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Abstract

Electronic data exchange along the supply chain has been discussed in the information systems (IS) academic literature for many years and remains a practical problem for enterprises worldwide. In this paper we present a Maturity Model for B2B Integration (BIMM). The model is a result of a longitudinal research project on B2B integration. The BIMM was developed to assess the capability level for electronic document exchange of players in a supply chain and addresses current limitations of existing maturity models. The BIMM was developed a-priori from an extensive literature review and an explorative study of 112 company cases. In the next stage of the research the model will be validated using real-world data from leading B2B integration providers.

Keywords: B2B Integration, IOS, Maturity, Classification Framework

1   Introduction

Businesses are increasingly involved in various kinds of collaborative activity ranging from simple electronic document exchange (e.g. orders and invoices) to complex supply networks with interfaces to business partners on many different levels. Nevertheless, "[…] even as B2B projects are proliferating, for many companies, the status of their multi-enterprise integration projects is in the same condition as their internal integration was in the mid-1990s" (Lheureux et al. 2009). Many companies still appear to be struggling with the implementation of inter-organizational systems (IOS) that are optimized for their internal needs.

Academics and practitioners have tried to address this problem by developing different kinds of theoretical assumptions and models for the classification of IOS (Reimers et al. 2010, Williams 1997). In the body of literature on IOS there are also some publications on IOS maturity models. The Capability Maturity Model (CMM) is one of the most prominent examples of a maturity model description and assessment. Probably stimulated by its success, many maturity model approaches for different domains have

subsequently been developed, characterised by different levels of detail (cf. Fraser 2002, Netland 2007 for a broader overview).

However, the literature indicates that many of these models lack a holistic view of all relevant maturity issues of a domain (Mettler et al. 2009). Our research attempts to overcome these deficiencies by developing a maturity model that addresses a broad range of relevant issues and is based on a solid empirical database. In the first step of our longitudinal research project, we developed an *a-priori B2B Integration Model (BIMM)* from an extensive literature review and an explorative study of 112 company cases (current state of research presented in this paper). We are now in the process of iteratively validating this a-priori model with real-world data from EDI transaction databases.

The following chapter provides a literature overview and a comparative analysis of maturity models within the domain of B2B integration. Chapter 3 describes our research steps for the model development. Chapter 4 contains our a-priori B2B Maturity Model (BIMM). We conclude the paper with some final remarks.

2 Literature Review

The term maturity has been discussed in the field of IS for a long time. First attempts can be found e.g. in Nolan's Stages of Growth Model for Enterprise Data Processing (EDP) where the evolution of an initial stage to a more mature stage for EDP is theorized (Nolan 1973). Several other model approaches followed for different domains of IS including: *quality management* (Crosby 1979), *organizational maturity* (Benbasat et al. 1980), *use of ERP systems* (Holland and Light 2001) or *service operations* (McCluskey 2004) to name a few.

2.1 Existing Maturity Models

In early attempts to define the term "maturity model", researchers struggled for a common formal and structural basis on which maturity of information systems can be defined and assessed properly. Elements found in the models were (1) a *staged level description* of (2) *evolutionary steps towards* and (3) a description of *good or bad practices* with intermediate or transitional stages (Fraser et al. 2002). In summary, maturity has been described by these authors as an *evolutionary process* guided by *domain-specific experience* towards a *final stage* (the most mature state).

The approaches suggested in these models each followed their unique way of defining and measuring maturity, which led to a large number of models differing in size, scope, depth and applicability (e.g. Paulk et al. 1995, McGrath 1996, Chisea et al. 1996, Clark and Jones 1999, Lockamy and McCormack 2004). With this wide range of individual maturity approaches in mind, Mettler et al. (2009) set out to make one of the first attempts to characterize maturity and maturity models for information systems on a broad scale. The authors investigated 117 articles dealing with maturity, capability and assessment models. For them, maturity "[…] implies an evolutionary progress in the demonstration of a specific ability or in the accomplishment of a target from an initial to a desired or normally occurring end stage" (p. 334). Following their definition, the purpose of a maturity model is to guide through this evolutionary progress in a

structured and formalized manner using evaluative and comparative measures (de Bruin et al. 2005).

Mettler et al. (2009) identified the following *three dimensions* that maturity models should include covering all relevant aspects and fulfilling their initial purpose: The first dimension, (1) the *General Model Attributes* serve mainly as a descriptive part for the model's assessment. The second dimension, (2) the *Maturity Model Design* deals with conceptual issues like construction and organization of the model. (3) The *Maturity Model Use*, as the third dimension, covers the deployment, the suggested assessment and practicality. Each dimension is given a distinct set of attributes, which represent a specific requirement or property of the maturity model.

Looking at maturity models within the domain of B2B integration, we found several suggestions for models that focus on the domain of Supply Chain Management ranging from a mere diagnostic tool (Foggin et al. 2004) to a complex framework-based assessment model like SCOR (SCC 2001). In order to give an overview, we selected the well-known maturity models from academia and practice in order to perform a comparative analysis based on the Mettler et al.'s classification framework. The identified models clearly reflect the overall struggle of finding a proper conceptual approach and a tool for analysing and evaluating the collaborative environment of a supply chain. The results of our analysis are presented in Table 1.

	Model / Attributes	SCM Process Maturity Model	The Supply Chain Maturity Model	Maturity Model for Virtual Organizations	Supply Network Capability Model
General model attributes	**Source**	Lockamy & McCormack	Butner & Geuder	Venkatraman & Henderson	Srai & Gregory
	Domain/ Topic	SCM/SCOR	SCM	Virtual Organizations	Supply Network
	Origin	Academia	Business (IBM)	Academia	Academia
	Target audience	Academia/ Business	Business	Business	Academia/ Business
	Year of publication	2004	2005	1998	2008
Maturity model design	**Concept of maturity**	Process Maturity	Object Maturity	Process Maturity	Object/Process Maturity
	Composition	CMM-like	Maturity Grid	Maturity Grid	CMM-like
	Reliability	Not Validated	Not Validated	Not Validated	Not Validated
	Mutability	Form	-	Form	Form
Maturity model use	**Method of application**	Self-Assessment	Self-Assessment	Self-Assessment	Third Party Assessment
	Support of application	Textual Description	No Supportive Material	Textual Description	No Supportive Material
	Practicality of Evidence	Implicit Recommen-dation	Implicit Recommen-dation	Implicit Recommen-dation	Implicit Recommen-dation

Table 1: Comparison of maturity models based on to the Mettler et al.'s (2009) classification

Several important differences can be identified:

(1) General model attributes
Starting with the *domain-specific* attribute, there are no models that actually represent the same or almost the same topic in their investigation. Lockamy and McCormack's (2004) SCM Process Maturity Model has the broadest scope of the four selected models as it builds on the original SCOR model with its vast process-oriented framework for supply chains. The IBM model (Buttner and Geuder 2005) is portrayed on a somewhat more abstract level where important issues for a mature SC organization are mentioned but not described in detail. Its actual applicability in practice is thus limited. The two other models have their focus on virtual organizations and supply networks and thus cover yet another aspect of supply chain research (Venkatraman and Henderson 1998, Srai and Gregory 2008). In summary, our literature analysis did not reveal any truly holistic approaches for the assessment of maturity in B2B relationships.

(2) Maturity Model Design
The conceptual basis of all four models is even more varying than their domain focus. Lockamy and McCormack (2004) use *processes* for their maturity assessment (SCOR processes), as do Venkatraman and Henderson (1998, general processes). The IBM model emphasizes three managerial aspects or *objects* that are categorized into five mature stages (condition demand, global buying power and logistics excellence). Only Srai and Gregory (2008) combine *process- and object-related* maturity aspects in their approach. *People-related* maturity aspects are hardly represented in any of the models.

The composition itself is on an easy to comprehend level for business audiences in all models, with a grid describing different stages of maturity. The two papers, which also address an *academic audience,* use a more formal and rigorous approach, which Mettler et al. (2009) call *"CMM-like"*.

When it comes to the underlying empirical database for creating reliability through *verification* and *validation*, none of the reviewed models provides data that is used to validate the constructs or could demonstrate the correctness of the maturity assessment. However, the authors use case studies or surveys to show the applicability of their work.

At last, *mutability* reflecting the constant change of an environment with respect to new best practices and emerging technologies cannot be identified in any of the investigated models. Adaption of form or functionality towards changed requirements is not incorporated within the original model design.

(3) Maturity Model Use
Evidence thus remains on an abstract level, as it is hard to formulate explicit *recommendations* in a given scenario without a validated database. The same observation over all domains can be made for many other maturity models dealing with inter-organizational issues such as supply chains (cf. an overview of models Srai and Gregory 2005 or Netland et al. 2007). The focus of the model approaches is typically not a holistic one concerning all institutional, organizational and technical aspects. Additionally, in most cases the maturity itself is derived from one or at most two conceptual underpinnings.

2.2   The Development of the a-priori BIMM

In the next sections we introduce and describe two models (SCOR and CMM) that were taken as a starting point for the development of our a-priori BIMM.

Supply Chain Operations Reference Model (SCOR)

Although not a maturity model, the most common and well-known model for supply chain process description and analysis is the Supply Chain Operations Reference Model (SCOR, SCC 2001). Its combination of process elements, corresponding metrics, best practices and actions for execution provides elements important for a maturity level assessment. With SCOR it is possible to define the scope and context, geography, segment and product of an organization within a supply chain according to the five main *process types* plan, source, make, deliver and return (management level). A multi-level structure allows for a drill-down from the management level to the so-called configuration level. There, each main process can be divided into several process categories specifying the management process. The third level allows for a distinct description of process steps (business activities), their input and their output information.

Capability Maturity Model (CMM)

The Capability Maturity Model (CMM) was developed by the Software Engineering Institute (SEI) and initially described in a book (Paulk et al. 1995). The model comprises five stages that organisations go through as they move from an immature to a mature understanding of business processes. It helps companies assess where they are today and provides a roadmap how to get to where they want to be. Its key assumption is that more mature organisations perform more consistently and are thus more successful. The levels are: Initial, Repeatable, Defined, Managed and Optimizing. Continuous process improvement is enabled by quantitative feedback from the process and from piloting innovative ideas and technologies.

3   Research Steps: The Development of a Maturity Model

In the last years, different authors have proposed different *methods for the development* of maturity models (e.g. de Bruin et al. 2005; Becker et al. 2009). Their methods address the problems of rigor and relevance and call for a detailed description of the steps in the development of the model.

For the development of the B2B Integration Maturity Model (BIMM) we follow the steps suggested by Becker et al. (2009). Their approach is based on the well-established principles for Design Science by Hevner et al. (2004). They suggest eight main phases for their procedure model which are: *Problem definition, Comparison of existing maturity models, Determination of development strategy, Iterative maturity model development, Conception of transfer and evaluation, Implementation of transfer media, Evaluation and Rejection of maturity model*. With respect to the intended long-term use of our model we extended the procedure model with one further phase: *Maintain*.

As part of our initial research within these steps we examined 112 case studies for the development of our a-priori model. All cases follow a common classification scheme that is used to report on project experiences, which make them an ideal source for a structured cross-case analysis. The so called eXperience Methodology (Schubert and

Wölfle 2007) has been specifically designed for the collection and the transfer of best practice experiences in enterprise systems projects. The methodology provides a toolset containing templates for (1) the writing of case studies, (2) the effective classification and storage in an online database (Web platform), and (3) ways of organising workshops and events where first-hand experience is being presented (knowledge transfer and teaching).

In the following sections we describe the steps that we performed as suggested by Becker et al. (2009). The intended result was an a-priori BIMM from an extensive literature review and an explorative study of 112 company cases.

3.1   Problem Definition

In the initial phase we defined the target domain of the proposed maturity model and the intended target group. As stated above we defined the BIMM as a maturity model for *B2B Integration*. This comprises all relevant technical, organizational and institutional issues dealing with inter-organizational collaboration in a specific environment.

3.2   Comparison of existing maturity models

We performed an extensive comparison of existing maturity models. A summary of this analysis was provided in the above literature review. It revealed that none of the aforementioned maturity models covers all relevant aspects (technical, organizational and institutional) in a thorough model description. The empirical database for the validation of the maturity model (reliability) was neither vast nor specific enough. In most cases the maturity itself was derived from one or at most two conceptual underpinnings. This proves to be insufficient for a holistic model approach.

3.3   Determination of development strategy

Based on our analysis of existing maturity models and frameworks in the domain of B2B integration we chose to combine certain elements of these models and frameworks to design a new maturity model.

We conducted an explorative analysis of a set of selected case studies to create a first *a-priori model* covering most of the prescribed aspects. With the identification of cases, coding of the content, triangulation and resolving of disputes we were able to find a description of dimensions and constructs relevant for maturity assessment. Our second step followed Becker et al.'s procedure for the development of our maturity model. Following the literature we needed a CMM-like structure as Mettler et al. (2009) call it to pay tribute to the overall complexity of the domain. De Bruin et al. (2005) suggest a so called "stage-gate" approach, which allows "[…] separate maturity assessments for a number of discrete areas, in addition to an overall assessment for the entity." This approach is most suitable for complex areas of interest, which can be assumed for supply chain integration with its multitude of different kinds of relationships, organizational integration scenarios and institutional dependencies.

As a starting point for thinking about the actual design, de Bruin et al. (2005) emphasize the target audience for the maturity model. The designer has to consider, *why* the audience should apply the model, *how* it can be applied with different organizational structures, *who* will apply this model and *what* the outcome of using it will be.

Starting with the *who*-question, the BIMM is supposed to inform auditors and managers alike about the current maturity situation of an organization ("as-is") and provide a set of prescribed actions/recommendations for improvement. Consequently, the model offers the possibility for a deep analysis of an organisation in a certain position in a supply chain and consolidates results at a higher and more abstract level acting both as an analytical and managerial tool for improvement (*why*-question).

The overall purpose of an assessment of our proposed maturity (*what*-question) model is a deep structural analysis of a given organization in its inter-organizational environment, a multi-level maturity assessment on the basis of this analysis, a prescription/ recommendation to reach the next stage of maturity and deliver a comparative analysis of two or more organizations.

To accomplish this purpose (*how*-question), a self-assessment with the help of this model would be preferable. The complex structure has thus to be reduced to a level that experts inside the company can understand and assess. A third-party assessment or even an assessment by a certified partner could follow in a next step to validate the self-assessment.

3.4 Iterative maturity model development

This phase serves as an identification process of so called domain components and their sub-components (cf. de Bruin et al. 2005). The goal is to collect all relevant criteria that are necessary for the assessment of the specific domain the maturity model is designed for. They should be mutually exclusive and collectively exhaustive to cover all important aspects without distorting the results by redundant or overlapping components.

As established methods de Bruin et al. (2005) list a number of research approaches that can serve as identification tools. These are e.g. literature research, Delphi studies, case studies, focus groups or interviews. As supply chain integration and inter-organisational systems (IOS) is a complex research topic, we decided to create a first population by starting with an extensive literature research that covers not only classical papers from academia but includes results from a long term case study research. Some selected results are presented in the next sections.

3.4.1 Perspectives on Inter-Organizational Integration

From the literature we derived three main perspectives on inter-organizational integration: (1) technical, (2) organizational, and (3) institutional (e.g. Massetti and Zmud 1998, Barrett and Konsynski 1982, Chatterjee et al. 2006).

- *Technical* integration describes how information is processed and shared electronically within and across organizations. Electronically supported communication eliminates manual workload, prevents false data capture and data redundancies and is thus deployed to save costs and transaction time.

- *Organizational* integration refers to the organizational structures and processes, which are put in place to improve the efficiency and effectiveness of the supply chain. Business processes are a key element of organizational design and are considered the core of IT-based value creation.

- *Institutional* integration describes the formal and informal agreements, which govern inter-organizational relationships, thereby reflecting the concepts that have been developed by transaction cost theory and the resource-based view. This area describes the governance structures among the players (Weill and Ross 2004).

3.4.2 Technical integration

In an explorative approach, we used 112 case studies, which were coded and analysed regarding their characteristic form of integration. On the one hand we found companies in which the involved parties deploy different information systems for the collaborative process. On the other hand solutions exist in which the integration is realized through a joint software system. The comparison of the solutions resulted in five identifiable integration scenarios (integration processing capabilities). The detailed results of this study have been published in (Schubert 2008). **Table 2** shows the distribution of the cases for the five integration scenarios.

Integration Scenario

Scenario 1: Parallel use of different information systems with manual access	28
Scenario 2: Parallel use of different information systems with data interchange and direct connection	47
Scenario 3: Parallel use of different information systems with data interchange provided by an intermediary	16
Scenario 4: Joint use of a self-operated, central ERP system	15
Scenario 5: Joint use of a central system operated by an intermediary	6
Total	**112**

Table 2: Number of companies using the identified scenarios (source: anonymized)

In addition to the five scenarios, our case analysis revealed different forms of operation of the information system (on premise / hosted) and different degrees in the use of standards (use of standards versus self-invented formats).

3.4.3 Organizational Integration

This perspective deals with the organizational structure and the corresponding processes that improve effectiveness and efficiency within an inter-organizational environment. SCOR delivers a vast overview of the process landscape of a supply chain. Therefore, we used the SCOR framework for defining large parts of the organizational integration perspective. Since many of the analysed maturity models within the domain of B2B integration typically follow a process-based view we incorporated parts of the approaches that were in line with our view related to the three perspectives (technical, organizational and institutional integration, cf. Table 4).

In order to analyse how the technical integration scenarios are used in an organizational context, we performed a cross-analysis of the two dimensions "integration scenario" and "direction of integration". The *direction of integration* (integration processing requirements) can be differentiated according to the position in the supply chain (Robertson and Langlois 1995):

- *Vertical* Integration: The partners are in the same industry sector but at different positions in the supply chain

- *Horizontal* Integration: The partners are in the same industry sector and at the same position in the supply chain

- *Diagonal* Integration: The partners are in different industry sector and at different position in the supply chain

The results showed 82 cases with *vertical* integration, 14 cases with *horizontal* integration, and 16 companies with *diagonal* integration (Frick and Schubert 2009).

3.4.4 Institutional Integration

On the level of institutional integration we followed the six archetypes suggested by Weill and Ross (2004). In their study of organisations Weill and Ross identified six distinctive archetypes, which represent the distribution of decision power in an organisation: Business Manager Monarchy, IT Monarchy, Feudal, Federal, IT Duopoly and Anarchy. The prevalence of such an archetype in the supply chain has an impact on the power structures and the resulting network setup.

The legal arrangement is embodied in contracts among the VC partners or between the VC partner and its respective business integration service providers. Typically, these arrangements are reflected in Value Added Network contracts (VAN) and/or Service Level Agreements (SLAs).

3.5 Conception of Transfer and Evaluation

Once the BIMM is fully developed we will start its dissemination (transfer of the maturity model to the intended target groups). The dissemination will be supported by *documents* describing the purpose and the dimensions as well as a *software tool* for online self-assessment. The target groups are academia and business alike.

3.6 Implementation of Transfer Media

Currently the development of the maturity model is still in the phase of Iterative Maturity Model Development.

3.7 Evaluation

It is our goal to conduct a thorough validation of the BIMM. In order to achieve this, the evaluation phase is designed to measure the real data flows of service providers for B2B integration. Their databases contain information not only about exchanged data but also about the underlying inter-organizational processes and institutional agreements for collaboration. Therefore, all three perspectives and their related criteria can be measured and analysed. In this stage, we will work together with selected providers from the German-speaking area (DACH) and analyse their transaction records. The following list shows some exemplary providers who we will endeavour to include in our sample: Crossgate, Comarch ECOD, Seeburger, GS1 Germany, EDI Center GmbH and Axway. Initial discussions with some of these providers indicate their interest in the results of our study.

3.8 Rejection of Maturity Model

According to Becker et al. (2009) the evaluation phase may lead to (1) rejection of the model or (2) another iteration of the development phase or (3) a reconceptualization of

the transfer and evaluation methods. We are following this cycle and our goal is to develop a viable model that is applicable in practice.

3.9   Maintain

When designing a maturity model de Bruin et al. (2005) argue that developers do not always consider maintain cycles to cope with new developments or technological innovations influencing the targeted domain of the model and even changing environmental criteria, which are important for the assessment. De Bruin et al. (2005) incorporated such a maintain phase that is given implicitly in Becker et al.'s model (evaluation can lead to another iteration of model development) but is not stated explicitly. We found that such a phase should be included in our approach, thereby extending Becker et al.'s procedure model, to reflect on the long-term use of such a model.

4   The current B2B Integration Maturity Model (BIMM)

Following Mettler et al.'s (2009) classification scheme, we classified our maturity approach as shown in Table 3:

	Model: Attributes:	The B2B Maturity Model (BIMM)
General model attributes	Source	Frick and Schubert 2011
	Domain/ Topic	B2B Integration
	Origin	Academia
	Target audience	Academia/ Business
	Year of publication	2011
Maturity model design	Concept of maturity	Object/Process/People (Technological, Organizational, Institutional Maturity)
	Composition	CMM-like
	Reliability	Step 1 (construct development): Explorative analysis of 80 B2B cases Step 2 (construct validation): Validation with real-world transaction data
	Mutability	Form/function
Maturity model use	Method of application	Self-Assessment
	Support of application	Assessment tool
	Practicality of Evidence	Implicit/explicit recommendations

Table 3: Classification of the BIMM

The current a-priori model is based on the three levels (technological, organizational and institutional) described above. Due to the limitation in space we are unable to show all levels in detail. Table 4 gives an overview of the constructs that are currently incorporated in the model.

Technology	Scenarios	1-5 as described above
	Operation	On premise / hosted
	Standards	Use of standards or "self-invented"
Organization	Processes	CMM levels 1-5: Initial, Repeatable, Defined, Managed, Optimizing
	Structure	Position in the SC following SCOR model
Institutional	Governance structure	Monarchy, oligopoly, democracy, federated, feudal, anarchy
	Contracts	VAN, SLA, other, none

Table 4: Dimensions of the a-priori model (current state of research)

5 Conclusions

This paper presents an a-priori model for a B2B Integration Maturity Model (BIMM). Its concept of maturity is based on *technological*, *organizational* and *institutional* issues reflecting on object, processes and people involved in the inter-organizational context. The BIMM addresses challenges of previous models, which according to the literature do not provide a holistic view and were not developed using an empirically sound approach. Our maturity model approach attempts to cover relevant issues and is based on a solid empirical database, exploratively developed from company cases and the model will in the long run be tested with real-world transactional data. In the next step we are going to extend and enhance the BIMM according to Becker et al.'s (2009) iterative maturity model development phases. During our validation phase we will use data from B2B integration providers to validate (and/or change) the model.

Based on the database, we will be able to classify companies and show typical maturity levels dependent on company characteristics. It is our hope that we will also be able to develop a database for assessment and derive recommendations for how to reach the ideal maturity level in a specific role and position in a supply chain.

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