Adoption of e-invoicing by SMES the business document standards aspect

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Master's Thesis 🛪 Business Informatics 🛪 Utrecht University

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ABSTRACT:

Nowadays, more and more organizations send their invoices electronically. Despite the fact that the potential benefits are irrelevant to the size of the company which applies the technology, e-invoicing has managed to appeal the interest of mainly the larger organizations, leaving the small and medium enterprises (SMEs) at an early stage of adoption. The vast majority of the invoice volume in SMEs continues to be published on paper, whereas the digitization of the process merely involves the exchange of files as attachments of e-mail messages in most of the cases. Thanks to various standardization approaches, innovative, simpler and more affordable methods of applying e-invoicing have been introduced. However, SMEs are still reluctant in proceeding into a totally automated, full scale application of the technology due to, among other reasons, the multitude of different standards which are currently in use. Companies are now facing the following dilemma: which business document standard is most suitable for them, and which of the available should be supported at the same time? The purpose of the present study is to provide a better understanding on how can business document standards be evaluated and utilized by SMEs during the adoption of e-invoicing. After assessing the importance of customizability and extensibility for the interoperability of standardization, we develop an evaluation framework that classifies standards according to their support on these two characteristics. We also construct a simple, step-bystep method that guides the evaluation of standards in a given organizational setting. Finally, we formulate a number of recommendations in order to consult SMEs about the utilization of standards in their e-invoicing plans.

After scrutinizing some of the most prominent business document standards, our first findings shed light on how they handle customizability and extensibility, and, as a consequence, reveal which of them are most suitable for SMEs. We proceed in the conduction of interviews with experts with the intention to validate the initial evaluation method and recommendations. The results, lastly, indicate which sub-characteristics of customizability and extensibility are crucial for the e-invoicing adoption venture of SMEs.

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Chapter 1

Introduction

The purpose of the current chapter is to introduce the topic and the research approach of the present thesis study. It also includes the reasons which motivated us to initiate the research, the final contribution of our results to the public interest, as well as a short description of related notions.

1.1. Research motivation

1.1.1. Problem description

Every year approximately 33 billion invoices are being sent within the European borders. Nowadays, just the 12% of the total business-to-clients volume and 18% of the business-to-business volume are invoices that are published and processed electronically. The vast majority of the invoice volume continues to be published on paper and – within the scope of small and medium enterprises (SMEs) in particular – the observed trend indicates that they only use email messages to exchange flat digital files as invoices instead of adopting the totally automated but complex methods of e-invoicing (Koch, 2012). On the same time, e-invoicing is crucial for the limited resources of SMEs as it allows them "to grow their business, in terms of orders, customers or suppliers, without having to invest in a proportionate number of employees to carry out repetitive administrative tasks" (Ciciriello & Hayworth, 2009). In addition to the improvement of productivity, due to the substantial optimization of business transactions e-invoicing can also reduce the administrative costs for SMEs even by 50% (Salmony & Harald, 2010). Consequently, the efforts to increase the awareness of SMEs for the potential benefits should be continued at an intensive pace. However, the current presence of various data models - the building blocks of any electronic document such as the e-invoice – which are semantically defined by multiple and diverse business document standards is considered as one of the biggest obstacles and challenges for the adoption of einvoicing by SMEs. The specific requirements of different geopolitical regions, industries or markets have encouraged an abundance of dominant standards in which an e-invoice can be expressed today. In the meantime, the evolution of internet offered lucrative opportunities even for SMEs, as long as they are ready to maneuver within multiple supply chains by supporting the co-existing e-invoice standards. This challenge has been addressed with conversion mechanisms, yet, they often comprise cumbersome implementation and maintenance, prone to errors and delays performance, and weak conformance with local legal regulations - overall a too complex and costly solution for SMEs. As a result, the discussion about the relation between standardization and e-invoicing should be intensified until we can find a feasible solution to the following problem statement: in order to increase e-invoicing adoption rates in SMEs, improved leverage of the diverse business document standards is required.

1.1.2. Research focus

Ciciriello and Hayworth (2009) in their "European E-Invoicing Guide for SMEs" identified the key issues of e-invoicing's adoption by SMEs (in order of significance): customer readiness/compatibility, readiness/compatibility with internal information sys-

tems, complexity, and legal uncertainty. More specifically, readiness/compatibility with internal information systems and complexity, two of the most major problems are technology-related matters which are the corollary of using the business document standards to express e-invoices. A recent, big-scale survey across enterprises in Europe revealed that 40% of even the large companies are reluctant to adopt e-invoicing due to the perceived complexity and lack of sufficient business document interoperability (YouGovStone, 2011), leaving SMEs with much less available resources to be much more intimidated for the same reasons. According to these indications, the use of multiple business document standards requires sophisticated information systems and encourages complexity; these are most major standardization-related issues which hamper the adoption of e-invoicing by SMEs. The standards have such an impact on e-invoicing simply due to their poor interoperability, i.e. their incapability to adjust in diverse contexts. Extensibility and customizability of the standards – the characteristics which are related with their operability (Kabak & Dogac, 2010) – are their weakest aspects up to today, and thus, they attract the main interest of our research.

1.1.3. Research goal

Regardless of the fact that the e-invoicing adoption barriers faced by SMEs have been researched extensively, our understanding on the role of business document standards remains fragmented. Many researchers refer to technology as an important factor of affecting the dissemination of the e-invoices between SMEs, the business document standards aspect though – just a segment of the technology factor – consists of unique characteristics and should be analyzed separately. The aim of our study is to address this matter, that is, to gather information about the impact of business document standards on e-invoicing and analyze how they can be leveraged in order to lead SMEs to higher e-invoicing adoption rates.

1.2. Research setup

1.2.1. Research model

We classify the present study into the *business research* category, which is often described as being *qualitative* or *quantitative* (Wilson, 2010). The purpose of our research is to discover insights and better understanding concerning the impact of the different business document standards on the adoption of e-invoicing in SMEs. The nature of the characteristics of the document standards in combination with the characteristics of the nature of SMEs cannot be numerically expressed through a measurement and computation of numeric values. Accordingly, we adopt the *qualitative* as the most suitable strategy to conduct our research. The qualitative notion in research determines techniques and procedures through which data is collected and analyzed descriptively (Saunders et al., 2009). Zikmund, Babin, Carr and Griffin (2012) explain that the *qualitative business research* is dealing with business objectives, allowing researchers to interpret market phenomena and elaborate on argumentations without relying on numerical measurements. The main goal is to discover true insights and better understanding concerning these phenomena in a non-strict manner, whilst researchers can extract valuable understandings in unstructured responses, like a recorded interview or a picture illustrating an activity.

Further on, we launch our investigation by following the stepwise approach on *case studies* in business research by Dul and Hak (2008). The authors define the *case study* as a research project in which one or a small number of cases are captured in their real-life context and they are analyzed in a qualitative manner. According to this definition, we notice that our choice to follow a qualitative research strategy fully coincides with the qualitative perspective of case studies. Figure 1.1 includes the generic stepwise approach (left side) as well as its utilization in our research (right side).



FIGURE 1.1 Research approach – adapted from Dul & Hak (2008).

After defining the research topic (*step 1*), the general research objective and the general type of research we follow is *practice-oriented*: we aim in enhancing the knowledge of practitioners on how business document standards should be improved in facilitating the adoption of e-invoicing by SMEs (*step 2*). The following activity (*step 3*) prescribes the collection of information about how standards affect e-invoicing, a hypothesis which is prevailed in the current literature in a certain extent. Next, we conduct an experiment to test the validity of the aspects of this hypothesis (*step 4*) on a chosen locally-relevant environment in the domain of our interest (*step 5*). We use interviews and direct observations on physical artifacts (*step 6*) to qualitatively analyze and validate the results of our experiment (*step 7*). Finally, we discuss the implications of our findings in e-invoicing's adoption by SMEs (*step 8*) and summarize our research to be used by practitioners (*step 9*). All the research activities are discussed in depth in the following sub-section.

1.2.2. Research setup in detail

The stepwise research approach by Dul and Hak (2008) contains three phases: the *preparation phase* (steps 1, 2, 3), the *research phase* (steps 4, 5, 6, 7), and the *implications and report phase* (steps 8, 9). After applying the direction and scope of our research, the phases and the steps they encompass are described as follows:

+ Preparation phase

The purpose of this phase is to formulate a generic plan about the tasks required for the designing and execution of our research project.

Step ^① ▶ Define research topic

During this step, we select and specify our research topic. We start generating ideas about e-invoicing and its current degree of diffusion in corporate environments. After a preliminary investigation, multiple sources including scientific articles, annual reports, expert opinions, newspaper columns, internet articles, and online magazines, confirm the fact that many companies – especially the SMEs – are still struggling in adopting the technology. The same sources attribute this phenomenon to several reasons; however, all of them mention the implications of using multiple business documents standards. While the existence of multiple e-invoice standards is an irreversible fact, our research topic becomes less broad by choosing to focus on a stage prior to the operation of invoicing, which is the acceptance of the standards. Our topic becomes even more concrete, when we decide to concentrate our interest on the SMEs and exclude the larger corporations, where the dissemination of the technology is much higher due to their additional physical and intellectual resources. We, finally, formulate the topic of our research: The impact of *different business document standards in the adoption of e-invoicing in SMEs*.

Step ⁽²⁾ > Define the general research objective and general type of research

The general research objective can be defined by two types of general research: the *theory-oriented* and the *practice-oriented*. In the first, the deliverables are contributing to the development of a theory which is evaluated, verified and used by members in the academic community. In the second, the results are enhancing the knowledge of specific members in the business community on how to deal with a specific practical issue.

Our goal is to contribute in enriching the knowledge of members in the business community – and practitioners employed by SMEs in particular – to surmount the problems caused in the progress of adopting e-invoicing by the diversity of the document standards. As a result, the most applicable option for our study is the *practice-oriented* paradigm.

Step ⁽³⁾ Define the specific research objective and the specific type of research

After espousing the practice-oriented paradigm as the general research objective, we must proceed into the choice of a more concrete research objective among three different practice-oriented types of research: the *hypothesis-testing*, the *hypothesis-building* and the *descriptive*. If a hypothesis is already available but it needs to be evaluated in order to provide missing knowledge that will enable practitioners to tackle a specific problem, the hypothesis-testing practice-oriented research is the most appropriate one. If practitioners are not aware about the association between aspects of their real-life business situations, then the hypothesis building practice-oriented research is more suitable. If we estimate that it is not necessary to create and evaluate a hypothesis, but it is rather necessary to identify and describe aspects related to the problem, we should resort to the last type of practice-oriented research, the descriptive one.

In our individual case, the very first activity to identify the problem is to approach the people who are related with our general research orientation. These practitioners are not just the "owners" of the applied knowledge, they are the most appropriate persons to confirm the existence or not of the problem we are about to investigate. By talking and working with them, we will have the chance to observe the problem while it occurs under real circumstances. The observation of realworld activities will help us to detect the conditions under which the different business document standards impede the adoption of e-invoicing. The next task is to identify if the problem is covered in the existing literature through the exploration of the related theory. Our findings will help us to support the hypothesis that business document standards are greatly affecting the adoption of e-invoicing within SMEs' environments. After having a hypothesis successfully formulated, the next plausible step is to design and conduct *hypothesis-testing* practice-oriented research.

• Research phase

The purpose of this phase is to select a specific type of a research strategy and conduct the related research activities.

Step ④ Choose the research strategy

Dul & Hak (2008) suggest a method of detecting the most appropriate research strategy, based on the type of the research question. There are four types of hypotheses: the ones that express a *sufficient* condition in the form of "if there is A there must be B"; the ones that express a *necessary* condition in the form of "B does not exist without A"; the ones that express a *deterministic* condition in the form of "If A is higher then B is higher"; the ones that express a *probabilistic* condition in the form of "if A is higher, then it is likely that B is higher". After we specify the type of our hypothesis, we can proceed into the choice of the appropriate research strategy.

In our study, the derived hypothesis is comprised of conditions (*the impact of different business document standards*) causing an effect which already exists (*the adoption of e-invoicing in SMEs*). In that respect, a hypothesis can be expressed as "if there is 'diversity in business document standards' there must be 'an impact on the adoption of e-invoicing by SMEs'", which consequently positions it to the *sufficient* type of hypotheses. According to Dul and Hak (2008) the primary goal of practice-oriented hypothesis-testing research is not to verify a theoretical assumption within a generic theoretical domain. Instead, it aims in testing the validity of a hypothesis within a locally relevant set of conditions. Having to deal with the sufficient type of hypothesis, the authors suggest an *experiment*, a *case study* or a *survey* in priority order. Hence, we choose to conduct an *experiment*, the first in the list of the suggest-ed research strategies.

Experiments are conducted by an executor who is able to adapt behaviors in a direct, precise and systematic way. The focus of an experiment may lie on some isolated variables, excluding the remaining ones which affect behavior in a way that is beyond the scope of interest (Yin, 2008). In our study, an experiment takes place in a real corporate environment with the intention to investigate the characteristics of business document standards that influence the adoption of e-invoicing in SMEs, and, ultimately, to construct an evaluation method based on the investigated characteristics.

Iivari (2007) prescribes *design science* for the construction of IT artifacts – such as the evaluation method we will try to construct – within the discipline of Information Systems (IS) research. Hevner, March, Park, and Ram (2004), the mentors of the

design science, describe the IS as implementations which are taking place within an organization for the purpose of improving its usefulness and efficiency, whilst design science is improving the effectiveness and utility of IT artifacts to deal with real-world business problems. The same authors counted the real-life problems of IS where design science can provide effective solutions:

- ✗ non-stable requirements and limitations based on ill-defined environmental contexts.
- ★ conflicts among subcomponents of an issue
- * fragility in modifying design processes as well as design artifacts
- high degree of dependence on human cognitive abilities to deliver effective results
- ★ high degree of dependence on human social abilities to deliver effective results

The problem to be solved in our study can be best described by the second item of this list; the dissemination of e-invoicing across SMEs is hampered due to the multitude of different business document standards in use. We therefore choose to be guided by the principles of the design science research during our experiment.

Hevner et al. (2004) proceeded into providing an understanding on how to conduct, evaluate, and present design science research within the IS discipline. Moreover, they introduced a clear set of seven guidelines through which we can conduct and evaluate high quality design research. However, Hevner (2007) extended this study so as to provide a more detailed process in conducting design science research. Figure 1.2 illustrates the author's proposed process including three research cycles: the relevance, the rigor, and the design cycle. The figure also depicts how the design science paradigm was utilized in our study. The *relevance cycle* interconnects the contextual conditions of the research project with the design science tasks. It defines not only the requirements of the research problem but also the criteria through which the research results can be evaluated as successful by answering the question "does the design artifact make the environment better and how can this improvement be measured?". The shape suggests that the outcome of the design science research must be returned into the environment in order to be evaluated by the actual domain of interest. The rigor cycle interconnects past knowledge with the design science activities. It consists of the method to ensure the innovation of the designs artifacts and to claim their research contribution without repeating the practices of the already known design artifacts. The shape indicates that the outcome of the design science research must be evaluated through research and reference on the existing - relevant to the domain of interest - knowledge base. The central *design cycle* repeats the building and evaluative activities until the production of a design artifact which fulfills certain requirements and evaluation criteria. The input for the iteration is given by the relevance cycle (requirements) and the rigor cycle (evaluation criteria). While the design cycle is taking place, it is of a crucial importance to keep the balance among the construction activities (relevance cycle)

and the evaluation activities (*rigor cycle*). The value of artifacts should be thoroughly tested through multiple iterations in the design cycle, until they can finally become outputs in the relevance and rigor cycles, and contribute with tangible results in the environment and the knowledge base respectively.



FIGURE 1.2 Design science research circles - adapted from Hevner (2007).

Based on the guidelines suggested by Hevner et al. (2004), the experiment of our research project is conducted by adopting and applying the design science research paradigm as follows:

Guideline ^① Design as an Artifact

The very first direction towards a successful designing science research is to produce a purposeful and innovative computer-based IT artifact. Design science research leads to the construction of IT artifacts by demonstrating feasibility, not only in the artifact itself, but also the design process which yields the artifact. The IT artifacts may have the form of intellectual or software tools dedicated to improve the process of developing information systems. In our study, we apply design science research by creating an evaluation method useful in the adoption of e-invoicing in SMEs, and we seek constructs and ways in which the method itself and its construction processes can be significantly improved. After scrutinizing several business document standards, we detect and isolate the characteristics that influence the adoption of e-invoicing. These characteristics are turned into qualitative criteria in an evaluation method that facilitates the verdict on whether the standard is appropriate to be implemented in the e-invoicing platform of an SME. This evaluation method is the clearly identifiable artifact of our design science research. As far as the design process is concern, we rely on theories on how standardization characteristics influence e-invoicing in combination with practical observations while business document standards operate in an actual corporate environment.

Guideline ⁽²⁾ Problem relevance

As we already outlined, design science research aims in the implementation and development of technology-based artifacts that resolve important business issues. The second guideline designates the necessity of the IT artifacts to be properly combined with the existing organization-based and people-based artifacts to address these problems. The effective business processes introduced by IT artifacts play a crucial role in increasing revenues or decreasing costs, as long as they remain equally affordable to the related people, organizations, and information technology. This way, information systems remain relevant across business communities and facilitate their goals within their actual economic and social setting.

Numerous studies and surveys in the field of the adoption of e-invoicing by SMEs testify the importance of the benefits after the adoption. SMEs nowadays are more than convinced that such an adoption can lead to tremendous increment of performance in e-business activities. Nevertheless, the absence of inexpensive supportive tools in combination with the presence of numerous business document standards makes SMEs reluctant to embrace the e-invoicing technology, mainly because of the increased costs. Apart from the supportive tools themselves, the existing related theory covers the subject only superficially; such a deficit describes the two-fold relevant problem that our research addresses.

Guideline 3 Design evaluation

The *design evaluation* guideline requires the designed information system to be tested in terms of its utility, quality and efficiency, through a well-designed evaluation method. Evaluation inevitably occurs when the artifact is integrated within the technical infrastructure of the business environment. Then, the definition of appropriate metrics and the collection and analysis of appropriate data are necessary to be able to measure the quality attributes of the artifact within the working conditions of the organization. Our design artifact is evaluated through the opinions of experts who facilitate other SMEs in adopting e-invoicing. We build our evaluation method based on direct observations during the operation of business document standards within a particular corporate environment. Later on, we improve and adapt the method based on insights we extract by interviewing experts. In addition to the locally performed evaluation, supplementary evaluations on external contents are taken into account. Additional interviewees provide supplementary feedback which is taken into account on further improving of the system.

Guideline Research contributions

The fourth guideline asses the contribution of the implemented artifact on the areas of design artifacts, design construction knowledge, and/or design evaluation knowledge, by posing the question *"what are the new and interesting contributions?"*.

The first contribution of the present study to the design science research is the indepth analysis of a number of technical aspects of standardization. The second contribution is a classification framework that enables the taxonomy of business document standards based on their capabilities in supporting the detected technical aspects.

The essence of this guideline lies on the rigorous research methods and the way that they are applied in both the construction and evaluation of the designed artifact. Rigor is the outcome of the effective selection of theoretical knowledge and research methods while we construct or evaluate an artifact. If mathematical formalisms are absent in order to provide a tangible description of the artifact, rigor should be assessed in an abstract way, based on the applicability and the general abilities of the artifact.

The discovery of literature on e-invoicing systems, business document standards, and SMEs leads constructs the knowledge base of our study. Previous research studies have covered only partial the impact of business document standards on the adoption of e-invoicing by SMEs. Our motivation is driven from the current absence of a "recipe" instructing the use of different business document standards as ingredients in driving the adoption of e-invoicing in SMEs to higher levels.

The sixth guideline of Hevner et al. (2004) directs design science in becoming a search process towards the discovery of an effective solution to a problem. In design science, heuristic search strategies detect a set of all possible infrastructures (*means*), determine their utility and restrictions (*ends*), and specify all cost and benefit aspects (*laws*) in order to solve a problem. The problem is decomposed into sim-

pler - but significant - sub-problems and through an iterative progress, means, ends, and laws are refined to produce enhanced in relevancy and value artifacts. Means lead to the decision of feasible design solutions and they are expresses as variables. Ends also lead to the decision of a feasible design solution by forming utility functions and constraints expressed in variables and constants. Laws are expresses as the values of these constants.

The design process of our artifact expands in a period of eight months and it is mainly hosted by the real corporate environment of a company named *DigitaleFac-tuur* situated in the Netherlands (more details in Section 6.1 of Chapter 6). The project initiates by examining various business document standards in operation in an existing e-invoicing software system being used by numerous SMEs. We determine the available means, ends, and restricting laws while e-invoicing standards are utilized in practice. A repeated investigation cycle takes place in order to detect the most optimal methods of manipulating the technology features of standardization within an e-invoicing system.

Guideline ⁽²⁾ Communication of research

The final guideline scrutinizes the way in which the design research is presenting its results to both technology- and management-oriented audiences. Technology practitioners on the first hand must be able to understand the way that the artifact was constructed and evaluated. As long as the researcher provides sufficient details about how the artifact was implemented and the how it can be fit into various organizational-specific contexts, the technology technology-oriented audience can adopt and enjoy the benefits of the suggested solution, and even extent and/or evaluate the artifact even further. On the other hand, management-oriented audiences demand information concerning the organizational resources required for the adoption of the artifact. Researchers, apart from focusing on artifacts themselves, should also communicate the innovative way of bringing effective solutions to problems that managers are dealing with in their every-day businesses.

Although the main part of our study describes technology features of e-invoicing standards, we provide surrounded information which appeals the interest of both technical and managerial audiences. We avoid presenting any technical detail (i.e. syntax examples and content of e-invoices) on how the techniques of document standards are being utilized on e-invoicing. By referring to standardization details on a descriptive level, we try to motivate both managerial and IT researchers to pay attention on the influence of the variety of document standards on the adoption of e-invoicing by SMEs. As a result, the technical audience becomes aware about which standardization features are significant on that context. On the same way, the managerial audience becomes acquainted with efficient and cost-effective practices in facilitating e-invoicing in small-scale businesses.

The aim of this final phase is to summarize the outcome of the study, to discuss its implications and to present ideas for possible different or additional research directions.

Step (5) Select instances

This step dictates the evaluation of possible instances for the study, i.e. the choice of the best candidate(s) within the domain, the field of which is about to be bene-fitted by the creation of knowledge throughout the experiment. In order to gather the appropriate candidates, it is necessary to interact with experts and practitioners of that specific domain. Most of the times, the origin of the candidates is restricted by regional or national boundaries, no matter that the domain they belong is not defined by those boundaries.

The objective of the present study is related to the adoption of e-invoicing by SMEs; it is plausible therefore, for the sake of evaluating our topic, to seek for candidate cases in the related domain. Sections 6.1 and 6.2 provide more details about this step.

Step [®] ▶ Conduct measurement

The purpose of this step is to designate the most appropriate measurement method which is able to describe precisely the dimensions of the experiment at hand. The concepts of our research strategy should be defined concretely in the form of variables, so as their values can measure the instances of the concepts throughout the experiment.

In our study, we primarily deal with the "adoption" of e-invoicing in SMEs and the "impact" on it by the different business documents standards. The "adoption" and the "impact" factors should be defined in a manner which will allow us to detect their presence or absent, and in the first case, if they are present, we should be able to quantify the extent they are present. Barnes (2001) quotes five different measurement approaches that can be performed in a research project: *ethnography, interviews, strategy charting, questionnaires,* and *documentation.* Among those approaches, the author describes interviews as the means of conducing high quality and in depth measurement the superiority of which is only exceeded by ethnographies. Ethnographies on the other hand, are the most time and money consuming approaches, requiring the researcher to dedicate extended periods of time on site.

The first part of our study deals with the observation of e-invoicing documents standards while they operate within a real corporate environment. This part helps on the discovery of the qualitative criteria that our evaluation method should include. Moreover, we also have to approach additional sources so as to verify the significance of the detected metrics on the adoption of e-invoicing by SMEs. The

type of our research strategy leads us, therefore, to skip ethnography and incorporate the next most effective way of collecting high quality research data, the *interviews*. By choosing to conduct interviews with experts, we triangulate our initial findings with additional contextual data.

Step ⑦ ▶ Conduct data analysis

During this step, our initial hypothesis is confirmed or rejected by interpreting the scores we obtained in the previous step. We compare the pattern we witnessed during the measurement with the pattern we assumed in the hypothesis in a qualitative manner. The outcome of the analysis is derived through this straightforward comparison; a match between the predicted and the observed pattern confirms the hypothesis, whilst a mismatch indicates a rejection of the hypothesis.

More details about this step can be found in Chapter 7.

Step ⑧ ▶ Discuss results

The outcome of this step is the distilled knowledge deriving from the whole research venture. More details about this step can be found in Chapter 8.

Step ⑨ ▶ Report the research

This step yields the essence of the knowledge we obtained throughout this study in an extended format. Chapter 8 includes a summary of our most important findings.

Figure 1.3 summarizes all the above mentioned steps along with the corresponding deliverables of our study.



FIGURE 1.3 Research model.

1.3. Research validity

Validity in a qualitative research such ours, refers to whether its findings are *true* and *certain* – "true" in the sense that research findings accurately reflect a situation, and "certain" in the sense that research findings are supported by evidence (Guion, Diehl & McDonald, 2011). To ensure the validity of our study, we appeal to Johnson (1997) who proposed a number of validity types and a corresponding set of strategies that maximize the plausibility, the trustworthiness and the plausibility of qualitative research efforts.

First of all, we rely on *theoretical type* validity that explains how a phenomenon operates and why it operates as it does. Two strategies promote this type of validity. The first one is the *extended fieldwork* which prescribes researchers to collect data in the field over an extended period of time. During our study we spend a period of eight months within a corporate environment in order to observe patterns in relationships between a) capabilities of e-invoicing standards and requirements by SMEs, and b) standards and e-invoicing. Our aim will be to render our theoretical explanations more detailed and intricate. The second strategy is called *theory triangulation* and examines how the phenomenon being studied would be explained by different theories. In many stages of our study, we will try consider the ideas and explanations generated by additional researchers studying the relationships we described before: a) e-invoicing standards and SMEs, and b) standards and e-invoicing.

Secondly, we inherit the *interpretive type* of validity; it refers to the degree to which the research participants' viewpoints, thoughts, feelings, intentions, and experiences are accurately understood and portrayed. *Participant feedback* is the most important strategy for this validity. It requires feedback and discussion of our interpretations and conclusions with other members participating in investigated matters for verification and insight. We will share our findings on the business document standards aspect of e-invoicing in SMEs with people having expertise in dealing with the subject and deriving from different business environments. Through *expert interviews*, we will try to verify the extent in which our proposed evaluation method is valid, and later on, we will try to adapt and improve it so as it can reflect the insights obtained by the experts.

1.4. Research questions

The main research question which will help us to achieve our research goal is:

How can business document standards be evaluated and utilized by SMEs during *e*-invoicing's adoption?

In order to assist our research method, we divide the main research questions into the following sub-questions:

• What factors related to business document standards influence the adoption of e-invoicing?

• Why are customizability and extensibility important for the interoperability of business document standards?

• What different profiles of customizability and extensibility exist in business document standards?

• What factors influence these customizability and extensibility profiles?

• What customizability and extensibility lessons can be learned from existing business document standards?

O How can the identified influential factors be used to improve the evaluation of business document standards in SMEs?

The purpose of the first two sub-questions is to explore the pre-assumed by the main research question relation between business document standards and the adoption of e-invoicing. The problem between standards and e-invoicing becomes more specific through an extended literature review, and sub-questions 3 through 6 illustrate the aspects of the problem in a concrete manner. In the end, sub-question 7 aims in the construction of a generic method of improving the standards towards their optimization of facilitating SMEs' efforts to adopt e-invoicing. The research model depicted in Figure 1.2 allows us to following this approach.

1.5. Scientific & practical contribution

The first contribution of the present study is of a scientific nature; the proposed method of improving the customizability and extensibility abilities of business document standards extends the knowledge on standardization and its enhanced efficiency to be able to adapt in a given organizational setting (SMEs). The second contribution of our study is both practical and scientific; some of the most prominent and widely used standards are scrutinized and classified according to their customizability and extensibility being observed while they operate in real corporate environments. Later on, we seek sources in the literature to identify the weaknesses of the same standards when they operate in SME environments. Finally, the third contribution has a practical impact; we summarize a list of specific recommendations on how adoption rates of e-invoicing can be increased despite the current use of multiple business document standards. Corporations can, thus,

obtain concrete advices on how to deal with the implications of manipulating numerous standards during their efforts to embrace e-invoicing.

Chapter 2

Standardization & e-invoicing

In this chapter we investigate the relation between standardization and einvoicing. We start with an introduction on e-business and e-commerce, and we include the progress of e-invoicing standards starting from the first approaches till the most recent ones. We continue by collecting information from previous studies in order to identify and describe the factors related to standardization which influence the adoption of e-invoicing. Although many of the influential factors affect all types of corporate environments, those factors are closely bonded to SMEs are specifically indicated. In the end of the chapter we include the answer to sub-question **0**.

2.1. The importance of SMEs

According to the European recommendation (European Union, 2005) an SME is an "enterprise which employs fewer than 250 persons and which has an annual turnover not exceeding 50 million euro, and/or an annual balance sheet total not exceeding 43 million euro". They have attracted the interest of many researchers for basically two reasons: fore and foremost they conduct the majority of nowadays' business activities and secondly because they belong to a heterogeneous group of companies which require customized support. Nevertheless we are not dealing with an emerging research field.

The volume of the research started to increase back in the early 1970s, when largescale industries lost their confidence and SMEs gained governmental interest (Carter & Jones-Evans, 2006). Nowadays SMEs have managed to be recognized as the backbone of the economy in many countries; in the United States for instance, they create two of every three jobs, they produce 39% of the gross national product and they could invent more than half of country's technological advancements within a single year (Kuan & Chau, 2001). In Europe the scene is rather similar with the SMEs to be the initiators of 99% of the total business activities, the employers of 68% of the total occupations and 63% of the total business turnover (Matlay, 2000). The current progress in the evolution of SMEs requires them to have access in global markets. At this level, additional business opportunities – such as exploitation of technological advantages, decrement and share of costs and improved access to finance – arise and lead SMEs to a stronger strategic position (Lukacs, 2005).

The features that differentiate SMEs from larger enterprises are mainly their centralized management strategy, their rather poor management and business skills and their constant struggle for independence (Fredriksson, 2007). Practices which have been applied successfully in large organizations cannot easily be scaled down and adopted by SMEs due to those special characteristics (Supyuenyong, Islam & Kulkarni, 2009). Several factors have been recognized as influential on the successful adoption of new technologies, yet, they are generic in nature and therefore not well-adapted to the unique context of SMEs. Prior history of research in the field of e-commerce and e-business should be mapped specifically into the dimensions of smaller enterprises. Any set of identified enablers or barriers of earlier studies must be confirmed with practical evidences that they are applicable in SMEs (Windrum & De Berranger, 2003).

2.2. E-business & e-commerce

E-business refers to the state of companies when their activities are supported by and integrated with information systems. It includes electronically mediated information exchanges while business processes are carried out both within the

internal and the external environment of an organization (Chaffey, 2009). One of the most fundamental business processes is the invoicing and it is an integral part of any organization across the globe. It transfers billing information to the external environment, and since e-business is involved in the digitization of the inbound and outbound of information, e-invoicing is intertwined with e-business.

E-commerce describes the process of buying and selling products by using the internet. It encompasses all the electronically mediated transactions between companies and their trading partners (Chaffey, 2009). Through this point of view, e-invoicing is the corollary of the electronic purchases; it contributes to fully automated transactions by issuing electronic invoice information.

2.3. E-invoicing

Invoices are commercial documents containing billing information which derives from sales transactions between a supplier and a buyer. Prices, description of products, order numbers, dates of purchases, payment terms, and tax details are some of the data constituting an invoice and they provide proofs of the delivery of goods and services. Whereas invoices can be traditionally exchanged in a printed format, *e-invoicing* provides methods of sending *and* processing invoices via electronic means. The automated process of invoices is the most significant differential factor and advantage of e-invoices over the traditional paper invoices.

Nowadays, a considerable number of the total volume of invoices are being sent electronically contains unstructured data (Koch, 2012) and exploits only a few of the potential benefits that structured e-invoices can bring. E-invoicing in its fully structured and automated form entails coupling with procurement, production, inventory, ordering, payment, delivery, and bookkeeping systems, integration with suppliers' and customers' systems and, of course, electronic transmission of invoices. Unfortunately these sophisticated processes require extensive investments on information systems.

Companies – especially the small-sized ones – often choose to avoid or simply cannot afford such an expense and they continue sending unstructured invoices as attachment files in e-mail messages, a method which merely imitates a faster and more eco-friendly way of exchanging paper invoices. Luckily enough, the latest trend of software as a service, which allows the use of information systems on demand, introduced additional and more economical means of applying and using einvoicing. Such facilitation permits the transmission of e-invoices either directly, between the trading partners, or indirectly, via a third party consolidator, and raises the existence of three different e-invoicing models: *biller direct, buyer direct* and *consolidator* (Mai & Meyer, 2010) (Figure 2.1). At this stage of flexibility, companies can now have three options in adopting e-invoicing: *outsourcing, self-service* or *limited self-service* (Ciciriello & Hayworth, 2009). The first option enables firms to outsource the e-invoicing function and put a service provider in charge of translating the inbound and outbound of data during transactions with their trading partners. The second option prescribes the implementation and use of an in-house e-invoicing infrastructure based on an internal software application. The third option allows companies to preserve an internal e-invoicing infrastructure; however the exchanged data with the trading partners are carried out by using an external service.



FIGURE 2.1 E-invoicing models (Mai & Meyer, 2010).

2.3.1. E-invoicing in Europe

E-invoicing has been designated as one of the most efficient methods for companies to increase productivity. Currently, there are over 400 active e-invoicing service providers in Europe and they are increasingly cooperating towards firm interoperability agreements (Salmony & Harald, 2010). The current status of einvoicing in Europe can be analyzed through two important findings (Koch, 2012):

Finding 1: e-invoicing continues to grow very fast from a low base, but its penetration levels are still very low in under-addressed market segments, particularly in the SME sector.

Finding 2: the European market is too fragmented for e-invoicing services and solutions, facing the insurmountable challenge of reaching all potential e-invoice users.

The future scheme as it was predicted by Salmony and Harald (2010) wants Europe to move to a fully electronic real-time economy. E-invoicing is just a precursor towards *e-procurement*, providing electronic catalogues and online ordering, and *e-trade*, applying integrated e-financing and trade of digital papers). There are three directives towards this progression (Loughlin, 2013):

Mandate: mandating e-invoicing would act as major driver for the service providers to operate in a truly networked environment and make the e-invoicing eco-system work.

Regulate: regulations about anti-competitive, protectionist or exploitative behavior by dominant players or cartels will allow European Union (EU) to intervene prominently at short notice when necessary.

Educate: the member states within the EU should publicize e-invoicing's benefits by educating the markets and playing a full role in demystifying how e-invoicing rules are applied, especially in cross border transactions.

2.3.2. E-invoicing in the Netherlands

The results of a recent survey among various 500 companies in the country of origin of our study, the Netherlands (E-invoicing Platform, 2011; International Accounts Payable Professionals [IAPP], 2011), revealed that the country is heading to 94% of adoption by 2014. More specifically, 39% of the surveyed corporations are currently using e-invoicing, a further 34% intent to start the adoption during the current year (2012) and 21% plan to accept it between 2012 and 2014. Another remarkable outcome from a company's size point of view was that SMEs (including the ones which already adopted e-invoicing and the ones which are willing to do in the near future) tend to leverage or perceive e-invoicing in the least efficient way; the majority of them focuses on the merely transferring invoicing details from paper to flat electronic documents, whilst only the bigger companies are aware of the core innovations of the new trend and, thus, reap all the benefits. In another local study conducted by van Heck and Ribbers (1999), Dutch SMEs recognized since long ago the impact of the business document standards as a critical factor of structuring dynamic documents such as invoices. Standards that are widespread and popular are motivating users to rely on electronic means for efficient internal and external communication. Moreover, they guarantee minimized implementation time and cost.

2.4. E-invoicing benefits

E-invoicing is an integral part of e-business and e-commerce and consequently inherits most of their benefits. However, one of the most significant advantage, the reduction of administrative costs, is directly related to e-invoicing; by abolishing paper invoices the prices are plummeting to 75% (Aberdeen Group, 2005). Multiple authors have identified and measured the benefits of e-invoicing through different perspectives.

Sandberg, Wahlberg and Pan (2009) argued that the adoption of e-invoicing leads in higher automation of the trading process, in elimination of errors, in creation of benefits for both sellers and customers, and in standardization of problem solving practices. Mai and Meyer (2010) described the macroeconomic benefits of einvoicing: a) company modernization, b) modernization of public procurement, c) strengthening of the European single market, d) fight against tax evasion and accounting fraud, and e) showcase for new technology.

Salmony and Harald (2010) are defending the importance of the extensive adoption of e-invoicing for the following reasons:

- 1. Competitiveness, productivity and customer satisfaction is improved for both private and public sector organizations.
- 2. Substantial cost savings arise through the reduction of manual work, materials, transport and auditing costs, and fraud prevention.
- 3. Automation of payment and accounting practices reaches higher levels and improves cash flow between organizations.
- 4. Productivity of the workforce is leaded to more creative tasks.
- 5. Integration and harmonization of practices within a single market (such as the European enterprises) is fully established.
- 6. Minimizing carbon and natural resources saves the environment.

Korkman, Storbacka & Harald (2010) mentioned the two-fold benefits of einvoicing, for citizens and the society. In the first case individuals can reap benefits such as:

- ★ Memorizing key in amounts, payment receivers, dates and reference numbers is not necessary.
- Reminders of paying in case of a standing order are not required.
- No need to handle of paper copies of invoices.
- ★ No need to reserve specific time to pay invoices.
- ✗ Representation of information is simplest and easily understandable by non-experts.

According to the same authors, the benefits for the society are:

- ✗ Plummeting of processing, financing and risk costs making countries with faster uptake more competitive.
- ✗ E-invoicing can serve as "learning-by-doing" practice for further layers of digitalization and automation in other business practices.
- ★ The potential to reduce the environment load by 2.800.000 tons.
- ✗ Challenge for the EU growth as fewer resources will be required for the less value-creating labor work.

2.5. E-invoicing & SMEs

SMEs are forming a unique type of a business environment where the IT utilization is mainly driven by the limited availability of knowledge and resources. A European recommendation defines them as corporations which employ less than 250 individuals and obtain an annual turnover of less than 50 million euros. Despite the limitations, SMEs nowadays have realized the potential profits and customers by being part of the global marketplace through the internet. As we described in the introductory chapter, e-invoicing is the most efficient method of handling and processing invoices with electronic means. It has been also designated as the most inexpensive way to perform such a task, even for SMEs.

Nevertheless, even nowadays, SMEs still prefer using traditional paper invoices since they are facing special difficulties in coping with e-invoicing's high demands in invoice volumes, the increased costs of investment and integration, and, of course, the existence of different standards (Sandberg et al., 2009). On the other hand, the implications for the SMEs which will deny adopting the technology will be: a) lagging behind the market, b) missed opportunities, c) continued reliance of traditional methods of business, d) conservative image problem, e) lost customers, and f) new barriers to entry over time (Fillis, Johannson & Wagner, 2004). These two contradicting powers leave SMEs in doubt about the benefits of e-invoicing and attract the interest of many researchers. An additional reason that makes medium-sized firms the most interesting group of applying e-invoicing, is simply because they offer a greater scope than the big firms in structuring and automating business processes by adopting modern methods (Mai & Meyer, 2010).

2.5.1. Special benefits for SMEs

Salmony and Harald (2010) mentioned e-invoicing as the precursor to automated payments and financial practices. Due to the acceleration of the cash flow the credit losses are decreased and SMEs can seize the opportunity to enhance their credit availability at a lower cost. Fillis et al. (2004) claimed that the adoption of e-invoicing can lead SMEs in reaping the following multiple benefits: a) better relationships with customers and suppliers, b) increased information, c) increased visibility, d) competitive advantage, e) access to new markets, f) real time communication, g) increase knowledge, h) greater efficiency, i) cheaper promotional costs, j) more even playing field between small and large firms, k) new distribution and communication channels, and l) better targeting of customers.

Based on the empirical study of Sandberg et al. (2009), the following benefits were confirmed by the actual SMEs which had already adopted the technology:

- ✗ Cost savings.
- ★ Staff resources can be set free for other tasks.

- ★ Interest revenues and less invoice remainders needed.
- ★ Reduced paper handling is beneficial for the environment.
- ➤ Using modern, rational and environmentally friendly technique can be good from a PR perspective.
- ✗ Strengthening of customer relations.
- Improved customer loyalty.
- **x** Competitive advantage.
- Lower error rate.
- ★ Service for the customers which makes it easier doing business.

Similarly, Korkman et al. (2010) cited a number of benefits that could be especially related with the trading activities being carried out by SMEs:

- × Substantial cost savings in receiving, paying and sending invoices.
- ✗ Financing costs are decreased as cash flow is improved with faster invoicing and faster payments.
- * Credit risks and cost for risk insurance are lowered.
- ★ Fraud and fraud prevention costs are decreased.
- × VAT reporting, payments and auditing become cost-efficient.
- **x** Easier to outsource accounting.
- ✗ Savings are substantial and it is likely to be high enough to cover the einvoicing investments.
- ★ The same service can be used to send invoices to both consumers and businesses.
- ★ Automation of duplication, approval and return of invoices to the financing provider.
- ★ Automation of VAT reporting and payments.

2.5.2. Adoption of e-invoicing in SMEs

SMEs are attributed with special uniqueness in terms of needs, knowledge and resources when introducing e-invoicing (Fillis et al., 2004). Contrary to the extensive investments in e-invoicing by large enterprises of both the private and the public sector, SMEs remain slow in continuing at the same level of pace. Sandberg et al. (2009) identified in the literature the most prevailed reasons which explain why SMEs are still struggling with the adoption of e-invoicing:

- ★ Absence of business and IT strategy.
- Limited access to financial resources.
- ★ Strong influence of major customers.
- Limited information skills.
- ★ High degree of locus of control in decision making by managers/owners.
- ➤ Dependence of adoption of new technologies on managers'/owners' approach towards innovations.

However, the same yielded results which indicate that SMEs are fully ready to adopt e-invoicing and revealed the most significant factors which affect the adop-

tion: a) perceived benefits, b) organizational readiness, c) external pressure, and d) owner/manager characteristics.

Salmony and Harald (2010) claimed that SMEs are still unaware of the potential benefits e-invoicing can deliver; they tend to neglect the considerable labor required to administrate traditional invoices and they falsely believe the low volume of invoices they issue does not justify automation. The authors specified in addition a number of guidelines for any approach aiming to accelerate the speed of adoption in the SME-sector:

- 1) Local banking authorities should collaborate with service providers for financial solutions with zero IT investments and costs.
- 2) The public sector should impose restrictions and deadlines for the reception of traditional (non-structured) invoices.
- 3) The large and powerful enterprises should also apply similar restrictions in all transactions with their suppliers.
- 4) The transition of paper invoices should be charged with additional costs.
- 5) Financial practices such as accounting, cash flow estimates, VAT procedures, fraud and risk mitigation etc. should be intergraded with any einvoice solution.
- 6) The news about the benefits of e-invoicing should be broadly and constantly diffused across customers, suppliers, staff and society.

Penttinen and Tuunainen (2011) conducted a survey and they were able to identify the factors affecting the adoption of e-invoicing in SMEs: the organizational readiness, the perceived benefits, the external pressure from customers, the bandwagon effect, and the supplier pressure (in order of significance) are the driving forces of accepting the technology.

Svirskas and Roberts (2005) claimed that the most prevailing issue that keeps SMEs reluctant into embracing e-business practices is the lack of trust, which has the following consequent issues:

- ★ Secure and reliable messaging over the Internet.
- Resiness documents specification, applicable standards.
- Business process decomposition, identification of reusable collaboration scenarios.
- ★ Machine-readable business process definition and their run-time interpretation.
- ★ Atomicity of business transactions.

Naggi and Agostini (2011) attributed the slow diffusion of the technology in SMEs to the following reasons:

- B2B transactions are becoming complex by heterogeneous e-invoicing formats and transmission channels.
- ★ Multiple participants and processes create an intricate value chain.
- ★ Legislation is diversely interpreted by the different counterparts.

- ★ Regulatory requirements are different in every nation.
- * A common international standard for layout and data elements is missing.

2.6. Business document standards

2.6.1. The origin

Electronic data interchange (EDI) was one of the first standardization efforts in transferring data between different computer systems or computer networks. EDI is a topic that has been broadly covered by numerous of studies. And while its advancements are closely related to the advancements of IT, it underwent various steps of progression and maturity. It was initiated back in the mid-1960s as an effort to improve the information flow within companies by standardizing the interchange business documents and designating a new type of a data element: *the EDI message.* Since then, and mainly driven by the heterogeneous business industries and sectors, the diverse (proprietary or not) supporting systems and the need of arbitrary inter-corporate interactions, multiple initiatives have taken place in order to define EDI messages, leading to different domain-specific *business documents standards.* During all the initiatives, the primary goal has been remained the same: the inter- and intra-organizational exchange of information in an efficient, fast, meaningful and accurate manner.

While the focus was initially on the definition of the transferred data (semantics), the latest trends in business documents standards are characterized by the adoption of *Extensible Markup Language* (XML); the center of the attention lies on the structure of the data (syntax) and, thus, leads to the construction of more interoperable and comprehensible EDI messages (Hasselbring & Weigand, 2001). Nowa-days, we even distinguish the traditional EDI with standards defined in delimiterbased languages with machine-to-machine orientation, from the new era of XML EDI with standards defined in markup-based languages with machine-to-human orientation and business processes embedded in the transmitted messages. The more recent XML-based standardization of EDI messages revealed its superiority since the beginning of the new millennium and now is gradually displacing the obsolete standards originated in the traditional EDI period. Contrary to its obsolescence and mainly because of its numerous existing infrastructures, EDI faces an annual growth of 3 to 5% every year and carries out a heavy degree of the current electronic business transactions (Vollmer, Gilpin & Stone, 2007).

2.6.2. Business document standards and SMEs

The increasingly popular XML-based standards brought advantages towards a more seamless transmission of e-invoicing data, we notice though a much smaller degree of their penetration in SMEs. The extensive complexity and implementa-

tion effort which is required by the recent XML standards simply does not much with the specific technological and organizational infrastructure of SMEs' environments; e-invoicing then tends to become a risky choice and there might possibly be zero benefits or even lower performance after the adoption (Beck, Weitzel & König, 2002).

Furthermore, due to the great numbers of legacy EDI systems used throughout the network of partners and customers, it seems that the adoption of a unique XML standard - especially for the transmission of data deriving from the financial sector - is quite utopian (Liegl, Zapletal, Pichler, & Strommer, 2010). Liegl et al. (2010) in their recent extensive study on business document standardization categorized standards into families and classified them, among other criteria, according to potential business user groups. Some of the major results were the following:

- Legacy and regulatory matters demand the coexistence of traditional and modern standards; the bond to older data transfer technologies is still very strong. SMEs representatives are approaching new standards with skepticism; they are reluctant to invest on the implementation of a new standard, since the stability and the efficiency of using the old ones were thoroughly tested through years of application.
- 2) The most popular and prevailed standards are the ones were focusing on a specific business sector.
- 3) The best way to achieve a common and ubiquitous business document exchange standard in the future is an implementation neutral approach where documents are defined on a generic and conceptual level without complying with specific syntaxes and semantics. Separate reusable and scalable entities are the core components of this approach and through a mapping mechanism they can adopt the semantics of specific implementations (see Chapter 4).
- 4) The reason that a common and ubiquitous business document exchange standard has not established yet is mainly related to the political decisions that have to be made in corporate environments in order to adopt it.

And the survey of the authors (Liegl et al., 2010) concerning the evaluation of standardization approaches to cover the needs of the SMEs revealed the following outcomes:

- 1) The implementation of recent markup-based standards is far more too complex than the implementation of delimiter-based standards. The required implementation cost for most SMEs is too high and makes their adoption unaffordable.
- 2) The adoption of a recent document standard by SMEs can only be guaranteed if the standard is supported by affordable and customizable core components in the form of off-the-shelf software (see Chapter 4).
- 3) Recent document standards initially implemented and dedicated to facilitate SMEs, failed to become broadly accepted and suitable for them due to their limited support of customizable core components (see Chapter 4).
- 4) Recent document standards adopting the implementation neutral approach - designated as the best way to achieve a common and ubiquitous business document exchange standard - failed to become accepted and suitable for SMEs due to their limited support for customizable core components (see Chapter 4).
- 5) The architectural nature of SMEs does not allow standards which combine multiple stakeholders' individual requirements to flourish in their environment; they contain a lot of optional elements and their implementation becomes complex.
- 6) The architectural nature of SMEs does not allow standards with embedded business processes in the transmitted messages to be successful in their environment; their broad focus not only on the definition of documents but also on the overall business-to-business negotiations makes them complex and, thus, highly demanding in costs during implementation.
- 7) The most popular and successful standards across most SMEs are the markup-based ones that include an essential set of core elements with the concept of customized extensions to allow them to adapt in specific use cases (*a bottom-up approach*) due to considerably low implementation costs (see Chapter 4). However, this approach has suffered from low adoption rates, relatively high implementation complexity, poor customizability capabilities, luck of conceptual representation mechanisms and formal construction regulations for new extensions, moderate performance stabilization and, between other standards adopting different approaches, the lowest number of current users.

In a nutshell, the outcome of the research by Liegl et al. (2010) outlined the generic profile and the powerful characteristics of the most successful standards across SMEs (Table 2.1):

- 1) The standard must fulfill the business messaging compatibility requirement in terms of representation and semantics.
- 2) The standard must fulfill the technology features requirement in terms of low implementation complexity, backward compatibility, extensibility, availability of conceptual models, component support, high degree of maturity, and adoption rate.
- 3) The standard must be well-fitted and accepted at least from an industry specific to a national level.

The characteristics in Table 2.1 are practically reflecting the reality about how the transmission of data is carried out during the activities of today's SMEs. In the following sections we analyze these characteristics.

Characteristics of business document standards	Suitability for SMEs		
Business Messaging Compatibility features			
Representation	•		
Semantics	D		
Technology features			
Implementation complexity	۵		
Backward compatibility	•		
Extensibility	•		
Conceptual model availability	٥		
COTS support	•		
Standard maturity	٥		
Adoption	D		
Level of Acceptance features			
Industry specific acceptance	•		
National acceptance	•		

Legend: $(\bullet) \Rightarrow$ Fully meets the criteria $(\bullet) \Rightarrow$ Partly meets the criteria

 TABLE 2.1 Characteristics of the most successful business document standards across

 SMEs (adapted from Liegl et al. (2010)).

2.7. Features of standards affecting einvoicing's adoption

2.7.1. Business messaging compatibility

Liegl et al. (2010) designated the business messaging compatibility as one of the most critical factors for the success of a document standard to seamlessly conduct electronic transactions between arbitrary business partners. The first parameter of this factor is related to the explicit *representation* of the standard itself, i.e. the syntax and the vocabulary in which a business document can be defined. The second crucial notion of business messaging compatibility factor is the unambiguous *se*-

mantics of the standard which enables the translation of the business documents into meaningful data elements on the same way for all the relevant parties (Liegl et al., 2010).

2.7.2. Technology features

According to Liegl et al. (2010), there are some specific technology features that made business document standards popular across SMEs. To begin with, implementation complexity is perhaps the most influential parameter that makes a standard useful to SMEs; low implementation complexity allows fast and cheap integration, whereas high implementation complexity is related to expensive integration procedures, rendering the cost of the adoption forbidden for the abilities of SMEs (Liegl et al., 2010). The limited available time and economic resources affect the success of a document standard, while the standards with excessive needs in that respect are unaffordable by most of the SMEs (Gessa et al., 2010). Furthermore, if a standard focuses on *backward compatibility*, then it requires little or no adaptations upon the implementation and adaptation into a local business environment (Liegl et al., 2010). Another important technology-related parameter for the viability of a standard in SMEs is its degree of *extensibility*, namely the ability of the standard to accept amendments on a user or a domain-specific level (Liegl et al., 2010). The availability of conceptual models facilitates the communication among software architects and developers due to the abstract, higher-level representation of the business documents (Liegl et al., 2010). The implementation of standards is becoming more affordable by SMEs as long as the standards are simple enough to support customizable core components in the form of commercial off-the-shelf software (Liegl et al., 2010). Moreover, SMEs are less reluctant to adopt a standard which has become *mature* through the years of its use, and as a consequence it requires less stabilization and maintenance efforts (Liegl et al., 2010). The success of a standard is determined by number of implementations and uses; the higher the *acceptance rate*, the higher the attraction for new adopters to implement it in order to inherit the efficient communication with the (current or potential) parties who already use it (Liegl et al., 2010).

2.7.3. Scale of acceptance

The study of Liegl et al. (2010) determined the acceptance of a standard according to the scale of its popularity and usability. The most successful standards within the SMEs environments were the ones accepted in an *industry specific* or a *national* level. The even more popular standards being widely accepted even in a global level are not very popular in SMEs' communities, most probably because they are too complex by covering a broad number of semantics and representations (Liegl et al., 2010).

2.7.4. Sector of acceptance

According to Willumsen (2011) the evolution and the diversity of business document standards supporting e-invoicing in SMEs in the way we know today were driven through different approaches by the *private* and the *public sector*. The private sector was the initiator, inventing proprietary standards based on corporate requirements, such as the locally available hardware and software systems. Although these standards were accompanied with mutual agreements for the transaction of messages, the variety of individual requirements has led into such a diversity of agreements that renders the standard less standardized and makes it too complex and less suitable for SMEs. The public sector on the other hand, proceeded into creation of standards that fulfill national and international agreements based on open and non-proprietary document formats (Willumsen, 2011).

2.7.5. External pressure

Penttinen and Tuunainen (2011) analyzed the extent in which external pressure affects the infusion of business document standards by SMEs and they discovered that it is one of the most influential factors on the adoption of e-invoicing. Through the relationship of SMEs with their external environment consisting of business partners, suppliers and customers, specific requirements are deriving and they are leading to the adoption of supportive and compatible standards (Penttinen & Tuunainen, 2011). Institutional factors is the first parameter of the external pressure (Penttinen & Tuunainen, 2011). SMEs are influenced by other organizations in the same market in two major ways: they are depended on them or they are trying to imitate existing and successful business models. Another influential factor is the conformation to the professional norms that are required to conduct trade associations. In that case, companies adopt specific standards to support these associations. These standards may be determined by the associations themselves or after consultation by academic and training institutions. The perceived benefits by adopting a standard, is an additional parameter that belongs to the generic external pressure factor (Penttinen & Tuunainen, 2011). It refers to direct and indirect advantages that stem from the adoption of a specific standard. The advantages can be direct, such as reduced operational costs, paperwork, error rates, but also indirect, for example potential business opportunities and improved customer services (Chwelos, Benbasat & Dexter, 2001). The readiness of the organization has also a considerable influence on the adoption of a business document standard by SMEs (Penttinen & Tuunainen, 2011). It describes how well prepared is the company in terms of the procession of technological and financial assets to accept and implement a new standard.

2.8. Answer to sub-question **O**

• What factors related to business document standards influence the adoption of e-invoicing?

Table 2.2 contains all the discovered factors related to business document standards that influence the adoption of e-invoicing.

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Factors in the current study	Factors in previous studies	Description	Source
Business messages	Representation	Syntax and vocabulary to define business documents.	Liegl et al. (2010)
compatibility	Semantics	Definition of meaningful data elements unambiguously interpreted by all relevant parties.	Liegl et al. (2010)
	Implementation complexity	Time and cost required for the implementation of the standard.	Liegl et al. (2010); Gessa et al. (2010)
	Backward compatibility	Conformance to current standards and/or methods.	Liegl et al. (2010)
	Extensibility	Ability of the standard to accept amendments on a user or a domain- specific level.	Liegl et al. (2010)
Technology features	Conceptual model availability	Abstract representation of data elements defining the business document.	Liegl et al. (2010)
	Component support	Customizability of standard using off-the-shelf software components.	Liegl et al. (2010)
	Maturity	Stability and improvement after constant use of the standard.	Liegl et al. (2010)
	Adoption rate	Number of current users adopted the standard.	Liegl et al. (2010)
Scale of accentance	Industry specific	Coverage of domain-specific requirements.	Liegl et al. (2010)
סרמוב סן מרובלומוורב	National scale	Coverage of cross-country requirements.	Liegl et al. (2010)
Sector of accentance	Private sector	Coverage of corporate-specific requirements and use of proprietary doc- ument formats.	Willumsen (2011)
סברנסו סן מרכבלימוורב	Public sector	Coverage of cross-border requirements and use of open document for- mats.	Willumsen (2011)
	Institutional factors	Influence by depended-upon organizations, successful organizations and professional norms standardizing business associations.	Penttinen & Tuun- ainen (2011)
External pressure	Perceived benefits	Direct and indirect anticipated advantages upon the adoption of a stand- ard.	Penttinen & Tuunai- nen (2011); Chwelos et al. (2001)
	Organizational readiness	Degree of financial and technological preparation to adopt a standard.	Penttinen & Tuun- ainen (2011)



Interoperability of standardization

In this chapter we analyze the interoperability of standardization and we investigate the customizability and extensibility aspects of the concept. In the end of the chapter we include the answer to sub-question **2**.

3.1. Interoperability & standards

Based on the definition of International Organization for Standardization (ISO), interoperability is "the capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units". It is an attribute of products and services that allows them to interconnect people, data, and diverse systems (Tsilas, 2011). Interoperability in enterprise applications, such as the einvoicing, is similarly achieved when a system or a product operates with other systems or products and requires minimal effort from the customer or user (Konstantas, Bourrieres, Leonard & Boudjlida, 2006). Products and services in the IT sector obtain interoperability through the use of standards (Lippoldt & Stryszowski, 2009; Wilson, 2011) and e-invoicing is not an exception.

There are two important aspects of the concept; the people interoperability and the technical interoperability (Tsilas, 2011). The first aspect is concerned with intangible and often complex issues such as the organizational and policy interoperability. The second aspect deals with the ability of heterogeneous IT artifacts such as networks, applications, and components in exchanging and utilizing information. Business document standards are the sets of IT artifacts which ensure true interoperability between trading partners' systems by modeling both people and the technical aspect of interoperability

The degree of interoperability of each individual business document standard can be challenged and verified through their ability to be customizable and extensible. The first attribute, the customizability, requires them to provide customized artifacts that are able to adapt on specific contexts and to address the constraints of those particular contexts (Kabak & Dogac, 2010). It is their ability to support customizable core components in the form of publically available off-the-shelf software (Liegl et al., 2010). The second attribute, the extensibility, demands from them to be flexible in conveying context-specific information, since a generic data profile cannot cover all the existing contextual variations (Kabak & Dogac, 2010). It is their ability to accept amendments on a user or a domain-specific level (Liegl et al., 2010).

Technical interoperability may be achieved through various complementary methods: with intellectual property licensing and cross-licensing; with industry collaboration with companies working to facilitate interoperability between their products; with companies creating their products to interoperate with products of other companies; and with consulting services that facilitate interoperability among otherwise non-interoperable technologies (Baird, 2007). All these methods can be benefited by *reuse* and *customizability*, two principles stem from software architecture and being able to boost technical interoperability to higher levels.

3.1.1. Software reuse

According to Frakes and Kang (2005), software reuse takes advantage of existing software or software knowledge in order to lead in the construction of new software that enables companies to improve the quality of their products and services, and thus, maximize profits. A key principle in software reuse is the domain engineering: most of the software applications that are currently being implemented within a specific domain are not utterly new, they are just variations of what has been already implemented within that domain. The business case of software reuse has a twofold impact; it reduces the development and the maintenance costs (Poulin, 2006). Whereas software components are reusable, prefabricate assets that can be combined and lead to the creation of applications, business components belong to a special category of software components; apart from the inherited reusability attributes, they are also embedding meaningful and understandable business semantics, such as invoices, bills, purchase requests and orders (van den Heuvel, 2006). Thanks to the reuse of business components, the development of applications which involve utilization of document standards can be transformed into a flexible and standardized process. The more the reusable assets are growing, the higher is the degree of leveraging benefits like cost savings and reductions of the time-to-market (Poulin & Carlson, 2004).

Today's firms which conduct trading activities by using prevailed legacy and modern business document standards are forming a great environment to apply and explore software reuse. Modern standards bring enhanced and sophisticated methods of applying reuse. Legacy standards however suffer from looselystructured methods of defining transactional information and constantly decrease the efficiency of the conveyed message. It is very common for companies to invest on local implementations in order to align the different standards with their financial transactions. A plausible lesson to be learnt throughout all these individual efforts is that if standards' features had been implemented as coarse-graded assets to keep acquired knowledge reusable, all the organizational best practices would have been form well-defined objects available for any future implementations. By the same token, even the maintenance of an e-invoicing platform could have been facilitated by reusable components that are easily assigned to new trading partners and support their (legacy or not) business document standards.

3.1.2. Software abstraction

The realization of every reuse technique requires a certain degree of *abstraction:* it facilitates reusable components to be detected and chosen among others within a repository and to be smoothly integrated without conflicts in a system with other components, while it allows them to be adequately adjustable for a specific use at hand (Krueger, 1992). The choice of the right components allows a software appli-

cation to incorporate new functionalities without extensive reconstruction of its architecture (Jackson, 2011). Moreover, it inherits different abstraction levels and perspectives appropriate for customers and their requirements (high level of abstraction) and for developers and their working methods (low level of abstraction) (Kramer & Hazzan, 2006). During collaboration with other firms, abstraction aids in the flexible manipulation of businesses transactions by estimating dynamically and on-demand the transaction properties (Huhns & Singh, 2005).

Abstraction brings the desirable sophistication to business document standards by allowing them to support reusable, easy to "plug" and "unplug" components. Features of a standard can be transformed into artifacts with clear semantic representations and distinguishable characteristics. They can be chosen on demand, whenever a business transaction requires it and they can be incorporated into a system without excessive reorganization of the existing architecture. In addition, they permit overview and parameterization in different levels and perspectives: customers can have access to transactional data; developers make use of the available programming parameters and methods.

Abstraction is related with *customizability* on variable parts, while users can modify and customize the behavior of a system, on the contrary to the system's fixed parts which remain non-customizable. On the other hand, for the implementation of new requirements and extension of a system with new functionality, abstraction relies on *extensibility*.

3.2. Customizability of standardization

Nowadays, almost all businesses share a common set of data and all business document standards cover it to a certain extent. However, differences in industry, geopolitical, and regulatory contexts put obstacles in creating a generic data set that would be applicable to any kind of company across the globe. One of the methods that business document standards are using to absorb the individual user needs, and, on the same time, to remain simple, efficient and flexible is *customizability*. Based on the reuse of existing artifacts or elements of a standard, users obtain the power to construct their business documents according to their current corporate needs.

Standardization in business documents faces two major challenges (Gessa et al., 2010): 1) redundancy and uncertainty in the implementation of the standard, and 2) lack of proper, easy to use tools for ad-hoc modifications according to the contexts. Customizability has managed to eliminate these phenomena to a great extent. Furthermore, it enhances the sophistication of the standards to a level that they can facilitate organizations when they are trying to integrate modern applications with their legacy systems – on which they already have invested extensive-

ly – or when they require simple methods to apply security and confidentiality rules (Warkentin, 2002).

As it happened in the standardization methodologies of other fields, many business document standards inherited the paradigm of the *component model* (Weinreich & Sametinger, 2001). Such a model contributes in customizability by providing a set of tools and methods for component implementation, naming, interoperability, customizability, composition, and deployment. Customized components allow users to adapt details in the definition of the standard during its implementation and before its actual use. Customizability can take place starting from modifications of simple properties till the definition of parameters for the relation between components. The use of components has the additional contribution towards customizability by utilizing *metadata*, an additional set of data that "sticks" to components and describes the context (the business facts) on which the actual transferred data are valid (Debreceny, Felden, Ochocki, Piechocki & Piechocki, 2009). Some standards streamline the customizability process to even higher sophistication levels, by offering the adding value ability to automatically discover the required components (Ozgen, 2008).

The customizability practices we described so far enhance the potential of especially the smaller firms in leveraging and properly tailoring business document standards, despite their deficiencies in expertise and resources.

3.3. Extensibility of standardization

The aim of business document standards is to facilitate integration of technologies with minimum implementation effort for each organization. When they fail to fulfill the requirements of users, *extensibility* should take place. Standards should provide opportunities of defining new data constructs, relations and rules in order to cover the cases where the predefined definitions and their customizability cannot "describe" the contextual conditions of a given corporate environment.

Extensibility is related to scalability and interoperability, and describes how easy it is to add new elements to the definition of a standard (Chaffey, 2009). It permits the modeling and creation of virtually any business document or process, and provides a well-defined structure that makes the interpretation of the documents by software applications easy (Ahn, Childerhouse, Vossen & Lee, 2012).

Similarly to customizability, extensibility in many business document standards inherits the principles of the *component model* (Weinreich & Sametinger, 2001). Such a model contributes in extensibility by providing a set of tools and methods for component implementation, naming, interoperability, evolution, composition, and deployment. Users are able to create new structures of information without affecting the original structure of the standard. Some standards operate a common repository to monitor, verify and populate the newly-crafted elements. The trans-

mission of a message between two parties which use the same business document standard takes place as follows. First, the sender organization confirms that the "extension" elements were also obtained by the receiving organization with the aid of a pair mechanism provided by the repository. In the case the new elements are "unknown" by the receiving organization, the repository instantly populates them and the delivery of the message finishes successfully. The extensibility of component-based standards allows the easy deployment of additional components, the combination of which can further lead to the implementation of even new coordination standards suitable to document transactions within a particular business context (Bazijanec, Zaha, Albani & Turowski, 2006).

The extensibility practices we mentioned above simplify the implementation of new requirements and the replacement of existing definitions. Thanks to the simplicity, SMEs can now have access to these advanced techniques with a minimal effort.

3.4. Answer to sub-question @

9 Why are customizability and extensibility important for the interoperability of business document standards?

Customizability in business document standards enables a firm to construct documents based on the individual needs of its industry, geopolitical, and regulatory contexts, and, on the same time, establishes channels for the smooth transmission and interpretation of the documents. On the same way, extensibility is important because, on the one hand, enables a firm to create new elements in case the default form of standard cannot help in documenting the actual contextual state, and on the other, ensures that the communication of the messages is not hampered.

Chapter 4

Evaluation of customizability & extensibility

The present chapter introduces a method to facilitate the qualitative analysis and comparison of various standardization approaches in regards to their customizability and extensibility capabilities. SMEs are obtaining a handy technique to be able to extract more information about each standard's features and, thus, to proceed to a more objective decision on whether a standard is suitable for them or not. We also include the analysis of eight prominent business document standards based on the introduced customizability and extensibility qualitative metrics. In the end of the chapter we include the answer to subquestions **④**, **④** and **⑤**.

4.1. Introduction

One of the biggest challenges for e-Business nowadays is the interoperability between the heterogeneous enterprise systems operating autonomously within different organizations. As we saw in the previous chapters, numerous standardization frameworks have managed to mitigate many aspects of the interoperability issue, however, the multitude of the available approaches has raised the *business standards dilemma*: which business document standard is most suitable for a given corporate environment, or which of the available should be supported at the same time (Lampathaki, Mouzakitis, Cionis, Charalabidis, & Askounis, 2009)?

Each of the available business document standards assists trading partners in performing e-business activities in real time, and, yet, retaining loosely-coupled relationships. Previous studies have scrutinized the degree of their ability to fully support e-commerce in multiple perspectives and through various evaluation frameworks. Zhao and Sandahl (2000) reviewed the cooperativeness and competitiveness of various standards, and proposed a framework to increase the merge and compatibility of their produced messages. Bussler (2001) provided a list of classification criteria for B2B-intended standards: document types, semantics, transport binding, message definition, exchange sequence definition, process definition, security, syntax, and trading partner specific configuration. Hasselbring and Weigand (2001) investigate standards and their representation, accessibility, methodological, process support, implementation capabilities. Dogac and Cingil (2001) designated the importance of standardization aspects, like document conversion, automated business process support, service discovery, catalog support, product taxonomy support, specification, implementation, and core components support. The authors Kim, Agrawal, Jayaraman and Rao (2003) published a paper containing a benchmark of standards based on their target industries and purpose, metadata and ontology, standard XML efforts and legacy support. Moreover, they also examined their ability to support off-the-shelf core components based on the facilitation of the following e-business functions: service discovery, service brokering, service negotiation, service mediation, service billing, service payment, service composition, and service security. The study of Medjahed, Benatallah, Bouguettaya, Ngu and Elmagarmid (2003) contains a survey and comparison of several standards according to their communication layer, content layer, business process layer, type of coupling, autonomy, heterogeneity, external manageability, adaptability, security, and scalability. Nurmilaakso and Kotinurmi (2004) compared standards according to their business document support, validation, business process, process description and messaging capabilities. Androutsellis-Theotokis, Karakoidas, Gousios, Spinellis and Charalabidis (2005) examined the robustness of prominent standards in facilitating B2B transactions by comparing and evaluating the following criteria: adoption, compatibility, institutional support and community, formal description, resilience, code generation, completeness, process and document coverage, supported business sized/types, cooperation

with other standards, security policy, ease of implementation, ease of use, maturity, communication efficiency, adaptability and extendibility, effectiveness, and licensing and cost. In another paper by Janner, Schmidt, Schroth and Stuhec (2006) standards received scores on their horizontal integration, flexibility, maturity, common repository/dictionary, comprehensiveness of stack, ease of implementation, and degree of dissemination. The study of Mykkanen and Tuomainen (2008) introduces a framework for the interoperability of standards based on their information and semantics, functionality and interactions, application infrastructure, and technical aspects. Lampathaki et al. (2009) scrutinized standards on the following aspects: scope completeness (expressiveness, cross-country support, multilingual aspects), compatibility with other standards, openness, customizability capabilities (modularity, expandability, composability), maturity, standard support, ease of use and of implementation, modeling of messages, integrated management of enterprise and data models, configuration management (versioning, backward compatibility, and additional features (support for rules modeling, workflow capabilities incorporated into the documents). Melleri, Hiekkanen and Mykkanen (2011) used the flexibility, the understandability, the simplicity, and the consistency as quantitative metrics during the evaluation of several prominent business document standards. Kabak and Dogac (2010) analyzed aspects of standards such as the document design principles, the extensibility, the customizability, the communication and the business process interoperability layer, and the industry relevance. Liegl et al. (2010) classified standards after analyzing their business messaging compatibility (representation, semantics, business process, transport). technology features (used syntax, release iterations, implementation complexity, delta between releases, backward compatibility, extensibility, conceptual model availability, semantically unambiguous, core components support, standard maturity, community size, adoption), potential user groups (small enterprises, medium-sized enterprises, large enterprises), acceptance (industry-specific acceptance, national acceptance, global acceptance).

The common verdict throughout all these studies – starting from the oldest till the most recent ones – reveals several weaknesses and limitations of business document standards to support e-business adequately. The choice of a standard and all its potential befits is connected with interoperability trade-offs which should be able to be measured in the form of concrete knowledge and be publicized to the public audience.

Two of the most major interoperability challenges faced by any business document standard are to be *customizable* in order to absorb the particular constraints of the specific context, and to be *extensible* because no standard can contain all the required data for every environment (Kabak & Dogac, 2010). We also saw in Chapter 2 that integrated approaches with distributions of customizable and extensible components are the most suitable for SMEs (Liegl et al., 2010). Previous studies scrutinized the customizability and extensibility capabilities of different business document standards either by using generic classification models or by merely analyzing these aspects on a technical level. We now propose an evaluation framework which focuses on the customizability and extensibility capabilities of the standards by revealing their characteristics on a semantic level.

4.2. Customizability & extensibility evaluation framework

In Figure 4.1 we introduce a framework which allows the classification of business document standards in terms of their customizability and extensibility capabilities. The horizontal axis contains the degree of extensibility and the vertical axis the degree of customizability.





We further define the following four customizability and extensibility profiles:

1. Restricted compatibility (*low degree of customizability*, *low degree of extensibility*). In this profile business documents standards are characterized by limited extensibility and customizability. The derived documents are vertically defined in order to address transactions of a specific industry, country or business domain. Extensibility is hindered due to the statically defined documents. The introduction of new types of data elements requires excessive modifications of the supporting software and labor-intensive validation with the involved authorities. Customizability is

limited to the provision of pre-defined and non-reconfigurable components aiming to support the local requirements of some very specific domains.

2. Dynamic components (low degree of customizability, high degree of extensibility). At the beginning, a standard of this profile enables the dynamic creation of documents based on existing core components. If they are proved to be insufficient to support the specific situation at hand, users are able to define their own, new components – although there are no formal methods to facilitate and guide the construction. Formal methods of automatically validating the new extensions against standard's original definitions are also missing. Due to the implementation of non-conformant extensions, consistency cannot be retained among the users of the standard, thus, interoperability is endangered. The allowed modifications mostly lead to extensions rather than to customizability. Interoperability is basically detected in the syntax and not in the semantics of the produced documents.

3. Component repositories (high degree of customizability, low degree of extensibility). A standard of this profile produces highly adaptable to a given context documents through reusable and highly customizable core components derived from a single common repository. Users are able to define their own customizability, although there are no formal methods to facilitate and guide the construction. Formal methods to automatically validate new customizability against standard's original definitions are also missing. Due to the implementation of non-conformant customizability, consistency cannot be retained by all users of the standard, thus, interoperability is endangered. The allowed modifications mostly lead to customizability rather than to extensions. Interoperability is basically detected in the syntax and not in the semantics of the produced documents.

4. Extended interoperability (*high degree of customizability*, *high degree of extensibility*). Standards of this profile include numerous core components as a part of a common repository which can be used for new information constructs. In case the available components are incapable to support the context at a specific case, users can define their own conformant components, populate them to the central repository and share them with all the relevant parties. The construction of the components is facilitated and guided through formal methods. Future user-created customizability and extensions are harmonized and automatically validated against original definitions of standards; redundant definitions are eliminated. The allowed modifications are equally powerful and conformant by using either customizability or extensions. The interoperability is detected both in the syntax and in the semantics of the produced documents.

4.3. Qualitative metrics for customizability & extensibility

The classification of business document standards to one of the above mentioned customizability and extensibility profiles is feasible through the utilization of some criteria and metrics that expose the quality of the characteristics. For the evaluation of customizability we create a list of relevant qualitative metrics: *re-striction, aggregation, composability* and *conformity.* Similarly, for the evaluation of extensibility we identify the following related qualitative metrics: *enumeration, augmenta-tion, modularity* and *isolation.*

The metrics we introduce by no means exhaust the customizability and extensibility capabilities of a given standard. However, they amplify the scrutiny procedure of any standardization framework by defining the requirements towards the intuitive comprehension of the corresponding capabilities. In the following subsections we elaborate on the characteristics of each of the introduced metrics.

4.3.1. Metrics for customizability

Restriction

In the simplest form of a standard's customizability capabilities, a document standard merely allows users to isolate and use the number of elements which are required in their specific tasks, and exclude all the non-required elements. A restriction mechanism facilitates the selection of the relevant elements and elimination of the optional ones. The customizability can also take place by applying restrictions in the range of the potential values of an entity or dependencies between the values of two entities. On the one hand, the restriction methods represent the lowest degree of customizability's capabilities, but on the other, they also promote simplicity and permit the utilization of complicated standards including thousands of elements even by the smaller firms.

Aggregation

A business document standard adopts the notion of the "noun" and the "verb" with their actual function in verbal communication. Users can assign activities like "Post", "Get" or "Delete" to objects like "Invoice", "Order" or "Receipt" to introduce process-related activities in their documents. This method enhances the reusability of elements, since the same entity can participate in different activities at a time and create transactions like "Post Invoice" or "Delete Invoice". Moreover, the ability of the standard to correlate activities (coupling) allows the transfer of business logic and semantics from information systems to documents.

Composability

A business document standard can be consisted of core components stored in a single or multiple repositories. Users who would like to model custom information settings by using the standard can modify the existing components according the context existing in their businesses. The single, common repository ensures conformity to well-defined rules by restricting the uncontrolled customizability of the components which could reduce the interoperability of the standard. In addition, the same repository enhances the semantic interoperability at an incremental pace: it keeps record of the modified components and builds up a constantly growing digital library with customizability derived from and available to a broad number of industry contexts.

Conformity

A business document standard can adopt different customizability profiles according to the specific context it is applied. For instance, a business process profile can be assigned to customers-related transactions, an industry sector profile to transactions with the trading partners within a firm's industry, and a geopolitical profile for transactions between countries or other economically defined regions. The different profiles facilitate extensive customizability at a short time. Users apply the profile fitting to their specific situation and rapidly inherit the contextual elements of that profile. Each time users can adjust the standard under the scope of the impending transactions. The nature of a firm's transactions with its customers, local trading partners and global traders are different in nature. The conformity of standards allows them to imprint those differences to the exchanged documents and establish harmonization according to their actual business sector.

4.3.2. Metrics for extensibility

Enumeration

A business document standard can "express" relevant entity instances with code lists, i.e. lists with enumerated values assigned into an element. Apart from the pre-existing code lists of the standard, users can create unique code lists with new values according to their business requirements. One typical example is the creation of "Port code list" with the port codes as values, a required element for ship transportation transactions. The code lists are maintained internally without affecting the structure of the entities, as it is originally defined by the standard.

Augmentation

In this form of extensibility users append to their business documents new elements in order to introduce process-related activities that are not covered by the standard. As we saw in customizability's metrics, a business document standard can adopt the notion of the "noun" and the "verb" with equivalent function as in verbal communication. Users can introduce their own "nouns" and "verbs", as well as the logic deriving from their combination when the existing specification does not fit in the situation at hand. The new elements are compatible with the initial definition of the standard. The exchange of a message composed by those elements initiates a mapping mechanism to both the sender and the receiver party. Users can then manually map the unknown elements to significant information entities for the information systems they locally use.

Modularity

The business document standards with such an ability allow users to create their own components which remain compatible on a syntax-based level, although incompatible on a semantic-based level in comparison to the original definitions of the standards. All the existing components comprising standard are stored in a single or several repositories and they can be used as prototypes for the construction of new ones. Depending on the user specific situation, the newly constructed can be also made from scratch. A single, common repository keeps record of the new components and maintains a constantly growing digital library with amendments from various contexts and business settings. A new component can be further used as-is or modified in any future implementation.

Isolation

The standards featuring such a capability allow the creation of new elements by preserving a specific "area" for this purpose. Users define their extensions in the isolated and restrictions-free part of the standard without affecting its core definition. All the extensions are manipulated by a single common repository which validates, stores and populates the newly constructed elements. The semantic interoperability is limited, since this type of extension deals with the part of the standard which is always considered as "foreign". This inhibition of harmonization can be partially compensated by the ubiquitous availability of the new elements through the single repository.

Table 4.1 summarizes the qualitative metrics for both customizability and extensibility.

4.4. Standards under examination

In this section we overview eight business document standards which are prominent not only in supporting e-invoicing for SMEs, but also in the field of ebusiness in general: UN/EDIFACT, RosettaNet, CCTS, XBRL, ebXML, GS1 XML, OAGIS, and UBL. Apart from a short introduction on each framework's history and generic capabilities, we dwell into their up to now success to be accepted by SMEs. We proceed in identifying their customizability and extensibility by applying the eval-

Capabilities	Metrics	Sub-metrics
Customizskilite	Restriction	Selections
		Eliminations
		Ranges of values
		Dependencies of values
	Accreation	Reusable process-related activities
Custonnizability	Ayyregation	Couplings of activities
	Composability	Core components
	Composability	Single repositories
	Conformity	Contextual profiles
	Comportnity	Customized contextual profiles
	Enumeration	New values into code lists
		New code lists
	Augmentation	New process-related activities
Extensibility		Mappings of new activities
	Modularity	New core components
		Single repositories
	Isolation	Reserved extensible definitions
		Store to single repositories

 TABLE 4.1 Summary of metrics & sub-metrics for customizability & extensibility.

uation metrics we introduced in this chapter and by scrutinizing their progress in supporting these two capabilities. The identification was conducted during an 8month investigation including experiments of utilizing the eight standards in actual e-invoicing platform (operated by DigitaleFactuur – more details about the company in Section 6.1 of Chapter 6).

4.4.1. UN/EDIFACT

The United Nations Electronic Data Interchange for Administration, Commerce, and Transport (UN/EDIFACT) is a broadly used international EDI standard developed by the United Nations. Its development launched back in the 1980's as a delimited-based standard which managed to be internationally accepted and intrude in almost all sorts of industries. The syntax of the EDIFACT documents is a combination of characters and symbols, and it is not intended to be readable by humans. The structure of the documents follows a hierarchical order, starting from messages and continues with data element groups, data elements and their values. The standard applies composition as the method to embed business logic in the documents; data element groups combine related, simple data elements; messages combine several data element groups to form representations of specific business activities. All messages are communicated between partners via Value-Added Networks (VANs) and special interfaces being installed in both partners' internal information systems undertake the interpretation process. The interpretation rules and the subsequent business actions are both negotiated in advance.

Despite the up to now dominant presence of UN/EDIFACT (Vollmer et al., 2007), SMEs always struggled in implementing and developing their own UN/EDIFACTcompliant systems (Chau, 2001; Janner et al., 2006). The numerous institutions and individuals who involved in the development of the standard imposed a huge variety of individual business requirements and features. The lack of a single common repository – which could have been helpful in supporting central adaptations and maintenance – renders the standard extremely complex. It is required from users to put significant effort in order to select the appropriate ones in a huge list of redundant features. The complexity is even more enhanced by the fact that syntax is proprietary and machine-oriented, and consequently renders the implementation of the standard unaffordable for most of the SMEs. The use of VANs is an additional parameter which increases the cost.

The customizability degree of UN/EDIFACT is detected on its restriction and conformity. Extending UN/EDIFACT is the most complicated and time-consuming process a standard has ever exposed. It is detected on its enumeration, nevertheless there was no provision of an automatic extensive mechanism on an individual level and any extension initiative involves long-term discussions and negotiations with standard's authorities.

UN/EDIFACT is a delimiter-based legacy standard which is actively being used for more than 25 years. As one of the earliest standardization efforts, it cannot boast for its innovative customizability and extensibility capabilities. Throughout its history, therefore, there are some negative lessons to be learnt:

- 1) Customizability in UN/EDIFACT is limited on the selection of required futures among the numerous existing ones within the encapsulated structure of the standard. There was no provision for a customizability layer that would leave the definition of the standard intact; users have to implement their preferences by modifying directly standard's definition.
- 2) The exchange of UN/EDIFACT compliant data with a new trading partner entails customizability in the local implementation of all current partners. Users are basically forced to customize the standard at a low level, whereas the addition of trading partners should have been supported automatically and without modifications in the current infrastructure.
- 3) The extension of the standard with new business requirements is administered by standard's authorized comities and it is a cumbersome process that it might take years to complete. Nowadays' firms constantly create and modify products and services while they try to keep up with fierce

competition. When it comes to UN/EDIFACT such extensions demand at least the development of new software and may even require the approval by standard's official bodies. This method of extensibility is simply outdated and it does not match with the versatile profile of today's modern firm.

Figure 4.1 illustrates the verdict of UN/EDIFACT's capabilities to be customizable and extensible.



FIGURE 4.1 Evaluation results of UN/EDIFACT's customizability & extensibility.

4.4.2. RosettaNet

RosettaNet is an open business document standard named after the homonym non-profit consortium of IT, electronic components and semiconductor manufacturing industries. Its purpose is to facilitate the information exchange in the supply chain of these industries. Manufacturers, distributors, resellers, shippers and end users participate in an efficient peer-to-peer communication promised by the standard. The key components in the communication process are the Partner Interface Processes (PIPs) in which RosettaNet specifies guidelines for the execution of business processes between trading partners. PIPs encompass details about the business processes, such as the start state, the end state, the exchanged documents, the involved participants and their roles, and the sequence of actions. Seven functional clusters in PIPs are used to group within the supply chain with similar business requirements in terms of business processes and documents exchanged. RosettaNet makes use of dictionaries to eliminate common conflicts between PIPs and the unique terminology being used in each individual company. The RosettaNet Technical Dictionary (RNTD) specializes in defining reusable product properties and their relationships, whereas the RosettaNet Business Dictionary (RNBD) concentrates on the definition of business transaction properties. The standard guaranties the authentication, the authorization, the encryption, the nonrepudiation and the reliability of the exchanged messages through the RosettaNet Implementation Framework (RNIF). Apart from providing communication channels and protocols for the exchange of messages, users can also obtain formal guidelines for the construction of complied business documents.

SMEs failed to embrace RosettaNet to a great extent. The reasons of the failure are mainly identified in the high implementation costs, the lack of expertise to integrate PIPs with the private processes, the misalignment between the implementation time and the business needs and the pour utilization of popular types of data formats among SMEs (Fuks & Wieczerzycki, 2006). Apart from the start-up costs, the running costs are also high due to the required expensive systems to support the standard. The majority of the current RosettaNet solutions are mostly implemented within ERP solutions which are only suitable for larger enterprises (Balzert et al., 2009). An additional burden for SMEs is the lack of implementation guide-lines. Only recently RosettaNet issued guidelines for some major PIPs, however, most of the available PIPs come without any rule or description on how they can be modified (Ahn et al., 2012).

RosettaNet's aptitude to be customizable is detected in its restriction, aggregation, composability and conformity. The extensibility profile is constituted by its enumeration, augmentation and modularity.

RosettaNet was created in 1998 and it is a markup-based standard. Its history exposes some customizability and extensibility lessons to be learnt:

- 1) The pre-defined PIPs of RosettaNet contain reference processes which can be used on top of existing process and, thus, the design and deployment of new applications is conducted at reduced time and costs. Nevertheless, the maintenance and the customizability of the reference processes appear important limitations when it comes to the sequence of the processes. Some of them cannot be removed or rearranged as they are required by the subsequent processes or they have to follow a specific sequence according to regulatory requirements. Users should obtain more freedom in customizing the reference processes by changing their order or skipping some of them without restrictions. The extensibility of the processes should include more options as well, by allowing the replacement of the existing processes with new ones or the inclusion of new processes anywhere in the process-cycle.
- 2) The dictionaries of RosettaNet contain many reusable elements; yet, the applied reference techniques lead to repetitive information reuse. The implicit data should be stated explicitly and the resulted messages become lengthy and complex to interpret. For that reason the implementers of the standard must include reference techniques and rules with the intention to simplify the resulted messages from redundant repetitive information.
- 3) RosettaNet allow the incorporation of contextual constraints into PIPs either by manual implementation or separate informal documents. Some issues might arise when each trading partner applies its own constraints at

will without proper guidance and formal tools; interoperability is threatened. The standard should fortify PIPs with formal and automatic methods to capture the contextual constraints of each given environment.

In Figure 4.2 we depict the customizability and extensibility capabilities of RosettaNet.



FIGURE 4.2 Evaluation results of RosettaNet's customizability & extensibility.

4.4.3. CCTS

The CCTS (Core Components Technical Specification) by UN/CEFACT (United Nations Centre for Trade Facilitation and Electronic Business) is one of the few standardization efforts which do not inherit the traditional EDI's principles. It was developed from scratch by introducing a "process-centric" approach - in contrast to the "data-centric" direction of UN/EDIFACT - based on a unique method of using semantic building blocks named *core components*. Those blocks represent the most usual data entities of the exchanged documents during cross-organizational, national and international transactions. Thanks to their syntax-independent construction they can establish interoperability, even between partners with syntaxincompatible information systems. The transmission of information is still efficient despite the variety of syntaxes in the produced documents; as long as they assembled by the same core components, the standard takes over the automatic mapping of significant business data in all communicating parties. An extra added value of the core components is their similar to a language form use of vocabulary and grammar. The produced documents can be easily comprehended not only by the information systems but also by humans. All the core components are stored as abstract, reusable and context-independent artifacts in the available to all users depository of the standard named Core Component Library (CCL). The final goal of CCTS is to provide users with simple specifications, recommendations and guidelines to model and harmonize their organizational business processes towards the growth of global commerce.

The advent of CCTS created the foundation towards affordable and customizable core components in the form of off-the-shelf software – a method to guaranty the acceptance of a business document standard in SMEs (see Chapter 3). However, the components have not yet transformed into off-the-shelf software and the current status of CCTS's penetration levels among SMEs is still quite low. The standard remains unsuitable for the smaller of the SMEs (Liegl et al., 2010), as it exposes them to several technical complexities. The unnecessarily high implementation costs in combination with the limited exploitation of the web render it even more prohibitive for SMEs (Schroth, Pemptroad & Janner, 2007). Additional efforts are required from the implementers of CCTS in order to make it sufficiently intuitive and flexible to secure an easier access to SMEs.

CCTS exposes remarkable customizability capabilities in all four characteristics: restriction, aggregation, composability and conformity. The extensibility degree of CCTS is detected on its enumeration, augmentation and modularity.

CCTS is a markup-based standard and it was published in 1999. The subdivision of the standard into core components converted the modeling of semantic business information an easy job. The envisioned flexible method of customizing and extending components has become reality to a great extent, however, there were some lessons to be learnt for future improvements:

- 1) Any new component should be created based on the structure of an existing one in the CCL. In case the current components cannot provide the sufficient basis for the creation of the new ones, users must officially submit their proposal of the new structure to UN/CEFACT. This process might last long and keep the trading activities pending for an uncertain amount of time. The standard should provide automatic mechanisms of creating new components with sufficient degree harmonization and compatibility, without negotiating with the authorized bodies.
- 2) Any new contribution to the CCL must be overviewed and authorized centrally by the UN/CEFACT. The authorization of additional parties at a national or domain-specific level may speed up the authorization process when it comes to components created at these corresponding levels. Furthermore, the specialized knowledge in each local level stimulates direct interaction on common understandings and, in the end, yields more robust, practical, and suitable to the field components.
- 3) The creation of CCTS came with a set of non-formal core components which were later formalized and led to a new version of components. While compatibility was not retained between the older and the newer version, the early adopters of the standard were not guided through a transition progress and remained unaided by having to deal with discontinued components. While the progression of components is bound to lead to incompatibilities with their predecessors, standard authorities should provide tools and easy methods to facilitate in the transition of all firms

utilizing the older components, and thus, retain all the current users to the evolution choreography.

Figure 4.3 represents the analysis of CTTS in regards to its customizability and extensibility capabilities.



FIGURE 4.3 Evaluation results of CCTS's customizability & extensibility.

4.4.4. XBRL

XBRL (eXtensible Business Reporting Language) is a market-driven and royaltyfree business document standard. It is being developed by XBRL International, an international and non-profit consortium of companies, organizations, major national financial bodies and government agencies. By transferring the focus from the transactions to reporting, the standard aims to facilitate the exchange of business and financial performance information, XBRL's users have guidelines and methodologies at their disposal in order to streamline their supply chain with powerful financial documents and reports, including, among others, invoices, annual reports, ledger statements, reports targeting investors, audit schedules and fiscal analyses. The financial reports can carry meaningful business facts thanks to the provided high quality *metadata*, i.e. a set of additional data to describe the reported data and define their context. The problem is that neither the financial statement elements nor the relations between them can be defined at an international, cross-industry and cross-firm level, and XBRL deals with that by dividing the reporting information into instances and taxonomies. The instances hold information about the financial elements and the taxonomies describe their relations as well as additional semantic information. Groups of experts use taxonomies to embed the regulatory requirements and business terminology being used in their field of expertise. The public taxonomies provide adjustable methods to model the semantics of a given environment without requiring adaptations on the software handling the XBRL. Users are also free to extent taxonomies or their own

custom ones. Today the acceptance of XBRL is being supported by a multitude of data validation tools and compatible software applications.

The up to now success stories of the acceptance of XBRL in SMEs have shown three alternative scenarios: in-house implementations, outsourcing of the implementation to a third-party organization, or a combination of these two. Nevertheless, each of these options has significantly high costs in terms of acquisition of additional software interfaces, personnel training and expert advice. For this reason, XBRL has not managed to be popular among SMEs and nowadays there is only a small number of them using it (Florin, Groza & Aldescu, 2011). One of XBRL's promising features is its excellent ability to reduce the time and cost to circulate corporate information in stock markets, and moreover to enhance the compatibility of this information for integration among various information systems. Such an ability is unfortunately exploitable by larger companies, as XBRL has proved to be insufficient in handling the low volume of trading activities by SMEs (Yoon, Zo & Ciganek, 2011). An additional inhibitor for SMEs is the fact that XBRL is very complex and the manual production of instance documents is practically impossible. The benefits of XBRL can only be reaped through automated software tools and only few software vendors distributing them did take into account the particularities of the SMEs (Troshani & Doolin, 2005).

XBRL's customizability abilities are detected in its restriction, aggregation, composability and conformity. The corresponding extensibility features are enumeration, augmentation and modularity.

XBRL is a markup-based standard initiated back in 1998 and it was designed to become the *only* consistent and extensible standard for the coding and transmission of corporate information. Despite XBRL ambitious plans, customizability and extensibility have suffered from the following issues-lessons to be learnt:

1) Any modification to the taxonomies of XBRL in order to either customize or extend the standard may be incompatible with what has been implemented before. Despite the fact that customized and extended taxonomies are verified and approved by standards authorities, there was not provision for version control management and possible conflicts with the previous versions of the taxonomies cannot be prevented. The situation is similar when companies modify the off-the-shelf XBRL software interfaces, and then their developers upgrade them with the possibility to destroy the compatibility with the modified software currently in use. It is up to individual users to conduct the version control, however, the manual comparison of differences between modified and new taxonomies and software is difficult to be achieved. The existence of a central version control mechanism which operated and maintained by standard's authorities is crucial to resolve the incompatibility issues.

- 2) The customizability and the extension of XBRL are carried out through software tools with which users can edit, create, view and validate taxonomies. These tools also play the role of indirectly interconnecting the big network of XBRL's users, whereas the standard does not provide a direct communication channel. The usability of the tools is sometimes weak to the extent that might discourage users of not feasible or not worthwhile customizability or extension. For this reason, the communication channel should be separated from the tools and XBRL should provide a direct channel that will enhance communication and interaction between users.
- 3) XBRL allow in practice any user to customize or extend the taxonomies they use to suit their particular requirements. A mechanism is provided by the consortium of the standard to verify the quality and the integrity of the modified taxonomies. Nevertheless, this process is uncontrolled and the submission of modified taxonomies mostly depends on users' "good intentions". The result is to have non-conformant taxonomies in operations that may damage the interoperability of the standard. The first step to prevent such an issue is to impose strict submission deadlines. Another helpful parameter would be the publically visible discrimination between validated and non-validated taxonomies.

In Figure 4.4 we depict the result of customizability and extensibility analysis of XBRL.



FIGURE 4.4 Evaluation results of XBRL's customizability & extensibility.

4.4.5. ebXML

EbXML (Electronic Business using eXtensible Mark-up Language) is a business document standard developed by UN/CEFACT and Organization for the Advancement of Structured Information Standards (OASIS). Its purpose is to facilitate through a modular set or specifications the interactions among corporations, regardless of their size and the geographical location. The principles behind ebXML derive from traditional EDI standards such as the UN/EDIFACT; their interoperability gaps and high expenditures led to the creation of a more robust and lowbudget counterpart. The significant differential factor though - not only in comparison to traditional EDI standards but also to some modern XML standards like UBL – is ebXML's ability to imprint business processes to the conveyed messages. An additional, equally important feature is the use of common internet connections for the transmission of the messages. EbXML provides five B2B collaboration layers in which a conveyed message can be interpreted to: messaging, registries and repositories, collaboration protocol agreements, business processes, and core data components. The "messaging" layer is responsible for the reliable exchange of messages between partners. The "registries and repositories" layer contains business processes and their descriptive details. It also includes collaboration protocol profiles in order to express particularities of each business partner, such as what products and services they offer, which processes they can support, how these processes can be accessed and other communication constraints. The "collaboration protocol agreements" layer relates collaboration protocol profiles so as to signify trading conditions between partners. The "business processes" layer carries the representation of the elements as well as their relationship that participate in business processes. The "core data components" layer contains the ebXML-compliant basic components which can be arbitrary applied in various business sectors and contexts.

One of the envisioned goals of ebXML was to attract tool vendors to implement their own customizable core components in the form of off-the-shelf software. The intention was to create a big source of e-business solutions tailored to various contexts and being especially affordable for SMEs. Unfortunately this hopeful scenario has not become reality; ebXML has managed to attract a rather low number of software developers. The required implementation efforts are still high and the popularity of the standard among SMEs remains low (Liegl et al., 2010; Naujok & Huemer, 2008). Another reason that SMEs cannot be benefited from ebXML yet is the weak response of larger organizations in creating open, out-of-the-box and reusable components to describe the most popular business process and information models (Naujok & Huemer, 2008). EbXML creates additional barriers due to the fact that it can be poorly integrated with the lower level middleware applications that are being used by most of the SMEs (Rawlins, 2001). Nevertheless, in the long run ebXML is considered to become potentially promising for SMEs due to its vision to create a marketplace using the Internet and open definitions based on XML (Beck et al., 2002).

The customizability methods of ebXML are detected in its restriction, aggregation, composability and conformity abilities. The extensibility profile is comprised by enumeration, augmentation and modularity.

The ebXML initiative started in 1999 and throughout its evolution in supporting customizability and extensibility, we derive the following lessons to be learnt:

- 1) One of the co-implementers of ebXML is UN/CEFACT, the same implementer of CCTS we reviewed in the previous subsection. Both of these two standards were launched on the same period and they made use of a global library of customizable and extensible core components. The intention was to create a common set of semantic grounds in order to achieve convergence, interoperability and compatibility between the compatible standards. Unfortunately, the following progression deviated a lot from what was initially planned due to the fact that the core components were not formally specified at the beginning. The involvement of an additional party (OASIS) contributed further in the divergence of the two standards. In the end, each one had its own library of incompatible components, not only at a syntactic but even at a semantic level. The customizability and extensibility abilities of the components did not manage to yield realistic solutions to the different firms across the globe simply because they did not managed to be harmonized and aligned according to the initial political agreements and commitments.
- 2) The utilization of core components inherits the customizability and extensibility of reusable data elements however it is not exhausted there. As a standard which embeds business process information in the transmitted messages, ebXML also provides a set of reusable business process models. The customizability and extensibility of business processes in comparison to the corresponding activities for the data elements is more advanced and it is based on a different layer of semantics. Up to now there are not separate methods of applying these two types of modifications (business processes in contrast to data elements) and this situation should be changed in the future. A dedicated approach to support customizability and extensibility on business process level will enhance the ability of the standard to easily absorb additional contextual conditions.

Figure 4.5 summarizes the customizability and extensibility analysis of ebXML.



FIGURE 4.5 Evaluation results of ebXML's customizability & extensibility.

ebXML's customizability ebXML's extensibility

4.4.6. GS1 XML

Clobal Standards 1 (CS1) is a family of business document standards named after its implementer, an organization dedicated to improve the efficiency and visibility of supply and demand chains globally and across sectors. Official institutions and international associations like the United Nations and the European Commission have participated in its implementation and they now remain active members of CS1's further development and evolution. Among the standards in the family of GS1, eCom is segment focusing on the electronic document interoperability and encompasses two different standards: 1) GS1 EANCOM and 2) GS1 XML, GS1 EANCOM was implemented first; it promotes simplicity and cost-effectiveness by constructing less complex traditional EDI documents based on a subset of UN/EDIFACT. GS1 XML on the other hand is a modern markup-based standard introduced by eCom more recently and attracts the attention of our research. Based on a business process modeling methodology GS1 XML enables the synchronization of information concerning the attributes of the trade items between the trading partners. The standard also covers activities supply chain such as planning and executing orders, dispatches, payments, transportations, and replenishments of products. The creation of GS1 XML messages is conducted in two steps: first, the business processes are defined, including the identification of business semantics that ensure common understanding between all the relevant parties. Then, the information is used to build the electronic documents. Communication is finally executed in both ways: downstream (between suppliers and their customers) and upstream (between customers and their suppliers). GS1 XML utilizes core components developed according to UN/CEFACT's CCTS.

Despite the fact that SMEs did not participate in the initial standardization approach of GS1 XML, the latest figures show a recent growth in SME members (Briggs, 2012). Yet, SME cannot afford the costs of using the standard and in some cases they are not even aware about its existence (Fel, 2008). Surprisingly enough for a non-profit organization, GS1 still charges high operational fees as it was started as a profit-making project (Rodgers, 2010). Apparently the cost of supporting a truly global family of standards is unavoidably significant, especially in the case of the SMEs and their limited resources. Nonetheless, there are a few new methods of reducing the costs and render GS1 XML an attractive alternative solution for the representation and exchange of business documents even for the SMEs (Shamsedin-Tekieh, 2009; Shamsedin-Tekieh, Rabhi, & Motahari-Nezhad, 2010).

The customizability abilities of GS1 XML are detected in its restriction, aggregation, composability and conformity. The extensibility capabilities on the other hand are met in standard's enumeration, augmentation, modularity and isolation.

In comparison to the other standards, GS1 XML has a shorter life, as it was introduced in 2005. No matter that its existence spans over just eight years, some valuable customizability and extensibility lessons can be taken throughout standard's short history:

- Users are quite restricted when they are customizing or extending GS1 XML due to the rigid rules of modifying the definitions of the standard. There are numerous restrictions that will not allow the unlimited declaration of elements as well as the values of these elements. On the one hand the modification rules yield simpler documents, but on the other hand the users miss the flexibility they require to adjust the standard in their actual business environment.
- 2) Despite the fact that the structure of GS1 XML elements is based on XML a markup technical language which remains both human- and machinereadable – internal annotations and documentation is missing from the lengthy resulted documents. There is only little provision from the developers of the standard to include comments and guidance aside to the definitions of elements. Thus, users have to struggle to fully comprehend the semantics existing locally in the data they are about to customize or extent. The lack of internal description of the documents leads to the creation of additional external implementation guidelines.
- 3) GS1 XML is fully compliant with the core components technology of CCTS and inherits its customizability and extensibility. The required modifications and adjustments though in order to utilize the rest of GS1 XML infrastructure results in incompatible with the CCTS core components. The lack of harmonization and standardization causes interoperability problems between those two standards. The burden of this heterogeneity is to require additional conversion tools as CCTS and GS1 XML are in essence different standard formats despite the fact that are based on the same technology.

Figure 4.6 displays the customizability and extensibility profile of GS1 XML.



FIGURE 4.6 Evaluation results of GS1 XML's customizability & extensibility.

4.4.7. OAGIS

The Open Applications Group Integration Specification (OAGIS) is an XML-based standard created by Open Application Group (OAGi) with the purpose to increase interoperability in business software applications. OAGi collaborated with a plethora of vertical industry groups in order to identify their specific requirements and incorporate them to OAGIS in the form of 1) predefined business messages called Business Object Documents (BODs) and 2) business processes called scenarios. As a result, the standard has managed to create the most complete set of business messages ever existed. The latest version of OAGIS (Version 9.5 - May 2011) includes 498 BODs and 68 scenarios covering the scope of diverse implementations in Customer Relationship Management, eCommerce, Enterprise Resource Planning, Manufacturing, and Logistics systems. Additionally, OAGi also cooperates with other standard authorities to further optimize, harmonize and integrate the applications which accommodate both internal and external corporate activities. OAGIS now contains in itself portions of seven other standardization approaches, including making use of the core components by CCTS we investigated previously. A user starts the implementation of the standard starts by choosing one of the available business processes (scenarios); these contain common business scenarios on how the standard can be fit in the actual process. Once the most suitable business scenario is identified, it can help to further identify the BODs that are required to enable the integration. Through an extended network of numerous implementation providers and application vendors, OAGIS became popular in more than 40 countries across the globe.

The up to now approach of OAGIS towards the massaging needs of certain industries was the creation of specifications for these industry-specific requirements. Each individual approach is not always compatible with the rest of the existing ones and the cross-industries transmission of messages may raise conflicts (Rowell, 2002). One additional approach of OAGIS is to integrate business processes with business messages. Yet, the integration task demand compliant interfaces which are unfortunately too complex and costly for most of the SMEs (Liegl et al., 2010). Depending on the specific situation at hand, the implementation of OAGIS's business process scenarios in SME environments can sometimes be easily accomplished. However, the low-end software infrastructure which exists in most of the SMEs requires additional third party messaging architecture and backend integrations to enable interoperability with other businesses (Azad, 2010).

The customizability of OAGIS contains the restriction, the aggregation and the composability characteristics. The corresponding extensibility characteristics are the enumeration, the augmentation, the modularity and the isolation.

The history of OAGIS expands in almost 20 years (it was introduced in 1994) and throughout this period some valuable customizability and extensibility related lessons can be deduced:

- 1) The intention of OAGIS's implementers by utilizing portions of other standardization frameworks was, first of all, to inherit their customizability and extensibility abilities, and secondly to create a list with fully compatible and interoperable standards. One example is the reusable core components of CCTS. Nonetheless, the inclusion of the portions was not conducted by following a structured method. Especially in the case of CCTS, the identification and the elements of the borrowed core components were modified according to OAGIS's infrastructure. Without keeping the consistency of every imported element of the other frameworks, the interoperability between those standards is hampered.
- 2) Whilst OAGIS supports extensibility through formal mechanisms, its customizability does not follow any prescribed method or guidance. Users are free to customize the standard according to their will without the constraints that would maintain the compliance with the original definition of the standard. In that case, non-formal customizability may lead to the exchange of unstructured messages, and as a consequence, to negatively affect the interoperability of the conveyed information.

In Figure 4.7 we illustrate the customizability and extensibility profile of OAGIS.



FIGURE 4.7 Evaluation results of OAGIS's customizability & extensibility.

4.4.8. UBL

The Universal Business Language (UBL) is a royalty free XML-based document standard which promotes easy access to international e-commerce activities in conformance to government and domain-specific regulations. It is developed by the Organization for the Advancement of Structured Information Standards (OA-SIS) and its purpose follows three main directions: first, to represent into a reusa-
ble, modular and extensible form common data elements of business documents derived from a variety of industries and fields; second, to accomplish the same task but for complete common business documents; and third, to embed in the data exchange process a set of business management practices and rules. The generic data elements and documents are created as core components stored in a common repository named UBL Library. The implementation of the standard can be initiated as generic as possible by applying existing components representing requirements common to all companies. Users can also modify components or even create their own, in case the existing ones cannot sufficiently fulfill their vertical requirements. The UBL Library keeps record of the modifications and the extensions ensuring the scalability of the standard. Regardless of the fact that UBL used the technology of CCTS to create its own definitions of core components, the latest developments in the advance of the standard wants it to become fully compatible with the definitions of UN/CEFACT'S CCTS. OASIS will eventually integrate UBL into the UN/CEFACT family of standards which share the same core components stored in CCTS's CCL.

The invention of UBL was sparked by the aim of some authorities to reduce the costs of the adoption of e-business technologies to the lowest possible and make their adoption economically feasible for SMEs. What was envisioned has become reality to a certain degree and nowadays UBL is a broadly used standard within European governments and SMEs (European Committee for Standardization [ECS], 2012). However, further success of UBL among SMEs is still prohibited by the complex and costly implementation of interfaces that are required for the integration of the core components into their internal enterprise systems (Gessa et al., 2010; Liegl et al., 2010). The collaboration of their big partners they depend on is also of crucial importance. So far they avoided investing on adjusting UBL according to the particularities of SMEs simply because the investment on bigger companies is still more lucrative (Tolle, 2008).

The customizability capabilities are key aspects of UBL and they cover all four customizability's sub-characteristics: restriction, aggregation, composability and conformity. On the other hand, standard's extensibility is detected in its enumeration, augmentation, modularity and isolation.

UBL was first released in 2004 and the up to now maturity state of the standard has given the following lessons to be learnt in regards to its customizability and extensibility:

 The number of the existing UBL elements approaches the 850 thousand and the UBL elements exceed the two million mark. The names of the elements do not follow self-describing conventions so they can refer to the activity to which they can be useful. The lack of supporting free tools to select and combine the required components contributes even more to the complexity of UBL. Companies spend considerable amounts of efforts in detecting the interesting elements and attributes within a vast pool of definitions. Users fail to identify the presence of existing elements and they proceed in customizing or extending the standard.

2) The focus of UBL lies on the encoding (syntax) of documentation and the allowed customizability and extensibility capabilities are conducted through modifications of documents' data structures. However, e-business is a lot more than just exchanging information between partners. Some of the standardization approaches we analyzed in this chapter (RosettaNet and ebXML) permit users to modify documents based on the actual business processes they participate to. UBL do not reach such a sophistication level on which the contextual adaptations of the standard could also inherit the corresponding business activities.

Figure 4.8 depicts the customizability and extensibility capabilities of UBL.



FIGURE 4.8 Evaluation results of UBL's customizability & extensibility.

4.5. Results of the evaluation

In this chapter we aimed to analyze some of the most prominent business document standards in order to characterize them according to their customizability and extensibility capabilities. According to the chosen analysis criteria and the proposed qualitative metrics we recapitulate the evaluation results in Table 4.2. We used the following notation to express the degree of the support in each characteristic and sub-characteristic: $\circ\circ\circ$ \Rightarrow *no support*, $\bullet\circ\circ$ \Rightarrow *low degree*, $\bullet\circ\circ$ \Rightarrow *medium degree*, and $\bullet\bullet\bullet$ \Rightarrow *high degree*. Furthermore, we proceed in the characterization of the standards with one of the four customizability and extensibility profiles based on the customizability and extensibility evaluation framework we introduced in Figure 4.1. The results are portrayed in Figure 4.9. To begin with, UN/EDIFACT as an obsolete standard is connected with the most customizability and extensibility insufficiencies. There is some minor provision for restriction and conformity in

customizability, whereas the extensibility is practically unachievable. We associate UN/EDIFACT then to the restricted compatibility profile with low degree of customizability and low - almost non-existed - degree of extensibility. RosettaNet emphasizes in customizability which is comprised by all four sub-characteristics, all in a low degree apart from restriction supported in a medium degree. The extensibility of the standard is moderate and it is comprised by the enumeration, augmentation and modularity characteristics. The low degree of customizability and low degree of extensibility classifies RosettaNet to standards with restricted compatibility. CCTS has a strong focus on customizability with high degree support in two out of four characteristics: restriction and composability. The extensibility capabilities are also high; the isolation characteristic however is not supported at all. CCTS is therefore characterized as a standard of extended interoperability. The case of XBRL reveals a standard with stronger customizability rather than extensibility. The weaker extensibility capabilities are comprised by low to medium degree of modularity, augmentation and enumeration. Thus, XBRL is associated with component repositories. EbXML is the firth of the reviewed standard with stronger customizability rather extensible capabilities: restriction and aggregation are supported to the fullest, however conformity is met at a low degree. The extensibility characteristics were discovered to be supported from a medium to a high degree, with the absence of isolation to limit the overall performance. As a result, ebXML is another one of the three standards associated with the extended interoperability profile. GS1 XML once more emphasizes in customizability; it exposes the highest degree in comparison with the rest of the reviewed standards. The extensibility aspect is rather weak, with medium support of modularity and augmentation, and no support for isolation. GS1 XML manages to obtain the extended interoperability profile, nevertheless its weak extensibility aspect partially connects it to the profile of component repositories. OAGIS is the only standardization approach we analyzed with the extensibility aspect stronger than the one of customizability. Together with UBL, they share the first place in supporting extensibility. The moderate support of customizability's characteristics and especially the low to medium support of composability forces the standard to inherit the dynamic components profile - the only of the outlined standards associated with this profile. At last but not least, UBL is the only of the reviewed standard which manages to support high degree of customizability and extensibility in balance. Despite some weaknesses (like the low degree of support in customizability's augmentation and extensibility's aggregation) it remains at the peak of the classification and obviously obtains the extended interoperability profile. UBL exposes exceptional extensibility characteristics, yet, its customizability performance is superseded by GS1 XML and CCTS.

TABLE 4.2 Evaluation matrix of the investigated standards.

ity capabilities Eliminations Dependencies Reusable proc	ability of Reusable proc	Composabili	ton Core compone	Conformity	Contextual pru	Customized cu	Enumeration	New values in	ti New code lists	bilitie New code lists	pabilitie Augmentatic New process-	capabilitie Augmentatic New process- Mappings of r	ity capabilitic Augmentatic New process- Mappings of n Modularity	ibility capabilitie Augmentatic Mappings of n New core com	ansibility capabilitie Augmentatic Mappings of n Modularity Single reposit	xtensibility Capabilitie Augmentatic New process- New core com Single reposite Isolation	Extensibility capabilitie Augmentatic New process- New core com Single reposito Reserved exte
les of values ess-related activi-	ctivities	ty	nts		ofiles	ontextual profiles		to code lists		on	on related activities	s on related activities ew activities	; on related activities ew activities	; on related activities ew activities ponents	; on related activities ew activities ponents pries	s related activities rew activities ponents pries	; on related activities ew activities ponents pries ories
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Legend: $(\Box\Box\Box) \Rightarrow$ No support ($\Box\Box\Box$) \Rightarrow Support at a low degree ($\Box\Box\Box$) \Rightarrow Support at a medium degree ($\Box\Box\Box$) \Rightarrow Support at a high degree



FIGURE 4.9 Classification of standards according to customizability & extensibility evaluation framework.

4.6.Answer to sub-questions 8, 9 & 9

• What different profiles of customizability and extensibility exist in business document standards?

Based on the evaluation framework for customizability and extensibility of business document standards we introduced in this chapter, four main profiles exist: 1) *restricted compatibility* with both low degree of extensibility and low degree of customizability, 2) *component repositories* with high degree of customizability but low degree of extensibility, 3) *dynamic components* with low degree of customizability, yet, high degree of extensibility, and 4) *extended interoperability* with both high degree of extensibility and high degree of customizability.

• What factors influence these customizability and extensibility profiles?

The four customizability and extensibility profiles are influenced by some characteristics and sub-characteristics connected with either customizability or extensibility. In Table 4.3 we include the corresponding details.

Capabilities	Metrics	Sub-metrics			
		Selections			
	Destriction	Eliminations			
	Restriction	Ranges of values			
		Dependencies of values			
Customizability	Aggregation	Reusable process-related activities			
Custonnizability	Ayyregation	Couplings of activities			
	Composability	Core components			
	Composability	Single repositories			
	Canfannitu	Contextual profiles			
	Comportativ	Customized contextual profiles			
	Enumeration	New values into code lists			
	Enumeration	New code lists			
	Augmontation	New process-related activities			
Extensibility	Augmentation	Mappings of new activities			
EXTENSIONILY	Modularity	New core components			
	Modularity	Single repositories			
	Isolation	Reserved extensible definitions			
	ISUIALIUII	Store to single repositories			

 TABLE 4.3 Summary of factors & sub-factors influencing the customizability & extensibility profiles.

9 What customizability and extensibility lessons can be learned from existing business document standards?

Table 4.4 repeats and summarizes the customizability and extensibility lessons we identified during the analysis of each individual standard.

Standard	Lessons					
	Absence of customizability' layer forces users to directly modify the core definition of the standard.					
UN/EDIFACT	Inclusion of trading partners cannot be carried out automatically; it requires labor- intensive modifications in both the standard and the supporting software infrastruc- ture.					
	Extensibility at a user level is not supported; it can be only achieved through 1) the development of new software in combination with new elements of the standard, a then, 2) the approval of the extensions by standard's official bodies.					
	Customizability and extensibility of business processes lacks flexibility and it is sensitive to the sequence of the activities; rearrangements, inclusions or omissions of activities are generally restricted.					
RosettaNet	Weak reference techniques create lengthy and complex documents due to repetitions of implicit data.					
	Formal guidance and automatic tools of capturing the contextual constraints are missing; users are sometimes forced to modify core definitions jeopardizing standard's interoperability.					
	Extending the standard with new elements is not supported by automatic tools; users have to submit their additions to authorized bodies, a process that sometimes lasts long.					
CCTS	All extended elements are overviewed and authorized centrally by a single organiza- tion; additional national or domain-specific parties could speed up the authorization process and embed their specialized knowledge in the produced elements.					
	Severe incompatibility issues between new and older versions of customized and extensible techniques.					
	Absence of a central version control management system causes conflicts between customized or extended elements and their initial definitions.					
XBRL	Weak usability of software tools supporting customizability and extensibility discour- age users to modify the standard according to their needs, despite the potential capa- bilities. The extra supporting functionality to interconnect standard's users provides limited interaction.					
	Absence of rules and deadlines in the submission of customized or extended to the standard's consortium may lead to creation of non-conformant elements and put interoperability at risk.					
ebXMI	Deviation of the initial plan to inherit and remain compatible with CCTS's customiza- bility and extensibility methods due to inconsistency in both syntax and semantics.					
EDAINE	A single method to implement both customizability or extensions and business pro- cesses keeps standard's ability to absorb additional contextual conditions low.					
	Very strict customizability or extensibility rules make the standard inflexible to efficiently adapt in given contexts.					
GS1 XML	Lack of internal annotations and documentation impedes comprehension of lengthy documents.					
	Nonexistence compatibility with CCTS despite the common customizability and exten- sibility grounds.					
OAGIS	Absence of consistency and structure in adopting customizability and extensibility techniques from other standards led to interoperability issues and rendered OAGIS incompatible with them.					
	Absence of formal methods to apply customizability may risk standard's interoperabil- ity.					
	Customizability or extensions might be unnecessary if the standard would provide users with methods to distinguish and detect their required components.					
OBL	Weak customizability and extensibility capabilities in documenting business process activities.					

 TABLE 4.4 Customizability & extensibility lessons learned from existing standards.

Chapter 5

Model development

In the previous chapter we defined the factors influencing the customizability and extensibility of business document standards, however, these factors should be further assessed in combination with a given domain or context. In this chapter, we now present a method for the evaluation of customizability and extensibility of standards against e-invoicing project-specific requirements by SMEs. Some of the steps in the evaluation raise a number or recommendations. In the end of the chapter we include the answer to sub-question **G**.

5.1. Introduction

We already saw in the preceding chapters that the aim of standardization to efficiently support the interoperability between applications and information systems has led to a wide range of business document standards. Nowadays, firms are facing the challenge of which standard to accept among the numerous approaches currently exist (Soderstrom, 2003). The multitude of popular standards in combination with the absence of a universally accepted standard impedes the interactivity within a constantly growing network of global trading partners. When users apply contextual conventions to standards or align them with other standards in use, compatibility issues arise and interoperability is threatened. It is therefore necessary for organizations to proceed in the evaluation, comparison and selection of standards for projects which involve application development and integration (Mykkanen & Tuomainen, 2008), such as the e-invoicing. While an ad-hoc evaluation of capabilities and features cannot yield objective results, a systematic analysis with well-defined evaluation steps is needed in order to achieve an accurate verdict. What is more, some of standardization's characteristics require situationspecific qualitative measurements.

Mykkanen and Tuomainen (2008) argued that the majority of the evaluation methods found in literature merely list different standards and serve little in the need of selecting and evaluating the interoperability of standards. Some others describe a time-consuming evaluation process, require specific expertise, miss detailed guidelines for different features to be evaluated or neglect important interoperability aspects. These were some of the reasons which urged the authors to propose a comprehensive but practical approach to support the evaluation of coverage, technical consequences and design implications of interoperability standards. Their framework is displayed in Figure 5.1 and it is consisted of 54 considerations grouped into nine Forms (evaluation phases. Form I provides an overview and basic information of the standard to be evaluated; Forms II-V contain detailed examinations of standard's specification of information and semantics, functionality and interactions, application infrastructure, and technical aspects, consecutively; Forms VI and VII are used to detect the flexibility, accuracy, maturity and dissemination phase of the standard; Form VIII estimates the relation of the standard to the life cycle of applications; and finally, Form IX assess the application domain-specific considerations.

The aim of the evaluation framework by Mykkanen and Tuomainen is to provide the qualitative features to be analyzed and then it is up to the potential evaluators to choose which aspects are emphasized and perform the actual analysis. Despite the fact that a lot of attention was given by the researchers to the descriptive guidance and the simplicity of the method, our literature study and a preliminary interview of experts concerning 1) the interoperability of standards and 2) the special nature of SMEs, revealed some of its weak aspects:

- 1. The method by Mykkanen and Tuomainen do not cover customizability and extensibility in depth. Extensibility is mentioned in one of the phases, however, standards are scrutinized on this aspect superficially. Customizability on the other hand is not mentioned at all as it is considered a part in extensibility or flexibility.
- 2. Standards are scrutinized in many details that render the evaluation process time consuming and complex for the capacity of knowledge and resources existing in most of the SMEs.



FIGURE 5.1 Activities in evaluation process proposed by Mykkanen & Tuomainen (2008).

These two reasons motivated us, first of all, to adopt the practical method proposed by Mykkanen and Tuomainen, and adjust it to the scope and needs of SMEs. The focus on e-invoicing makes the evaluation process even more specific and imposes higher levels of simplicity. Secondly, the method of Mykkanen and Tuomainen is extended to include the in-depth analysis of interoperability aspects customizability and extensibility according to their sub-characteristics we identified in the previous chapter. Evaluators obtain, thus, more detailed guidelines for the above mentioned features and the required knowledge to conduct the evaluation method is related to those very specific qualitative metrics.

5.2. Method

5.2.1. Overview

In Chapter 2 we described e-invoicing as a segment of e-business which can be adopted by any kind of firms, regardless of their size. However, business document standards – the integral part of any e-invoicing project – are connected with two crucial interoperability aspects which can make them successful among SMEs: customizability and extensibility. We now construct an evaluation method, especially simplified to be used by SMES, for the systematic analysis of customizability and extensibility of business documents standards being used in an e-invoicing project. The execution of the evaluation yields a summary combining the aim and the scope of e-invoicing with a detailed analysis of standard's interoperability in regards to customizability and extensibility capabilities. The method was constructed according to the guidelines and meta-modeling notation proposed by van de Weerd and Brinkkemper (2008), and it is displayed in Figure 5.2.

The method includes several activities and groups of activities which are described in detail in the following sub-section. In order to facilitate the evaluation process, we include in Appendix A a sample of nine evaluation and implementation forms which can be used by future investigators. Figure 5.2 also displays the name of the forms (from A till J) placed next to the corresponding activity or activities with which they are related. Form A, B and C start with a preparation of the evaluation by identifying the scope and needs of e-invoicing, by assessing company's internal resources which can be placed at the disposal of implementing the standard, and by valuing the influence of partners and customers who are currently using the specific standard. Form D creates an overview of the standard's generic capabilities of constructing business documents. Form E and F contain the evaluation of the standard's customizability and extensibility capabilities, and their subcharacteristics into detail. By using the Form G investigators can include an estimated value of costs implementing the standard. Our method does not include detailed steps of calculating this cost. However, the evaluation of standard's ability to be customizable and extensible exposes at least the amount of effort using the standard. A standard with high levels on those two aspects, and thus, enhanced capability to absorb efficiently the local conditions of a given corporate environment, is bound to require low usage costs. In Form H investigators can fill in their final verdict, i.e. whether the standard is appropriate to be implemented in the current e-invoicing platform based on what was evaluated in the previous forms. Lastly, Form J provides a plan for the implementation of the standard.

It must be noted that our method focuses on the standardization aspects which were detected and described in chapters 3 and 4 as having strong relations with einvoicing projects in SMEs. We argue that even a brief evaluation with the emphasis on customizability and extensibility in combination to the contextual conditions of a given environment renders the assessment of a standard feasible by SMEs. The use of the method requires from the evaluators to have some basic knowledge about business document standards and the software systems they support them, however, no specific technical or engineering skills are needed.



FIGURE 5.2 Evaluation method for business document standards as means of improving e-invoicing's adoption by SMEs.

5.2.2. Description in detail

All the individual steps of the method we introduce in Figure 5.1 are analyzed below. Some of the steps include a number of recommendations having the objective to improve the adoption of e-invoicing in SMEs by utilizing business documents standards efficiently.

Step ① ▶ Identify e-invoicing scope and needs

It is typical for the initiation of any type of project to require a preliminary work concerning collection of specified features and functions for the delivery of a product, service, or result (Project Management Institute, 2013), and an e-invoicing is not an exception. Among the list of tasks contributing to the identification of einvoicing's scope and needs (Ciciriello & Hayworth, 2009; ECS, 2012), two of them are strongly related with business document standards (Figure 5.3). First of all, the target group of current or potential customers and trading partners (define target group of customers and trading partners) who already conduct business electronically has a great impact on the scope of e-invoicing. Later on, our method goes into detail about what standards are being used in the external environment of an SME. It is therefore helpful, during this very first step, to detect which of the current or potential customers/trading partners are e-invoicing capable or not. The second task of this step (identify preferences for specific standards) aims at identifying the reasons of having preferences to the use of specific standards. Apart from the pressure applied by the external environment of an SME which is comprised by customers, suppliers and competitors, specific standards might tantalize for their acceptance due to, among other reasons, their popularity, their embedded support in software packages, and their predominant use in a geopolitical market segment. The two tasks we mentioned in this step could also be carried out in reverse order.



FIGURE 5.3 Sub-activities included in identifying scope and needs.

Step ② ▶ Assess internal capabilities

The internal capacities of SMEs have significant influence on the adoption rates of e-invoicing (ECS, 2012). One of the crucial success factors for e-invoicing projects in SMEs is to become realistic regarding mid- and long-term technical capabilities in their organization (Koch, 2012). A typical path for an SME to follow during the adoption of e-invoicing starts with the assessment of the internal readiness in order to define the human and systems involved in the process (Ciciriello & Hayworth, 2009). The inclusion of a business document standard, as a part in the einvoicing process, does not differ in entailing the recruitment of organization's internal resources, and for this reason they should be enumerated in advance. There are two individual tasks towards this state (Figure 5.4). SMEs should, first of all, be ensured that the acceptance of the standard will not be hampered due to insufficiencies in IT skills and resources (identify human and technology assets). Furthermore, the capabilities of the current or planed internal e-invoicing platform to handle documents such as orders, dispatches and reports, will formulate the aspects and the boundaries of the implementation of the standard (identify current einvoicing status).

We argue that the evaluation of different standards within SMEs should be launched with the analysis of scope and needs of e-invoicing and the studious assessment of the internal capabilities. Many "powerful" and popular recent standards are connected with extensive demands in human and technological resources, which may be beyond the actual e-invoicing requirements or even beyond the capabilities of an SME. The adoption of the wrong standards may put the whole e-invoicing venture at risk. For this reason, we articulate the following recommendation:

R1 • SMEs should avoid performing extensive adaptations in their e-invoicing scope and needs in order to accept a standard. SMEs should also not allow extensive expansion of their internal capabilities (in terms of human and technology assets) with the intension to accept a standard.

Step ③ • Apply external pressure

Penttinen and Tuunainen (2011) claimed that organizational readiness, external pressure, and perceived benefits are the most important factors affecting the adoption of e-invoicing in SMEs. While the organizational readiness was investigated in the previous Step 2 and the perceived benefits are outside the scope of our study, we now inherit the external pressure in order to investigate the impact of this factor in the acceptance of a business document standard. SMEs should be prepared to accommodate several suppliers and customers by supporting the standards they use. In the previous Step 1 we identified the current or potential target



FIGURE 5.4 Sub-activities included in assessing internal capabilities.

group of customers and trading partners; it is now time to investigate in this step which standards they use in their e-invoicing platform (Figure 5.5). This way, SMEs can obtain an overview of which standards are assigned to which customers and trading partners (apply pressure from trading partners and apply pressure from customers), so they can proceed in at least accepting the standards assigned to the largest clients and/or suppliers. The external environment of an SME is also constituted by competitors operating in the same market segment. By detecting which standards are being used by current or potential competitors (apply pressure from competitors), SMEs can extract best practices and valuable lessons of utilizing standards in successful e-invoicing projects, or, on the other hand, identify issues connected with the choice of specific standards. The three tasks of the present step are nonsubsequent.

We believe that the evaluation of an e-invoice standard should be initiated after detecting the extent of its use within the external environment of the SME. Trading partners, customers and competitors influence of even impose the use of specific standards. Our opinion can be also expressed through the following recommendation:

R2 • SMEs have more chances to succeed in e-invoicing if they choose to accept standards which are extensively used by their business partners, customers, and competitors.

Step ④ ▶ Evaluate business document standards

The core stage of our method is the evaluation of a given business document standard based on its business messaging compatibility, customizability and extensibility capabilities, as well as on the cost required for its incorporation to the einvoicing platform of an SME. The individual steps assessing those different aspects of a standard are described below.



FIGURE 5.5 Sub-activities included in applying external pressure.

Step ⊕① ▶ Assess business messaging compatibility

The integration of internal systems and the automation of business processes promise increased accuracy of invoice data and processing speed, however, these benefits can only be reaped if the invoice data is structured (Ciciriello & Hayworth, 2009). The use of fully structured data is the one-way option to exchange einvoices which can be automatically processed by senders, receivers and all other involved parties, and business document standards are the means to achieve the desirable structure in the invoice data (European Commission, 2009). Liegl et al. (2010) refer to the ability of the standard to translate business documents into meaningful data elements on the same way for all the relevant parties as business messaging compatibility. For this reason, our method includes the present step which investigates the business messaging compatibility aspect of standards (Figure 5.6). The first task towards this assessment is to isolate all the mandatory invoice information which will be exchanged with the external environment (identify (mandatory and auxiliary) invoice data). By clarifying the invoice data set we construct the content of the business message (invoice) which will remain interoperable and compatible with the information systems of all the relevant parties. The determination of auxiliary invoice data is also important to be defined through the standard, as they facilitate internal audit-compliant electronic archiving and logging procedures. Some of the techniques standards can utilize during the "expression" and the transfer of business messages eliminate the requirements of specific technical assets and human interaction, and, as a result, simplify the whole e-invoicing process (detect ease of use in applying cross-reference, acknowledgement, validation and troubleshooting features). Thanks to standardization, e-invoicing becomes simpler and more

intuitive, and thus, obtains the ideal conditions to be adopted by smaller firms. Despite the fact that the transfer and the process of e-invoices is carried out through software systems, standards can nowadays embed or at least utilize practices like cross-reference, acknowledgement, validation and troubleshooting. Cross-reference is important for the mapping between the inbound and outbound invoice data fields. Acknowledgements are also important to confirm that an e-invoice was received in a good order. By the same token, validation contributes on the accuracy of the transmitted invoice data. Troubleshooting is an equally important feature which aids in handling adequately rejected e-invoices due to technical failures or data incompatibilities. Finally, a standard should be versatile in transmitting messages by utilizing various transport methods (*identify transmission channels*). The three tasks consisting the present step can be performed in a random order.

Our up to now analysis indicates that the process of evaluating e-invoice standards within SMEs should be initiated with the rigorous analysis of the exchanged data. The first step concerns the identification of the mandatory and auxiliary invoice data. Further on, the identified data should be used during the evaluation of the cross-reference, acknowledgement, validation, and troubleshooting features of the standards. The presence of simple methods to manipulate those features has a beneficial impact towards the acceptance of the standard and, further on, the promotion of e-invoicing in SMEs. A standard should be able to transmit all the mandatory invoice information to all the relative parties through the internet. By taking into consideration all these matters, we propose the following recommendation:

R3 • Reduced efforts in applying the cross-reference, acknowledgement, validation, and troubleshooting techniques in the exchanged data while using a standard promote higher penetration levels of e-invoicing in SMEs. Moreover, the success of e-invoicing in SMEs can only be guaranteed if the standard utilizes the internet for the transmission of the invoice data.

Step ④② ▶ Assess customizability capabilities

In Chapter 4 we described the importance of a standard's customizability capabilities to support e-invoicing in the scope of SMEs. Four qualitative metrics were introduced with the purpose of assessing the customizability of a standard: *restriction, aggregation, composability* and *conformity* (Figure 5.7). Each of the four metrics is decomposed into a number of sub-metrics which reveals customizability's aspects in detail (Table 4.1). We now include those metrics in the evaluation process by dedicating an individual stage for the assessment of the corresponding submetrics. Our evaluation process inherits those metrics and dedicates to each one of them a separate stage. To begin with, the assessment of restriction (*assess restriction*) includes four non-sequential tasks: *detect support for selections of elements, detect support*



FIGURE 5.6 Sub-activities included in assessing business messaging compatibility.

for eliminations of elements, detect support for defining ranges of values and detect support for defining dependencies of values. The assessment of aggregation (assess aggregation) includes two sequential tasks: detect availability of reusable process-related activities and detect support for coupling of activities. Composability (assess composability) is assessed through two sequential tasks as well: detect availability of reusable core components and detect existence of single repository. Finally, the assessment of conformity (assess conformity) is comprised of two sequential tasks: detect availability of contextual profiles and detect capability of customizing the contextual profiles. The four tasks included in the major step assess customizability capabilities can be performed at a random order.

At this point, we claim that the rigorous analysis of the customizability capabilities of a standard is crucial during its evaluation to support e-invoicing within SMEs. The customizability aspect of every standard should be scrutinized by detecting the support of restriction, aggregation, composability, and conformity – the customizability's characteristics we defined in Chapter 4. We therefore propose the following recommendation:

R4 • Enhanced customizability capabilities of standards are crucial for the adoption of e-invoicing by SMEs.



FIGURE 5.7 Activities and sub-activities included in assessing customizability capabilities.

Step @3 • Assess extensibility capabilities

Aside to the analysis of customizability's impact, Chapter 4 examines the importance of a standard's extensibility capabilities to support e-invoicing in the scope of SMEs. Four qualitative metrics were introduced to facilitate the estimation of a standard's extensibility: enumeration, augmentation, modularity and isolation (Figure 5.8). In order to reveal the extensibility's aspects in detail, we split each of the four metrics into a number of sub-metrics which (Table 4.1). Our evaluation process inherits those metrics and dedicates a separate stage for the assessment of the corresponding sub-metrics. To begin with, the assessment of enumeration (assess enumeration) comprises two non-sequential tasks: detect support for definitions of new values into code lists and detect support of definitions of new code lists. The assessment of augmentation (assess augmentation) includes three sequential tasks: detect support for definitions of new process-related activities, detect support of mappings of new activities and detect support of defining new core components, Modularity (assess modularity) is estimated through two sequential tasks: detect support of defining new core components and detect existence of single repository. Finally, the assessment of isolation (assess isolation) involves the operation of two sequential tasks: detect availability of reserved extensible definitions and detect support of storage of extensible definitions to single repositories. The four tasks included in the major step assess extensibility capabilities can be performed at a random order.

Our experience indicates that the rigorous analysis of the extensibility capabilities of a standard is crucial during the assessment of an e-invoicing standard within SMEs. The extensibility aspect of every standard should be scrutinized by detecting the support of enumeration, augmentation, modularity, and isolation – the extensibility's characteristics we defined in Chapter 4. As a result, we propose the following recommendation:

R5 • Enhanced extensibility capabilities of standards are crucial for the adoption of e-invoicing by SMEs.

Step (5) Analyze implementation cost

The construction of business documents based on some of the existing standards is related with very high implementation costs, especially for the SMEs (Liegl et al., 2010). During this step, the evaluator estimates the cost required for the implementation of the standard. It is out of our evaluation method's scope to provide a detailed guidance and methods for the precise calculation of the standard's implementation costs. However, we argue that evaluators can draw important conclusions about the standard's implementation costs by roughly calculating the cost for the required additional labor and/or technical resources in order to cover the results of Step 2, *assess internal capabilities*. Furthermore, we mention once again that the evaluation of standard's ability to be customizable and extensible at a high



FIGURE 5.8 Activities and sub-activities included in assessing extensibility capabilities.

level exposes low implementation and usage costs. Evaluators can, thus, proceed into a rough verdict about how much it will cost if they decide to accept the standard.

It is common truth that many standards are connected with implementation costs which might prove to be high or even forbidden for the limited resources of SMEs. The companies must determine the required costs of implementing an e-invoice standard before proceeding in its acceptance. This matter encourages recommending the following:

R6 • Accepting a standard with high implementation costs in SMEs should be avoided because it puts e-invoicing at risk.

Step Step Appropriate standard?

At this phase, the evaluator must use the results of the evaluation conducted in Step 4 in combination with the results of the preparation Steps 1, 2, and 3, and the estimated implementation cost in Step 5 in order to articulate a justified decision concerning the acceptance or not of the standard. Some of the indicated evaluation criteria might be weighted as more important as the others; it is up to the evaluator's discretion to designate the most significant characteristics and proceed in accepting a standard which covers them adequately. Nevertheless, during our study we tried to meticulously collect the most crucial standardization criteria which promise advancement in e-invoicing's adoption by SMEs. We therefore suggest evaluators to put equal interest in measuring all our metrics and sub-metrics before proceeding into their verdict.

Step ⑦① ▶ Abandon standard

In case the verdict of the previous step is negative due to low evaluation scores, the acceptance of the standard under scrutiny should be abandoned, as it may jeopard-ize the SME's e-invoicing venture.

Step 🕫 🕨 Implement standard in e-invoicing platform

In case the verdict of the previous step is positive due to high evaluation scores, the acceptance of the standard under scrutiny should be approved, as it can facilitate the SME's e-invoicing venture. Once the decision is taken in favor of accepting the standard, the implementation stage can begin (Figure 5.9). According to the paradigm of implementing whole e-invoicing platforms (Ciciriello & Hayworth, 2009), the company has three options of implementing the standard and incorporating it to the current e-invoicing platform: insourcing, outsourcing or partial insourcing (*implementation of the standard through an insourcing, outsourcing or partial insourcing solution*). The first option of insourcing, expects from the company to implement the standard and internally by using the skills and resources it has at its disposal. The option of

outsourcing assigns the implementation to a service provider who takes over the integration of the standard into the current e-invoicing platform. Finally, the option of partial insourcing solution connects the e-invoicing platform with an internet portal for the automated conversion of inbound and outbound data into a specific standard. As soon as the implementation is finished, a virtual exchange of some invoices should be carried out to verify the quality and compliance of the implementation (ECS, 2012) (conduct virtual transactions to evaluate integrity and performance). This last task ensures that the standard has been integrated correctly to the current e-invoicing platform and it can be utilized smoothly in the e-invoicing process.



FIGURE 5.9 Sub-activities included in implementing standard in e-invoicing platform.

5.3. Answer to sub-question @

O How can the identified influential factors be used to improve the evaluation of business document standards in SMEs?

In Chapter 4 we identified the factors and sub-factors which influence the customizability and extensibility profiles of a standard and we include them in Table 4.3. In the present chapter we incorporated all these factors and sub-factors into an evaluation method with a sequence of specific tasks presented in Figure 5.2. Being part of the evaluation process, the individual elements shed light on different aspects of customizability and extensibility, and, thus, help evaluators to assess the potential of a standard to be efficient on regards to those two characteristics. Figure 5.7 and Figure 5.8 display respectively the factors influencing the customizability and extensibility profiles transformed into evaluating tasks.

Chapter 6

Evaluation

In Chapter 5 we introduced an evaluation method for business document standards as means of improving e-invoicing's adoption by SMEs. During the evaluation process we also drew some recommendations targeting SMEs and concerning advices related with the acceptance of a standard. In the current chapter, we now validate the recommendations through expert opinions.

6.1. Selection of companies

The objective of the present study is related with the adoption of e-invoicing in SMEs. We followed the *participant feedback* validation strategy (Johnson, 1997) and we sought candidate cases in the specific market segment of our interest.

Our main research question and sub-questions themselves sketch the profile of the appropriate candidate corporate environments where the most important parts of our study could be evaluated and yielded useful results. Aiming to investigate the adoption of e-invoicing in SMEs, our first requirement was to find SMEs fulfilling the criteria of the SME definition by the European recommendation (Section 5.1). And by focusing on the domain of e-invoicing, additional attributes of the business environment are arising as requirements. For example, the volume of the published invoices should be above an amount that justifies the electronic transformation venture. Another criterion is enforced by the limited time we had at our disposal and it is related with the physical location of the candidate corporations; we only had time to investigate a few companies within the national borders set by the origin of our study, the Netherlands.

Rather than seeking for simple cases of random SMEs, then detecting their possible current state of e-invoicing practices, and, in the end, perform locally several evaluations of business documents standards through our proposed method, we decided to follow a more flexible approach which has the potential to reveal holistic insights based on a few investigated companies. We discovered firms which do not only practice e-invoicing themselves, but also *provide e-invoicing services to numerous other SMEs*. By having the opportunity to put such companies under the microscope, our experiment automatically obtains additional benefits at many levels:

- 1) The professional e-invoicing solutions offered by the investigated companies are not merely exhausted till the provision of the service. After years of collaboration, clients have a personal relationship with the employees of those companies. They ask for support, they transfer the implications occurred after the use of different business document standards, or even they demand the implementation of a standard that is not supported by the provided e-invoicing platform. By dealing with all these issues, those firms accumulated condensed knowledge from a heavy number of cases, and, as a result, they became an expert of knowing the implications of each individual standard and their impact in e-invoicing applied in SMEs.
- 2) The SMEs that retrieve e-invoicing services from the investigated companies are coming from both the private and the public sector, as the einvoicing services they developed aligned several business documents standards to the needs of both of them. We were therefore enabled to discover truths that can explain how standards affect e-invoicing in SMEs to both of these sectors.

- 3) The restricted available time to conduct our study would not have allowed us to extract results from multiple SMEs among their numerous existing clients. By approaching the investigated companies which reach hundreds of SMEs themselves, we practically reach their needs and preferences on how business document standards can facilitate their e-invoicing practices. Moreover, the SMEs-clients are situated not only across the Netherlands, but also in the whole Benelux area. Therefore, the opinion of the chosen experts reflects the standards-related requirements that are valid in this broader area.
- 4) The investigated companies gave us access to the process of developing their e-invoicing platforms where we could investigate how business document standards are accepted and operate in practice. By having such practical insights of nature of many business document standards and how these can facilitate e-invoicing in SMEs, we could ask opinions and collect advices even during the preliminary design of our research approach and the definition of our research questions.
- 5) The investigated companies and most of their SME clients are situated in the Netherlands, one of the European countries with the highest einvoicing adoption rates (IAPP, 2011). Such a high volume of e-invoices indicates that the domain in this country is quite mature to be able reveal valid insights about the impact of the business document standards on the adoption of e-invoicing.

All the above mentioned reasons motivated us to approach the following corporations:

DigitaleFactuur (① www. digitalefactuur.nl): *DigitaleFactuur* is a software house situated in Leiden, the Netherlands and its mission is to create affordable electronic products and services dedicated to cover the needs of small-scale customers, such as SMEs. It was founded in 2001 and today, being an SME itself, it employees 10 individuals and has an annual turnover of €150.000. Its customers can be counted up to approximately 24.000 and the majority of them are SMEs. The most profitable product of the company is an online e-invoicing platform, a software system which was lunched upon the foundation of the company and now has 1900 active users. Being online for more than a decade, it is now considered one of the most popular and affordable e-invoicing solutions among SMEs. Its success is also confirmed by the fact that it appealed the interest of Dutch government agencies and there are already plans underway to incorporate the platform into the official public financial services.

MoneyBird (① www.moneybird.nl): Since its foundation in 2008, *MoneyBird* has managed to become one of the most prominent e-invoicing providers in the Netherlands. It is situated in Enschede and its focus lies mostly on small-scale customers, from individual users to large-scale SMEs. The number of the existing clients exceeds the 35.000 and almost all of them are SMEs. All of them are subscribed as

members of the core product of the company, an e-invoicing platform which enables them to create and send invoices online. The company's annual turnover is estimated at around ϵ 550.000.

Logius ([®] www.logius.nl): Logius was established in 2006 as an income and expenditure service of the Netherlands Ministry of the Interior and Kingdom Relations. The work of Logius is commissioned by bodies responsible for policy, including the Ministries of the Netherlands Interior and Kingdom Relations, Economic Affairs, Public Health, Welfare and Sport and Education, Culture and Science. Logius offers a government-wide ICT solutions and common standards that simplify the communication between authorities, citizens and businesses, with a view to cohesion of the e-government networks. The supplied products are related with access, data exchange, standardization and information security. The standardization products in particular provide government organizations with advice about how they are able to reliably exchange data between themselves and with citizens and businesses and how to reuse that data. E-invoicing is extensively supported by those products.

6.2. Selection of experts

In order to verify the validation of the recommendations we defined in Chapter 5, we approached some persons from the staff of the investigated companies with the aim to interview them and extract their knowledge. Table 6.1 contains the name of experts who dedicated time to talk to us, as well as their professional profile. We put special effort in talking to both managerial and engineering employees so as to deliver diversity in the opinions and to enable comparisons of the given answers. All of the chosen experts have extensive knowledge and previous experience in dealing with business document standards in combination with e-invoicing's adoption by SMEs.

6.3. Recommendations to be verified

In Chapter 5, the construction of specific stages in the evaluation method for business document standards led to several propositions with some related recommendations. Table 6.2 summarizes both the propositions and the recommendations which are going to be presented in the chosen experts and be validated by them through concrete questions.

Name	Profile
Bas Avis ① bas.avis@logius.nl	Current function: Connection coordinator of Digipoort (a back- bone for the exchange of information between government and corporations) at Logius (government agency of the Neth- erlands Ministry of the Interior and Kingdom Relations). Previous experience: IT entrepreneur, marketing consultant, project manager, business consultant, functional designer, information analyst. Education: MSc, Business Economics at University of Amster- dam. MBA, Strategic management and organizational behavior at Leiden University.
Joost Diepenmaat ① j.diepenmaat@bluetools.nl	Current function: Owner/Product designer at MoneyBird, mar- ket-leader for online invoicing in the Netherlands. Previous experience: IT entrepreneur, software engineer. Education: MSc, Computer Science at Twente University.
Philip Niewold (1) philip@projectie.com	Current function: Owner/Software Engineer at DigitaleFactuur, market-leader for online invoicing in the Netherlands. Previous experience: data analyst, legal consultant. Education: MSc, Law and Psychology at Leiden University.
Ravi Chotkan ① ravi@projectie.com	Current function: Owner/Head Software Engineer at Digitale- Factuur, market-leader for online invoicing in the Netherlands. Previous experience: software engineer. Education: BSc, Information and Communications Technology at Hogeschool Leiden.
Tijmen Dobbenburgh ① tijmen@projectie.com	Current function: Owner/ Information Architect at DigitaleFac- tuur, market-leader for online invoicing in the Netherlands. Previous experience: general administrator. Education: MSc, Farmaceutical Science at Leiden University.

 TABLE 6.1 Profiles of interviewed experts.

6.4.Results

6.4.1. Evaluation of recommendation R1

R1 • SMEs should avoid performing extensive adaptations in their e-invoicing scope and needs in order to accept a standard. SMEs should also not allow extensive expansion of their internal capabilities (in terms of human and technology assets) with the intension to accept a standard.

The validity of above mentioned recommendation was investigated by posing to the experts the following two questions:

Q1 • Does the adoption of an e-invoicing standard justifies extensive adaptations in the scope and needs of e-invoicing in an SME?

Propositions from Chapter 5	Derived recommendations
The evaluation of different standards within	
SMEs should be launched with the analysis of	
scope and needs of e-invoicing and the studi-	D1 • CMEs should avoid performing extensive
ous assessment of the internal capabilities.	RI • SIVIES SHOULD avoid performing extensive
Many "powerful" and popular recent standards	adaptations in their e-involcing scope and needs
are connected with extensive demands in hu-	not allow extensive expansion of their internal
man and technological resources, which may	not allow extensive expansion of their internal
be beyond the actual e-invoicing requirements	capabilities (in terms of numain and termology
or even beyond the capabilities of an SME. The	assets) with the intension to accept a standard.
adoption of the wrong standards may put the	
whole e-invoicing venture at risk.	
The evaluation of an e-invoice standard should	
be initiated after detecting the extent of its use	R2 • SMEs have more chances to succeed in e-
within the external environment of the SME.	invoicing if they choose to accept standards
Trading partners, customers and competitors	which are extensively used by their business
influence of even impose the use of specific	partners, customers, and competitors.
standards.	
The process of evaluating e-invoice standards	
within SMEs should be initiated with the rigor-	
ous analysis of the exchanged data. The first	
step concerns the identification of the manda-	R3 • Reduced efforts in applying the cross-
tory and auxiliary invoice data. Further on, the	reference acknowledgement validation and
identified data should be used during the eval-	troublesbooting techniques in the exchanged
uation of the cross-reference, acknowledge-	data while using a standard promote higher
ment, validation, and troubleshooting features	penetration levels of e-invoicing in SMEs. More-
of the standards. The presence of simple meth-	over the success of e-invoicing in SMEs can only
ods to manipulate those features has a benefi-	be guaranteed if the standard utilizes the inter-
cial impact towards the acceptance of the	net for the transmission of the invoice data
standard and, further on, the promotion of e-	
invoicing in SMEs. A standard should be able to	
transmit all the mandatory invoice information	
to all the relative parties through the internet.	
The rigorous analysis of the customizability	
capabilities of a standard is crucial during its	
evaluation to support e-invoicing within SMEs.	R4 • Enhanced customizability capabilities of
The customizability aspect of every standard	standards are crucial for the adoption of e-
should be scrutinized by detecting the support	involcing by SMES.
of restriction, aggregation, composability, and	
Conjornity	
i ne rigorous analysis of the extensibility capa-	
bilities of a standard is crucial during the as-	
sessment of an e-involcing standard within	R5 • Ennanced extensibility capabilities of
SMES. The extensionity aspect of every standard	standards are crucial for the adoption of e-
should be scrutinized by detecting the support	involcing by SMES.
of enumeration, augmentation, modularity, and	
ISUIdUUII.	
tation costs which might prove to be high at	
cation costs which might prove to be high or	R6 • Accepting a standard with high implemen-
even jorbidden jor the limited resources of	tation costs in SMEs should be avoided because
Sivies. These companies must determine the	it puts e-invoicing at risk.
required costs of implementing an e-involce	
stanuard before proceeding in its acceptance.	

 TABLE 6.2 Propositions and recommendations.

Q2 • Does the adoption of an e-invoicing standard justifies extensive expansion of the internal capabilities (in terms of human and technology assets) of an SME?

Responder →	B. Avis	J. Diepenmaat	P. Niewold	R. Chotkan	T. Dobbenburgh
Questions ↓					
Q1	X	*	-	-	-
Q2	+	-	X	*	*

The responses of the experts are included in Table 6.3.

TABLE 6.3 Responses in Q1 & Q2 (\Rightarrow \Rightarrow positive, \Rightarrow \Rightarrow negative, \clubsuit \Rightarrow possible/not always).

Question Q1 does not receive positive answer by none of the experts and verifies one of the fundamental principles of our topic, that is, SMEs should proceed in extensive adaptations of their e-invoicing scope and needs with the aim of accepting a business document standard. However, two out of five responses indicate that the situation can be reversed under some circumstances. Avis and Diepenmaat claimed that SMEs should proceed in adapting their e-invoicing scope and needs in case the acceptance of a standard demands it and in case this standard is the only option to exchange information with company's major clients and/or business partners. Most of the answers in question Q2 indicate that SMEs should sometimes justify massive extensions to their human and technology capacity in order to accept a standard. Once again, the communication of the companies with major customers/suppliers should be depended on that specific standard before SMEs proceed in such adaptions so as to accept it. Avis was the only expert who supported positively question Q2 by arguing that the acceptance of a new standard enhances either way the communication channels of SMEs with current and potential customers/suppliers, and, thus, companies should invest in expanding their internal capabilities in order to accept it. Diepenmaat, on the other hand, disagreed by stating that if the acceptance of the standard requires extensive expansions of internal assets, SMEs should never proceed in accepting them.

Conclusion (VR1): SMEs should avoid performing extensive adaptations in their einvoicing scope and needs in order to accept a standard. Nevertheless, SMEs should sometimes allow extensive expansion of their internal capabilities (in terms of human and technology assets) with the intension to accept a standard, depending on the importance of its existence to establishing communication channels with major customers/suppliers.

6.4.2. Evaluation of recommendation R2

R2 • SMEs have more chances to succeed in e-invoicing if they choose to accept standards which are extensively used by their business partners, customers, and competitors.

The above mentioned recommendation was verified by asking the experts the following three questions:

Q3 • Is it necessary for SMEs to only accept e-invoice standards which are extensively used by their current trading partners?

Q4 • Is it necessary for SMEs to only accept e-invoice standards which are extensively used by their current customers?

Q5 • Is it necessary for SMEs to only accept e-invoice standards which are extensively used by their current competitors?

Responder →	B. Avis	J. Diepenmaat	P. Niewold	R. Chotkan	T. Dobbenburgh
Questions ↓					
Q3	+	+	*	*	-
Q4	×	+	+	*	*
Q5	*	X	×	*	*

Table 6.4 contains the responses of the experts on these questions.

TABLE 6.4 Responses in Q₃, Q₄ & Q₅ (\Rightarrow \Rightarrow positive, \Rightarrow negative, \clubsuit \Rightarrow possible/not always).

Question Q3 led to ambiguous answers. Avis and Diepenmaat advocated the absolute necessity for SMEs to only accept e-invoice standards which are extensively used by their current business partners. Niewold and Chotkan were less strict towards this statement by suggesting SMEs to assess first the importance of a standard in retaining business relationship with suppliers. According to their opinion, it depends on the explicit request of the suppliers to exchange invoices by using a specific document standard. Dobbenburgh stated that SMEs should be impartial by their supliers' influence while accepting a document standard, and gave a negative answer. Question Q4 investigates the influential power of customers and the given answers indicate that is greater than the power of suppliers. Diepenmaat and Niewold strongly believe that SMEs should only accept e-invoice standards which are extensively used by their current customers. The other three experts who partially support this statement, mentioned the importance for an SME to accept all the standards are being used by its current customers, regardless of the high or low degree of a standard's usage in the amount of the published e-invoices. Finally, question Q5 considers the impact of competitors in the decision regarding which business document standard should be accepted by SMEs. It received a unanimous answer by all the responders, indicating the opinion that SMEs should be skeptical in accepting the standards are being used extensively by competitors. All experts mentioned the importance of investigating the special circumstances and individual parameters which are applicable in the acceptance of a standard in single SME, no matter the common practices and successful scenarios of other companies in the same field of business.

Conclusion (VR2): SMEs have more chances to succeed in e-invoicing if they choose to accept standards which are extensively used by their customers, business partners, and competitors (in order of priority).

6.4.3. Evaluation of recommendation R3

R3 • Reduced efforts in applying the cross-reference, acknowledgement, validation, and troubleshooting techniques in the exchanged data while using a standard promote higher penetration levels of e-invoicing in SMEs. Moreover, the success of e-invoicing in SMEs can only be guaranteed if the standard utilizes the internet for the transmission of the invoice data.

The following two questions were posed to the experts with intention to seek validity in the above mentioned recommendation:

Q6 • Do you consider as crucial for a standard to provide easy methods in applying crossreferences, acknowledgements, validations, and troubleshooting in the exchange of e-invoicing data in SMEs?

Q7 • Is the support of inexpensive transmission methods such as the internet crucial for a standard supporting e-invoicing in SMEs?

Responder →	B. Avis	J. Diepenmaat	P. Niewold	R. Chotkan	T. Dobbenburgh
Questions ↓					
Q6	+	+	+	*	+
Q7	+	+	+	+	-

In Table 6.5 we placed the responses of the experts on these questions.

TABLE 6.5 Responses in Q6 & Q7 (\blacklozenge \Rightarrow positive, \neg \Rightarrow negative, \blacktriangle \Rightarrow possible/not always).

Through the responses in question Q6, experts expressed the almost unanimously positive opinion that the success of an e-invoicing standard in SMEs is strongly depended on the easiness of applying cross-references, acknowledgements, validations, and troubleshooting while using the standard. Chotkan noted that the com-

plexity of applying those methods should not always intimidate SMEs in accepting a standard and gave a moderate answer. Question Q7 elicited once again an almost unanimously positive belief that the utilization of internet by an e-invoicing standard secures its success within SME environments. Dobbenburgh was the expert who disagreed by stating that the secured private networks required by some standards – such as the UN/EDIFACT – is the one-way option of accepting a standard. In that case, it is important for SMEs to be able to support the networking infrastructure required by those standards, no matter that the utilization of the internet by other standards promotes flexibility in applying e-invoicing practices.

Conclusion (VR3): Reduced efforts in applying the cross-reference, acknowledgement, validation, and troubleshooting techniques in the exchanged data while using a standard promote higher penetration levels of e-invoicing in SMEs. Moreover, the success of e-invoicing in SMEs is facilitated through standards which utilize the internet for the transmission of the invoice data.

6.4.4. Evaluation of recommendation R4

R4 • Enhanced customizability capabilities of standards are crucial for the adoption of e-invoicing by SMEs.

The validity of the above mentioned recommendation is assessed by posing to the experts the following four questions:

Q8 • Does the availability of methods to select relevant elements, to eliminate the optional ones, to define ranges of elements' values and to set dependencies in these values affect the success of a standard to support e-invoicing in SMEs?

Q9 • Do the availability of reusable process-related activities and the ability of methods to couple those activities affect the success of a standard to support e-invoicing in SMEs?

Q10 • Do the presence of customizable core components and the existence of single repositories affect the success of a standard to support e-invoicing in SMEs?

Q11 • Do the availability of contextual profiles and the ability to customize those profiles affect the success of a standard to support e-invoicing in SMEs?

In Table 6.6 we include the given responses.

Responder →	B. Avis	J. Diepenmaat	P. Niewold	R. Chotkan	T. Dobbenburgh
Questions ↓					
Q8	+	+	+	+	+
Q9	*	*	+	+	*
Q10	*	+	*	*	*
Q11	+	*	+	+	*

TABLE 6.6 Responses in Q8, Q9, Q10 & Q11 (\Rightarrow positive, \neg hegative, \blacktriangle \Rightarrow possible/not always).

Question Q8 introduces to the experts the first of customizability's subcharacteristics, the restriction. All the experts gave positive answer about the significance of these features for the success of a standard to support e-invoicing in SMEs. Question Q9 investigates the significance of customizability's aggregation and receives neutral responses in the majority of the answers. The unanimously positive answers come from the two engineers in the group of experts; Niewold and Chotkan implied that the availability of reusable process-related activities and the ability of methods to couple those activities affect the success of a standard to support e-invoicing in SMEs to a great extent. The importance of customizability's composability is estimated through question Q10. Diepenmaat is the only expert who fully defends this significance. Surprisingly enough, the majority of the experts adopt a neutral opinion towards this feature in contrast to its designated significance in the literature (Liegl et al., 2010). Apparently, according to the experts the customizability's modularity in the field of e-invoicing is not the most crucial feature that will drive the success of the standards in SMEs. Finally, through the question Q11 we tried to elicit the experts' verdict concerning the customizability's conformity. Three out two experts gave a positive answer, with the other two to characterize this feature as not very important.

Conclusion (VR4): Enhanced restriction and conformity aspects in a customizability's capabilities of a standard are crucial for the adoption of e-invoicing by SMEs.

6.4.5. Evaluation of recommendation R5

R5 • Enhanced extensibility capabilities of standards are crucial for the adoption of e-invoicing by SMEs.

The above mentioned recommendation is now verified through the following four questions:

Q12. Do the availability of methods to define new values into existing code lists and the ability to define new code lists affect the success of a standard to support e-invoicing in SMEs?

Q13 • Do the availability of methods to define new business processes related activities and the ability to map those activities to the actual business process of every trading partner affect the success of a standard to support e-invoicing in SMEs?

Q14 • Do the presence of methods to extend core components and the existence of single repositories affect the success of a standard to support e-invoicing in SMEs?

Q15 • Do the reservation of designated definitions as extensible and the store of them in single repositories affect the success of a standard to support e-invoicing in SMEs?

Responder →	B. Avis	J. Diepenmaat	P. Niewold	R. Chotkan	T. Dobbenburgh
Questions ↓					
Q12	+	+	+	*	+
Q13	+	+	+	+	+
Q14	*	-	+	*	*
Q15	*	-	-	*	-

Table 6.7 contains the responses of the experts.

TABLE 6.7 Responses in Q12, Q13, Q14 & Q15 (\Rightarrow positive, \neg negative, \clubsuit \Rightarrow possible/not always).

Question Q12 presented to the experts the enumeration, the first subcharacteristic of a standard's extensibility. Most of the given answers give evidence that the availability of methods to define new values into existing code lists and the ability to define new code lists affect the success of a standard to support einvoicing in SMEs. Chotkan was the only responder who claimed that this is not always the case. Question Q13 also extracted positive responses towards the importance of extensibility's augmentation with all the experts to agree unanimously. Question Q14, on the other hand, which is related with extensibility's modularity, led to neutral responses. Diepenmaat was even negative to support the presumption that the presence of methods to extend core components and the existence of single repositories affect the success of a standard to support e-invoicing in SMEs. Niewold was the only responder who defended this significance. Once again, as it happened with customizability's composability, the majority of the experts adopt a neutral opinion towards core components in standardization. This result contradicts the designated importance of components as the most crucial feature that drives the success of the standards in SMEs (Liegl et al., 2010). Lastly, question Q15 about extensibility's isolation led to answers that indicate the rather low contribution of this sub-characteristic to the success of a standard to support e-invoicing in SMEs. Only Avis and Chotkan claimed that the contribution sometimes is important indeed.

Conclusion (VR5): Enhanced enumeration and augmentation aspects in extensibility's capabilities of a standard are crucial for the adoption of e-invoicing by SMEs.

6.4.6. Evaluation of recommendation R6

R6 • Accepting a standard with high implementation costs in SMEs should be avoided because it puts e-invoicing at risk.

In order to seek validity in the above mentioned recommendation, we posed to the experts the following two questions:

Q16 • Should the high costs related to the implementation of a popular e-invoice standard discourage SMEs to accept it?

Q17 • Some standards are related with high implementation costs. Is such an investment justified nowadays in order for the SMEs to accept additional popular standards and thus be more versatile in supporting e-invoicing?

Responder →	B. Avis	J. Diepenmaat	P. Niewold	R. Chotkan	T. Dobbenburgh
Questions ↓					
Q16	*	*	-	-	-
Q17	*	*	-	-	-

Table 6.8 contains the corresponding responses.

TABLE 6.8 Responses in Q16 & Q17 (\Rightarrow \Rightarrow positive, \Rightarrow \Rightarrow negative, \clubsuit \Rightarrow possible/not always).

Questions Q16 and Q17 receive the exact same responses from all the experts. There were no positive answers at all with the prevailing answer to be between negative and neutral. According to the experts' opinion, the high costs related to the implementation of a popular e-invoice standard should not discourage SMEs to accept it, as long as the standard is being used dominantly for exchanging einvoices in their field of business. Avis and Diepenmaat were reluctant in giving their full consent in such a statement; they argued, it depends on the availability of resources in SMEs to support the high costs, as well as on which customers/suppliers use the standard. Most of the responses in the next question Q17 indicate a different attitude towards additional standards that might enhance the einvoicing function in SMEs. Evidently, the high costs related to the implementation of an additional standard that is not currently being used by customers/suppliers should be granted as determinative factor for their acceptance. Avis and Diepenmaat gave a neutral response by mentioning the possibility that the high implementation costs of a standard that is not currently necessary might be
justified, in case the SME is about to enter marketplaces where the corresponding standard is being utilized to a great extent.

Conclusion (VR6): Accepting a standard which is connected with high implementation costs and on the same time it is not popular in the actual business field of an SME should be avoided as it puts e-invoicing in this SME at risk.

Chapter 7

Analysis

In the previous chapter we evaluated the validity of our initial recommendations through the opinions of experts. Now, in the present chapter, we use the results of the evaluation in order to weigh the significance of the activities included in our evaluation method. In the end, we include the answer to our main research question.

7.1. Evaluated status of recommendations

The construction of the evaluation method for business document standards as means of improving e-invoicing's adoption by SMEs led to several propositions and recommendations, which are summarized in Table 6.2 of Chapter 6. The evaluation we conducted helped us to obtain practical insights which are required for the verification of validity of these statements. According to the responses of the experts, all the initial recommendations were confirmed to a great extent. However, the experts' opinions aided in clarifying and/or extending what was initially hypothesized in order to construct statements that reflect the practical reality. Table 7.1 contains the initial recommendations, the verified recommendations and the modified propositions.

7.2. Evaluated status of the evaluation method

Since our propositions and the related recommendations were derived while constructing the stages of the evaluation method for business document standards, we now use the verified recommendations and modified propositions of Table 7.1 with the intention to make the stages of the method more practical.

To begin with, the verified recommendation VR1 encourages SMEs to allow extensive expansion of their internal capabilities (in terms of human and technology assets) in order to accept a standard, depending on the importance of that standard in establishing communication channels with major customers/suppliers. Such a statement implies that the external pressure of the SME to apply and use specific business document standard(s) should be taken into account before proceeding into measuring the internal resources required for the implementation of the standard. The prior knowledge about which standards are imposed by the external environment, would help SMEs to assess possible expansions in their internal capabilities afterwards. Both of these parameters are considered as a preparation stage in our evaluation method, nevertheless their order should be reversed. The result is to have the step "apply external pressure" preceding the step "assess internal capabilities" (Figure 7.1).

Initial recommendations	Verified recommendations	Modified propositions
R1 • SMEs should avoid performing extensive	VR1 • SMEs should avoid performing extensive adapta-	The evaluation of different standards within SMEs should be launched with the analysis of scope and needs of e-invoicing, and
adaptations in their e-invoicing scope and needs in order to accept a standard. SMEs	accept a standard. Nevertheless, SMEs should sometimes allow extensive expansion of their internal capabilities (in	the studious assessment of its external pressure. Many "powerful" and popular recent standards are connected with extensive de-
their internal capabilities (in terms of human and technology assers) with the intension to	terms of human and technology assets) with the inten- sion to accept a standard, depending on the importance	the actual e-invoicing requirements or even beyond the capabilities of an SME. The adoption of these standards that none of the existing of the existing the existing of the existing the existing of the existing th
and technology assessy with the interision to accept a standard.	of its existence to establishing communication channels with major customers/suppliers.	customers/suppliers are using may put the whole e-invoicing ven- ture at risk.
R2 • SMEs have more chances to succeed in	VR2 • SMEs have more chances to succeed in e-invoicing	The evaluation of an e-invoice standard should be initiated after
e-invoicing if they choose to accept standards	if they choose to accept standards which are extensively	detecting the assessment of its internal capabilities. Customers,
which are extensively used by their business partners, customers, and competitors.	used by their customers, business partners, and competi- tors (in order of priority).	crading partners, and competitors (in order of their power) influence of even impose the use of specific standards.
		The process of evaluating e-invoice standards within SMEs should
reference, acknowledgement, validation, and	VR3 • Reduced efforts in applying the cross-reference,	first step concerns the identification of the mandatory and auxiliary
troubleshooting techniques in the exchanged	acknowledgement, validation, and troubleshooting	invoice data. Further on, the identified data should be used during
data while using a standard promote higher	techniques in the exchanged data while using a standard	the evaluation of the cross-reference, acknowledgement, validation,
penetration levels of e-invoicing in SMEs Moreover, the success of e-invoicing in SMEs	promote nigher penetration levels of e-invoicing in SMEs. Moreover, the success of e-invoicing in SMEs is facilitated	and troubleshooting leatures of the standards. The presence of simple methods to manipulate those features has a beneficial im-
can only be guaranteed if the standard utilizes	through standards which utilize the internet for the	pact towards the acceptance of the standard and, further on, the
the internet for the transmission of the in- voice data.	transmission of the invoice data.	promotion of e-invoicing in SMEs. A standard should be able to transmit all the mandatory invoice information to all the relative
		parties through the internet.
R4 • Enhanced customizability capabilities of	VR4 • Enhanced restriction and conformity aspects in a customizability's canabilities of a standard are crucial for	The rigorous analysis of the customizability capabilities of a standard is crucial during its evaluation to support e-invoicing within SMEs.
invoicing by SMEs.	the adoption of e-invoicing by SMEs.	The customizability aspect of every standard should be scrutinized by detecting the support of restriction and conformity.
R5 • Enhanced extensibility capabilities of	VR5 • Enhanced enumeration and augmentation aspects	The rigorous analysis of the extensibility capabilities of a standard is
standards are crucial for the adoption of e-	in extensibility's capabilities of a standard are crucial for	crucial during the assessment of an e-invoicing standard within SMEs. The extensibility aspect of every standard should be scruti-
		nized by detecting the support of enumeration and augmentation.
R6 • Accepting a standard with high imple-	VR6 • Accepting a standard which is connected with high	Many standards are connected with implementation costs which might prove to be high or even forbidden for the limited resources of
mentation costs in SMEs should be avoided	popular in the actual business field of an SME should be	SMEs. These companies must determine the required costs of im-
טברמשפ ור לחריז ב-ווואסורוווא מר ווזאי	avoided as it puts e-invoicing in this SME at risk.	their field of business before proceeding in its acceptance.

TABLE 7.1 Initial recommendations, verified recommendations and modified propositions.



FIGURE 7.1 Contribution of VR1.

The verified recommendation VR2 introduces a priority on the influence that an SME might get from its external environment. It is implied that SMEs have more chances to succeed in e-invoicing if they accept, first of all, the e-invoicing standards being used by their customers. The success can be further guaranteed if the companies continue in accepting the standards being used by their business partners. The influence of competitors is the weakest, yet, it can further contribute to the success of e-invoicing to an SME. Once again, our evaluation method should be modified so as to reflect such a reality. The unordered activities included in step "apply external pressure" should be transformed into sequential activities based on the discovered order of influence (Figure 7.2). SMEs could, thus, be guided into constructing an ordered list with standards assigned into specific customers, business partners and competitors, and prioritize the acceptance of the standard based on that order.



FIGURE 7.2 Contribution of VR2.

The verified recommendation VR4 reveals which customizability's subcharacteristics are important for a standard aiming to support e-invoicing in SMEs. The significance of aggregation and composability had not have confirmed by the experts, with the focus to lie on restriction and conformity. Consequently, the corresponding activities should be eliminated from the step "assess customizability capabilities" in our evaluation method (Figure 7.3). As a result, SMEs could be consulted in driving the evaluation to the customizability aspects that are most crucial to the adoption of e-invoicing.





On the same token, the verified recommendation VR5 reveals which extensibility's sub-characteristics are important for a standard aiming to support e-invoicing in SMEs. The significance of modularity and isolation did not manage to attract a confirmation from the experts, with the importance to lie on enumeration and augmentation. The corresponding activities should be, therefore, eliminated from the step "assess extensibility capabilities" in our evaluation method (Figure 7.4). Accordingly, SMEs could be consulted in keeping the focus of the evaluation to the extensibility aspects that are most crucial during the adoption of e-invoicing.



FIGURE 7.4 Contribution of VR5.

7.3. Answer to main research question

How can business document standards be evaluated and utilized by SMEs during einvoicing's adoption?

During the adoption of e-invoicing by SMEs, business document standards can be evaluated and utilized by using the activities of the evaluation method displayed in Figure 7.5a and Figure 7.5b.



FIGURE 7.5B Activities and sub-activities of "assess customizability capabilities" and "assess extensibility capabilities".



FIGURE 7.5A Evaluation method for business document standards as means of improving e-invoicing's adoption by SMEs.

Chapter 8 Giscussion

In this chapter we discuss our research, its findings and their implications. We also provide directions for future studies.

8.1. The research and its limitations

The major goal of our study was to increase the awareness of today's SMEs in choosing to accept the right business document standards during the adoption of e-invoicing. Our findings were derived by following the specific research approach we designed in Chapter 1. Due to limited number of practical investigations, we cannot proceed into generalizations that would be able to describe the situation in every possible SME. Nevertheless, we have managed to select and combine many theoretical sources in order to explore and extensively describe, for the first time, the business document aspect of the adoption of e-invoicing in SMEs. Moreover, we used a number of qualitative metrics with the intention to analyze and classify eight prominent business document standards according to an evaluation framework for customizability and extensibility. We also have formulated a number of recommendations with the intention to consult SMEs with practical advices for their future e-invoicing plans. Finally, a step-by-step evaluation method suitable for SMEs guides the assessment of accepting a standard for e-invoicing.

Although the study was carefully prepared and its goals were reached, the conduction of research during a master's thesis project imposes some unavoidable restrictions. Our research method - and especially its validity process - had to be adapted to limitations of time and scope. The intention of our proposed evaluation method is to help SMEs to decide whether a business document standard is appropriate to be accepted during the adoption of e-invoicing. It was designed based on practical findings of other related scientific sources and, later on, it was validated and improved through the opinions of experts who specialize in providing einvoicing solutions to SMEs. However, we did not have the chance to execute the evaluating steps in the real corporate environment of SMEs. If we had had the chance to do so, we would have obtained more evidences to adapt and/or to improve the evaluating steps according to accurate real-world scenarios. The small number of interviewees and their focused interest in conducting businesses with SMEs operating mainly in the Netherlands were additional inhibitor factors for the broad validity of our study. Finally, our evaluation method promotes simplicity by providing uncomplicated evaluation steps for aspects such as external pressure and implementation costs, and by emphasizing on standardization's customizability and extensibility. This comes in contrast to the rigorous evaluation of standards which involves numerous experiments, surveys or case studies (Kitchenham, 1996).

8.2. The results and their implications

The first part of our practical findings is related with the utilization of the evaluation framework for customizability and extensibility of standards we introduced in Figure 4.1. We scrutinized eight different document standards in order to classify them according to their customizability and extensibility characteristics to one of the following profiles: 1) restricted compatibility, 2) dynamic components, 3) extended interoperability, and 4) component repositories. Our analysis has designated UBL as the most powerful standard in applying customizability and extensibility, and, thus, as the standard with the highest potential of achieving high penetration levels in SMEs.

The relatively broad use of UBL within SMEs (ECS, 2012) confirms our first finding. However, further success of UBL among SMEs is still prohibited by the complex and costly integration of its core components into internal enterprise systems (Gessa et al., 2010; Liegl et al., 2010). The indifference of the authorities to adjust the standard according to the particularities of SMEs puts extra obstacles to a broader acceptance of UBL in these environments (Tolle, 2008).

By conducting the expert interviews we were not led in discovering new recommendations and/or extending the proposed evaluation method. However, our additional findings helped us to clarify which qualitative characteristics related to business document standards influence the adoption of e-invoicing in SMEs. Based on what was prevailing in the literature about the customizability and extensibility of standards, we have managed to specify which of their sub-characteristics are the most important in the creation of e-invoices in SMEs: restriction and conformity for customizability, and enumeration and augmentation for extensibility.

Previous research has shown that the success of some business document standards to achieve high penetration levels in SMEs is strongly related with the support of core components. Liegl et al. (2010) mentioned that the most significant determinant of acceptance of a standard in an SME is the availability of affordable core components in the form of off-the-shelf software, Hofreiter and Huemer (2003). and Naujok and Huemer (2008) line up with the same opinion, defending the presence of core components as a crucial characteristic in standardization that enables SMEs to conduct e-businesses. Conversely, our practical investigation reveals a different reality. The experts we interviewed did not agree about the importance of the core components on the adoption of e-invoicing in SMEs. The corresponding sub-characteristics of customizability (composability) and extensibility (modularity) which assess the capability of the standards to support core components - were not confirmed as significant factors, and, as a result, they were removed from the final evaluation method. A reason that possibly explains the divergence of views is the application of standards for a specific activity among the different e-business tasks. The special requirements and needs of the adoption of e-invoicing in SMEs do not presuppose the availability of core components in the supporting standards. Our outcome rather coincides with the opinion of some other researchers who claimed that the existence of core components acts as an inhibition of accepting standards in SMEs. According to Yan and Tan (2007) core components are eventbased process-centric by nature, whereas SMEs perform e-business tasks which are loosely coupled to process actions. Moreover, core components were designated as a costly aspect of applying standardization due to the redundant features which

are not needed by SMEs. In the study of Besimi and Dika (2011) the costly core components were also described as a deteriorating factor of accepting standards in SMEs.

Our analysis contradicts another study that tries to identify which qualitative characteristics in standardization drive the acceptance of standards in SMEs. Janner et al. (2006) referred to ease of implementation and operation as the qualitative attribute that has the strongest effect in securing a standard's usage by SMEs. The evaluation method we propose does include a related step that partially assesses the above mentioned factor; analyze implementation costs. For simplicity reasons, we omitted the assessment of the ease of operation of the standard, since we claim that the implementation is the most difficult stage of accepting a standard in an SME environment. We believe that once a standard is implemented successfully, the operation is bound to follow the general intuitive principles of e-business with minimal labor effort and human intervention. On the same token, we translated the ease of implementation to implementation costs, so as the evaluators could extract a more concrete result related to implementation through a simpler evaluation step. Our study proceeds one step further by designating the customizability and extensibility as the qualitative criteria that directs the standards' popularity within SMEs during the adoption of e-invoicing.

8.3. Suggestions for further research

Based on the discussion and limitations our study as they were noted previously, we suggest the following four directions for further research:

- 1) The ability of our evaluation method in leading SMEs into a verdict concerning the acceptance of a business document standard during the adoption of e-invoicing should be verified through evaluations in real corporate environments. Future researchers should perform the process by absorbing the local contextual conditions of SMEs operating in different market or even geopolitical segments. This way, potential weaknesses or omissions of the proposed method can be revealed and lead to an improved and/or extended evaluation method with broader validity.
- 2) Our research has revealed that the customizability and extensibility aspects should be the strongest decisive factors for the acceptance of a standard by SMEs. Future research activities should investigate the possibility of other standardization aspects to also have a strong influence in such a decision: validation, maturity, compatibility, modeling of messages, easiness of use, openness, support, integrated management of enterprise and data models, workflow capabilities (Lampathaki et al., 2009); flexibility, understandability, simplicity, consistency (Melleri et al., 2011).

- 3) The description of the characteristics and sub-characteristics of customizability and extensibility was derived from the methods applied by some of the most popular business document standards in order to become robust in the corresponding capabilities. Additional, more sophisticated methods of other, perhaps less popular standards, may reveal characteristics and sub-characteristics (and as a consequence, additional evaluating metrics) that are not included in our study.
- 4) Our evaluation method can be more comprehensive in some of the steps which are now covered superficially. The identification of e-invoicing's scope and needs, the assessment of the internal capabilities, the estimation of the implementation costs and the consideration of the external pressure can be performed through more rigorous activities that may help SMEs in obtaining more accurate evaluating results. However, special attention should be paid in retaining the simplicity of the method; additional assessing steps might turn the evaluation procedure into a complicated and resources-consuming process, and, thus, not suitable for SMEs.

8.4.Conclusion

Up to now, the benefits of e-invoicing continue to be acclaimed in numerous of studies, governmental and organizational reports. The adoption of the technology by SMEs, however, has not reached satisfactory levels and there is a lot of progress to be made until we reach a de facto state. The objection of the present research project was to give a better understanding on how can business document standards be evaluated and utilized by SMEs during e-invoicing's adoption. We started by investigating in the existing literature what factors related to business document standards influence the adoption of e-invoicing. After designating the importance customizability and extensibility through several sources, we defined four different profiles that are able to classify standards according to their corresponding characteristics: 1) restricted compatibility, 2) dynamic components, 3) extended interoperability, and 4) component repositories. In order to enhance and support the assessment of the standards, we also defined the qualitative metrics that influence these profiles: 1) restriction, 2) aggregation, 3) composability, and 4) conformity for customizability, and 1) enumeration, 2) augmentation, 3) modularity, and 4) isolation for extensibility. Afterwards, we used the qualitative metrics so as to analyze and classify to one of the four profiles eight prominent business document standards; 1) UN/EDIFACT, 2) RosettaNet, 3) CCTS, 4) XBRL, 5) ebXML, 6) GS1 XML, 7) OAGIS, and 8) UBL. Finally, we created a simple step-by-step method that guides the evaluation of accepting a standard for e-invoicing in an SME and takes into consideration all the related contextual conditions. Our initial findings led to number of recommendations intended to consult SMEs on the adoption of einvoicing.

Based on our practical results, GS1 XML, CCTS, OAGIS and UBL are four of the standards which are more advanced in applying customizability and extensibility,

and, thus, having better potentials in becoming successful in SMEs. Additionally, by conducting interviews with experts, we managed to highlight the importance of restriction and conformity in customizability, and of enumeration and augmentation in extensibility. Such insights helped us to create a practical and more suitable for SMEs evaluation process that facilitates the verdict regarding the acceptance of a standard during the adoption of e-invoicing. Lastly, we used the same findings to formulate a number of specific recommendations that give advices about the utilization of standards by SMEs in their e-invoicing plans.

Appendix. Evaluation forms

EVALUATION FORM FOR CUSTOMIZABILITY & EXTENSIBILITY OF STANDARDS USED IN AN E-INVOICING PROJECT

Evaluation date:	[DD-MM-YYYY]
Evaluator:	[name, contact information]
BASIC INFORMATION ABOUT THE STAND	ARD (Mykkanen & Tuomainen, 2008)
1. Name of the standard:	[official]
2. Version:	[# or date of standard's publication]
3. Standard organization:	[name of organization and official web- site]
4. Availability:	[free, limited, commercial, open source, proprietary, voluntary etc.]
5. What are the main external (other) standards compatible with the standard under investigation?	[description, references]
6. Additional considerations	[description]

A. IDENTIFY E-INVOICING SCOPE AND NEEDS		
Define target group of customers and trading partners		
 7. List current/potential customers and suppliers who are e-invoicing capable. 	[name, type (customer/supplier), state (current/potential)]	
Identify preferences for specific standards		
8. Which e-invoicing standards are pre- ferred and why?	[name of standards, description or n/a]	

B. ASSESS INTERNAL CAPABILITIES	
Identify human and technology assets	
Does the acceptance of the standard require specific IT skills?	[y/n, description]
10. (if 9): Are these skills available?	[y/n, description]
 Does the acceptance of the standard require specific IT infrastructure? 	[y/n, description]
12. Is this infrastructure available?	[y/n, description]

Identify current e-invoicing status	
13. Does the current or planed e-invoicing platform include (ECS, 2012):	
a) orders	[y/n, description]
b) dispatches	[y/n, description]
c) remittances	[y/n, description]
d) statements	[y/n, description]
e) reports	[y/n, description]
f) other documents	[y/n, description]
14. Does the current or planed e-invoicing platform support the standard?	[y/n, description]

C. APPLY EXTERNAL PRESSURE	
Apply pressure from trading partners	
15. Which standards are being used by current/potential suppliers?	[list of suppliers and the standards they use]
Apply pressure from customers	·
16. Which standards are being used by current/potential customers?	[list of customers and the standards they use]
Apply pressure from competitors	
17. Which standards are being used by current/potential competitors?	[list of competitors and the standards they use]

D. ASSESS BUSINESS MESSAGING COMPATIBILITY	
Identify (mandatory and auxiliary) invoice data	
18. Define a list of data that must be transmitted with e-invoices (ECS, 2012).	[description]
Detect ease of use in applying cross-reference, a ing features	cknowledgement, validation and troubleshoot-
19. Does the standard support some of the following? How easy it is to apply them?	
a) cross-references to map external e- invoicing data with the internal ones, when customers/suppliers use different data identification coding.	[y/n, description, ease of use (1=difficult, 5=easy)]

b) acknowledgements to inform the arrival and the process of sent e-invoices.	[y/n, description, ease of use (1=difficult, 5=easy)]
c) validations to ensure data integrity and minimize errors.	[y/n, description, ease of use (1=difficult, 5=easy)]
d) troubleshooting to intuitively accom- plish the transmission of the e-invoices despite potential communication prob- lems.	[y/n, description, ease of use (1=difficult, 5=easy)]
Identify transmission channels	
20. Which transmission channels can be leveraged by the standard?	
a) public networks (internet)	[y/n, description]
b) private networks	[y/n, description]
c) web services	[y/n, description]

E. ASSESS CUSTOMIZABILITY CAPABILITIES		
Assess restriction		
Detect support for selections of elements, Detect support for eliminations of elements		
21. Which mechanisms are used to sepa- rate the useful data elements from the redundant ones?		
a) selections	[y/n, description]	
b) eliminations	[y/n, description]	
Detect support for defining ranges of values		
22. Is it feasible to apply restrictions in the range of the potential values of data ele- ments?	[y/n, description]	
Detect support for defining dependencies of values		
23. Is it feasible to apply dependencies between the values of data elements?	[y/n, description]	
Assess aggregation		
Detect availability of reusable process-related activities		
24. Does the standard support process- related activities in the produced docu- ments by using "nouns" and "verbs"?	[y/n, description]	
Detect support for coupling of activities		

25. (if 24): Can the process-related activi- ties be connected with others to form sequences based on a business logic?	[y/n, description]	
Assess composability		
Detect availability of reusable core components		
26. Do the produced documents be com- prised by customizable and reusable core components which can be tailored to context-specific needs?	[y/n, description]	
Detect existence of single repository		
27. (if 26): Is there a single, common re- pository available to centrally store all the customized core components?	[y/n, description]	
Assess conformity		
Detect availability of contextual profiles		
28. Does the standard support application of contextual profiles containing data elements and activities of various busi- ness sectors?	[y/n, description]	
Detect capability of customizing the contextual profiles		
29. (if 28): Do these profiles permit cus- tomizability to allow further expressions of additional contextual details?	[y/n, description]	

F. ASSESS EXTENSIBILITY CAPABILITIES		
Assess enumeration		
Detect support for definitions of new values into code lists		
30. Does the standard provide pre- existing code lists, i.e. enumerated values assigned into a single data element?	[y/n, description]	
Detect support of definitions of new code lists		
31. Does the standard allow the creation of new code lists?	[y/n, description]	
Assess augmentation		
Detect support for definitions of new process-related activities		
32. Is it feasible to create business pro- cess-related activities based on new "nouns" and "verbs" that are not defined	[y/n, description]	

in the standard?		
Detect support of mappings of new activities		
33. (if 32): Does the exchange of a mes- sage composed by newly constructed activities be facilitated by a mapping mechanism to be able to assign unknown "nouns" and "verbs" to the local ones?	[y/n, description]	
Assess m	nodularity	
Detect support of defining new core components		
34. Can users be able to extend the standard by creating their own, compatible core components?	[y/n, description]	
Detect existence of single repository		
35. (if 34): Is there a single, common re- pository available to centrally store all the extended core components?	[y/n, description]	
Assess	solation	
Detect availability of reserved extensible definitions		
36. Does the standard allow the creation of new data elements in an isolated and restrictions-free part of its definition without affecting the core one?	[y/n, description]	
Detect support of storage of extensible definitions to single repositories		
37. (if 36): Is there a single, common re- pository available to centrally store all the new, unrestricted core components?	[y/n, description]	

G. IMPLEMENTATION COSTS	
Estimate implementation cost	
38. Which is the estimated cost of imple- menting the standard?	[#, description]

H. FINALIZATION	
Appropriate standard?	
39. Is the up to now verdict in favor or against of implementing the standard?	[positive/negative, reason(s) + description]

J. IMPLEMENT STANDARD IN E-INVOICING PLATFORM Implementation of the standard through an insourcing, outsourcing or partial insourcing solution (Ciciriello & Hayworth, 2009) 40. Which of the following solutions is preferred for the implementation of the standard in the e-invoicing platform? [y/n, description] a) insourcing [y/n, description] b) outsourcing [y/n, description] c) partial insourcing Conduct virtual transactions to evaluate integrity and performance (ECS, 2012) 41. Which of the current custom-[name, contact details] ers/suppliers would be the best to conduct pilot e-invoice exchanging based on the implemented standard? 42. Which are the quality and the compli-[description] ance of a test e-invoice based on the implemented standard?

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ADOPTION OF E-INVOICING BY SMES THE BUSINESS DOCUMENT STANDARDS ASPECT

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