.70;0.90;0.70)	(0.00;0.33;0.00)	(0.00;0.33;0.00)	(0.00;0.00;0.00)	(0.00;0.00;0.00)	(0.50;0.70;0.50)	(0.70;0.90;0.70)
A_2:	(0.50;0.70;0.50)	(0.70;0.90;0.70)	(0.70;0.90;0.70)	(0.70;0.90;0.70)	(0.20;0.60;0.20)	(0.00;0.20;0.00)	(0.00;0.20;0.00)	(0.00;0.20;0.00)	(0.00;0.00;0.00)	(0.00;0.00;0.00)	(0.00;0.14;0.00)
A_3:	(0.00;0.10;0.00)	(0.70;0.90;0.70)	(0.00;0.00;0.00)	(0.50;0.70;0.50)	(0.00;0.10;0.00)	(0.70;0.90;0.70)	(0.70;0.90;0.70)	(0.90;1.00;0.90)	(0.30;0.50;0.30)	(0.90;1.00;0.90)	(0.90;1.00;0.90)
A_4:	(0.00;0.11;0.00)	(0.00;0.11;0.00)	(0.70;0.90;0.70)	(0.70;0.90;0.70)	(0.30;0.50;0.30)	(0.70;0.90;0.70)	(0.90;1.00;0.90)	(0.90;1.00;0.90)	(0.90;1.00;0.90)	(0.90;1.00;0.90)	(0.43;0.71;0.43)
	(C_5)	(C_6)	(T_1)	(T_2)	(T_3)	(T_4)	(T_5)	(T_6)	(T_7)	(T_8)	(T_9)
A_1:	(0.70;0.90;0.70)	(0.70;0.90;0.70)	(0.43;0.71;0.43)	(0.00;0.00;0.00)	(0.43;0.71;0.43)	(0.00;0.00;0.00)	(0.50;0.70;0.50)	(0.10;0.30;0.10)	(0.70;0.90;0.70)	(0.50;0.70;0.50)	(0.20;0.60;0.20)
A_2:	(0.43;0.71;0.43)	(0.00;0.10;0.00)	(0.70;0.90;0.70)	(0.30;0.50;0.30)	(0.30;0.50;0.30)	(0.70;0.90;0.70)	(0.00;0.10;0.00)	(0.90;1.00;0.90)	(0.30;0.50;0.30)	(0.33;0.56;0.33)	(0.56;0.78;0.56)
A_3:	(0.43;0.71;0.43)	(0.43;0.71;0.43)	(0.43;0.71;0.43)	(0.14;0.43;0.14)	(0.70;0.90;0.70)	(0.10;0.30;0.10)	(0.70;0.90;0.70)	(0.70;0.90;0.70)	(0.00;0.00;0.00)	(0.70;0.90;0.70)	(0.90;1.00;0.90)
A_4:	(0.43;0.71;0.43)	(0.00;0.00;0.00)	(0.43;0.71;0.43)	(0.20;0.60;0.20)	(0.20;0.60;0.20)	(0.20;0.60;0.20)	(0.20;0.60;0.20)	(0.00;0.00;0.00)	(0.00;0.00;0.00)	(0.00;0.00;0.00)	(0.00;0.33;0.00)

Afterwards the two ideal solution points (positive-ideal solution and negative-ideal solution) should be determined:

$$A^+ = (v_1^+, v_2^+, \dots, v_n^+), \text{where } v_j^+ = \max_i\{v_{ij\ 3}\} \tag{19}$$

$$A^- = (v_1^-, v_2^-, \dots, v_n^-), \text{where } v_j^- = \min_i\{v_{ij\ 1}\} \tag{20}$$

v_j^+ and v_j^- are calculated with a help of min and max functions. That is the reason they are the real numbers and not a triangular number. In the next step ,we need to calculate the distances from the positive-ideal solution and the negative-ideal solution to each alternative according to (21-22):

$$d_i^{K+} = \sum_{j=1}^{n} d\left(v_{ij}^K, v_j^+\right), \text{where K is number of expert judges} \tag{21}$$

$$d_i^{K-} = \sum_{j=1}^{n} d\left(v_{ij}^K, v_j^-\right), \text{where K is number of expert judges} \tag{22}$$

As previously mentioned v_j^+ and v_j^- are real numbers which should be converted into triangular numbers to calculate the distance. Real number v_j^+ and v_j^- can be replaced with the following triangular (1, 1, v_j^+) and (v_j^-, 0,0) correspondingly. After calculation of distances and with the purpose of estimating of group preferences provided by multiple expert judges the following formula can be used for determination of geometric mean

$$d_i^{-+} = \left(\prod_{p=1}^{K} d_i^{p+}\right)^{1/p} \tag{23}$$

$$d_i^{--} = \left(\prod_{p=1}^{K} d_i^{p-}\right)^{1/p} \tag{24}$$

For calculation of the relative closeness of alternative Ai with respect to the ideal solution A^+ the following formula is used:

$$C_i^- = \frac{d_i^{--}}{d_i^{-+} + d_i^{--}} \tag{25}$$

Tab. 6 Final computation: (a) all criteria are from type "benefit" / (b) incl. "cost" criteria

(a)	d_i^{-+}	d_i^{--}	C_i^-
A_1:	23.5276448092238	10.40325587990	**0.3066**
A_2:	25.4502469301641	8.50889572348	0.2506
A_3:	25.8343252969503	7.93683341148	0.2350
A_4:	25.5485702206592	8.25775494150	0.2443

(b)	d_i^{-+}	d_i^{--}	C_i^-
A_1:	21.8148978681285	12.11600282099	0.3571
A_2:	21.0725291585089	12.88661349514	**0.3795**
A_3:	22.0442890077157	11.72686970071	0.3472
A_4:	22.3329082421697	12.15368829482	0.3524

The set of alternatives will be ranked accordingly to the descending order of C_i^-.

Tab. 6a shows that FTOPSIS calculation leads to the same result as WSM method, where the alternative 1 is favored. It means the main advantages and drawbacks of both methods are crucial for choosing the preferred one.

5 Discussion, Limitations and Recommendations

WSM causes less cost measured by the time to be spent by decision makers. (Neubauer and Stummer 2009). Compared to other methods, it can be applied rather quickly and produces similar results. The implementation of this method within a spreadsheet tool (see Fig. 3) makes the proposed CRM-specific MCDM framework not only automatable but also easily manageable (Collier et al. 1999). Ratio scales used within WSM for weighting and rating of criteria have an unpleasant compensation effect where e.g. high scoring of quality and low scoring of cost leads to the same scoring result as an alternative with high scoring of costs and low scoring of quality on condition that all relative weights remain constant (Morisio and Tsoukias, 1997). In the presented example all the criteria were defined as "benefit" criteria (see Section 2) as it is recommended to always to use criteria of the same type for the correct application of WSM (Caterino et al. 2009). It is conceivable that a decision maker expects a better system hidden behind high purchase costs and therefore strives towards maximizing them. But it is also imaginable that the decision maker will at the same time try to minimize e.g. upgrade costs or costs for keeping the system up and running. Thus, should the criteria "upgrade" and "maintenance" be defined as type "cost", WSM calculation result will become unreliable. Compared with that, the usage of positive-ideal solution and negative-ideal solution within FTOPSIS helps to better take the CRM system selection criteria of type "cost" into account. Those criteria have a different effect on the decision making as benefit criteria (see Fig. 4) as the positive-ideal solution minimizes the cost criteria whereas the negative-ideal solution maximizes the cost criteria (Huang 2008). As a result, alternative 1 is no longer the preferred one. In case, where a rating of all cost criteria is minimized, the best is alternative 2 (see Tab. 6b).

Also FTOPSIS method seems to suit better to CRM system selection because of the following reasons (Olcer and Odabasi 2005; Huang 2008):

- FTOPSIS is effective in choosing the best alternative quickly
- "The preference order of the alternatives is obtained by their rank on a descending order of the ratings"
- The calculation of FTOPSIS is relatively simple
- FTOPSIS deals well with a situation of a multiple judgment (see Fig. 4), which is important for CRM system selection to avoid a "one person" and/or political decision.

Methodologically, the CRM system selection problem is a fuzzy multiple criteria group decision-making problem which combines a consideration of fuzzy evaluation and multiple expert judgment. The expert judges sometimes have to deal with the problem of selecting a solution from a limited predefined set of alternatives. Sometimes the set of alternatives does not include the best alternative for a specific company at all. The chosen alternative is not always the best but at least a better one. It can also be a compromise option that meets some objectives. (Olcer and Odabasi 2005).

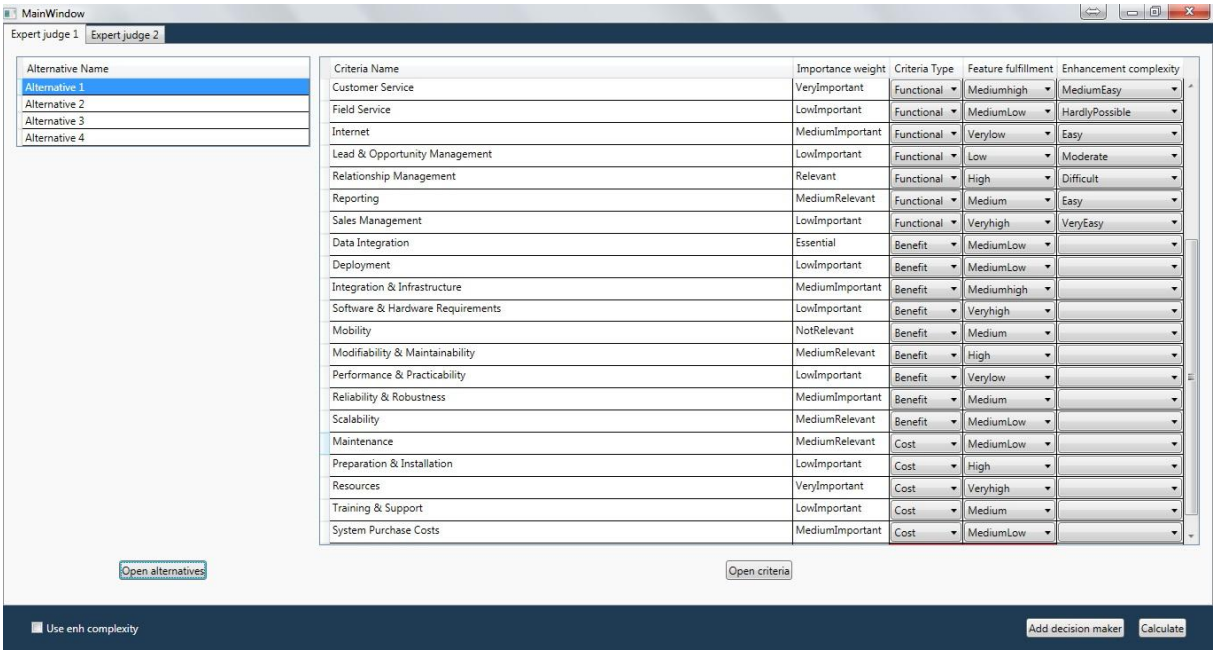

Fig. 4 FTOPSIS Calculation Tool for CRM system selection (program interface)

Although the literature review of the evaluation methods for software selection shows the tendency to FAHP method, the authors believe that the disadvantages of FAHP outweigh the advantages of FTOPSIS. Furthermore, CRM system selection projects often have different project budgets, duration and capacities compared to e.g. ERP solution selection. Even if FAHP e.g. allows a hierarchical criteria structure which is not possible within FTOPSIS, the added value does not justify the additional time and budget required. If a specific criterion should be considered in more detail, it can be replaced through the new detailed criteria without considering a complicated hierarchical structure for it. E. g. to better consider the functional criterion "sales force automation" it can be replaced thought the new detailed criteria

“quotation&order management”, “sales planning&forecasting”, “activity management”, “product configuration&pricing” and “contract management”. It will enlarge the criteria list but still can be easily managed by FTOPSIS within the developed tool. There are two perspectives in the rating phase that are the important conceptual contribution of this paper. Besides the rating an enhancement complexity factor is suggested. This dimension gives an important indication for how complex and costly a development or customization of a specific CRM system will be.

Without a doubt, there are too many factors that affect the final outcome of a CRM system implementation and strategies might change during evaluation and selection. The final ranking depends on the subjective judgment of the evaluation project team, which might change over time, too.

6 Conclusions and Outlook

The primary aim of this paper is to find and compile the relevant criteria for the selection of an optimal sustainable CRM-System. In order to generate an overview of significant selection criteria, a literature review was conducted on the major research databases in the field of ISR. The results were subsequently verified with CRM practitioners within an international online survey. The answer to the research question - *Which criteria should be taken into account while selecting a sustainable CRM-System?*- is as follows:

33 selection criteria from categories “quality”, ”cost”, ”functionality” and ”technical” were extracted as relevant for CRM system selection and discussed with regard to sustainability. Sustainable CRM means maintaining long-term profitable customer relations by taking economic, environmental, and social aims into account (Müller 2014). These aspects of sustainability should be considered in the detailed definition of functional criteria and they may differ depending on the industry. In addition to the sustainability issues related to sustainability of CRM (the functional criteria) the system independent software-based sustainability needs to be investigated. The requirements for software sustainability reflect most of the quality and technical criteria for CRM system selection.

The second research objective of this paper is to determine the most appropriate evaluation method regarding the criteria for CRM system selection. The result is a MCDM framework including a tool which supports the structuring of the underlying MCDM problem of sustainable CRM system selection. The research includes contributions to software evaluation and answers the research questions “*Which evaluation method, classic or fuzzy, is more suitable for the specific multi-criteria decision making problem of sustainable CRM system selection?”* as follows:

FTOPSIS is a fuzzy MCDM method for identifying the best from a limited number of alternatives - which the authors considered as the best for CRM system selection. The basic rule of this method is that the selected alternative has the shortest distance from the positive-ideal solution and the farthest distance from the negative-ideal solution (Yang and Wu 2008). The proposed method allows the experts to give their explicit judgments and to receive their final ranks directly. The linguistic variables of fuzzy set theory are considered to better present the

preferences and judgments of the experts and to better reflect the subjectivity of human judgments. It is easier and more natural for the experts to make linguistic judgments than to choose an appropriate crisp number by weighting or rating of alternatives (Wang et al. 2009).

FTOPSIS and the developed calculation tool in particular, both allow considering multiple judgments, which is important for CRM system selection to avoid a "one person" and/or political decision. The further advantage of FTOPSIS is the possibility to correctly treat the criteria of type "cost" and to consider them differently from those criteria which increase the system performance ("benefit" criteria). The results of the CRM-specific MCDM framework and tool are only meaningful for a particular company at a specific point in time. The linguistic variables used for rating and weighting in the Section 4 can be individually chosen. To validate the decision, the framework and tool should be adapted to different scenarios to analyze the robustness of the result.

Making a final decision still requires an in-depth analysis of available results to be made by decision-makers. According to the company's individual prioritization, considering TCO (all direct and indirect costs of the system that is in scope) and cost/utility ratio may also affect the final result (Le Blanc and Jelassi 1989). The presented MCDM framework and tool provides valuable insight in terms of analyzing various aspects that affect the efficiency of a CRM implementation. The decision is based on meaningful results that can be presented later in the implementation process if the decision is challenged. According to strategy consulting companies like Deloitte, AT Kearney, and McKinsey, evaluation methods are one of the four major key elements for implementation (Hart et al. 2004). The MCDM framework and tool aid the selection process of CRM systems in an efficient way. To even better validate the proposed MCDM framework, a comprehensive case study should be conducted, preferably in a context where a CRM system selection was carried out and the software has already been implemented for at least one year. The results achieved by the MCDM framework and tool must be compared to the results and outcome of the former CRM system selection in an a posteriori analysis and evaluation.

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