A Framework for Assessing Inter-organizational Integration of Business Information Systems

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Abstract: This paper presents a framework for assessing inter-organizational integration of business information systems. The framework is organized along two dimensions, intensity of integration and flexibility of integration. Intensity of integration describes the extent and strength of IS integration. It may be used as an indicator to assess the degree to which integration objectives can be achieved. Flexibility of integration denotes the ease with which integration implementations can be redesigned and collaborating partners can be replaced by other organizations. We specify these dimensions with relevant integration criteria.

Introduction

Inter-organizational integration of business information systems (IS) has gained considerable attention both from academia and industry. Scholars as well as practitioners have emphasized that the so-called business-to-business integration is one of the key challenges in information technology [12, 18, 23, 28]. (In this paper we use the terms inter-organizational integration and business-to-business integration interchangeable.) It is also a multifaceted field of research. It includes integration of heterogeneous infrastructures, application software, data, and business processes.

Previous approaches to explore IS integration have focused on identifying essential dimensions of IS integration or have proposed guidelines on how to integrate IS [12, 14, 15, 18]. These approaches often ignore that integration of inter-organizational IS has positive and negative effects. On the one hand, integration helps to exchange data, to unify software components, and to streamline business processes [5, 19, 30]. On the other hand tight integration of IS in different companies may well reduce flexibility and agility of these organizations [4, 12, 16, 21, 34]. Close integration of two companies may increase switching costs. In this context, switching costs denote the costs of switching from one cooperation partner to another [7, 9, 33]. The closer the integration of inter-organizational IS is the lower is the probability to switch to another partner [12]. This situation is called Lock-In in economics [7, 33]. Most previous publications do not sufficiently take into account these drawbacks of IS integration [34].
In this paper we introduce a generic framework that helps to analyze both sides of integration; (a) benefits that may be achieved when inter-organizational IS are tightly integrated as well as (b) undesirable effects that may impede future modifications of IS or integration with other business partners. The ability to assess the level of inter-organizational IS integration more thoroughly might be helpful both for academia and industry. The purpose of this paper is to propose a framework that helps to assess the level of integration of inter-organizational IS. Our framework will help researchers to explore business-to-business integration in more detail. Practitioners may use the framework when designing or evaluating inter-organizational IS.

In the next section we introduce and define some basic terms. In the following section an overview of previous research into inter-organizational or business-to-business IS integration is given. The main section of the paper explains our framework for assessing the level of inter-organizational IS integration. Finally, we draw some conclusions from our work and indicate directions for future research.

Terms and Definitions

Although IS integration has been widely discussed in the literature no commonly accepted definition or theory has evolved. In its most general meaning, integration describes the act or process or an instance of forming, coordinating, or blending into a functioning or unified whole [26]. We propose the following definition for IS integration. It denotes the process or instance of interconnecting or unifying previously separated IS or elements thereof into a functioning whole. Integration of IS is closely related but not equal to interoperability. The IEEE defines interoperability as “the ability of two or more systems or components to exchange information and to use the information that has been exchanged” [27]. Integration of IS extends the concept of interoperability. Whereas interoperability analyzes the interconnection of distinct systems, integration includes connecting separate systems and merging formerly separated systems or system elements into a unified whole. Two databases, for example, may be integrated by establishing interconnections between the two systems, or they may be merged into a unified database.

Previous Research into Integration of Inter-organizational Information Systems

Various researchers have chosen different perspectives on IS integration. Some have focused on data integration [10, 13] or application integration [3, 19]. Others have analyzed business process integration [25] or the integration of business partners in networks [23]. Some authors [3, 19, 30] have focused on information technology others have a more comprehensive view; they analyze business, managerial, and technological dimensions of IS integration [1, 21, 23]. Oesterle, Fleisch, and Alt, for example,
define integration “as the networking of human resources, their tasks and the information and communication technology used” [23]. According to Markus [21] business integration is “the creation of tighter coordination among the discrete business activities conducted by different individuals, work groups, or organizations, so that a unified business process is formed.” Markus points out, that business integration and systems integration are often imperfectly linked.

Some authors have explored internal business integration, enterprise application integration, or intra-organizational integration [19, 30] others have analyzed external business integration, business-to-business integration or inter-organizational integration of IS [15, 23].

Singletary conducted a qualitative research study that explored practitioner perceptions of applications integration downsides. He interviewed 51 managers, IT professionals and end-users in four organizations. Singletary found that although integration is believed to be desirable there are various concerns whether integration is always desirable. He identifies five dimensions of application integration downsides; data management, complexity, risk, economic issues, functionality and operational. As a consequence Singletary suggests creating an instrument to measure applications integration. Likewise Singletary, Pawlowski and Watson put forward “investigating and testing ways to measure or assess integration” [35]. However, to our knowledge, no such instrument has emerged yet.

Previous publications have focused on selected layers of inter-organizational integration, e. g. data integration [10, 13], application integration [3, 19], and process integration [16, 25]). Our framework attempts to combine these perspectives.

Most previous approaches to assess IS-integration have ignored that integration of inter-organizational IS has positive and negative effects. In this paper we introduce a generic framework that helps to analyze both sides of integration; (a) benefits that may be achieved when inter-organizational IS are tightly integrated as well as (b) undesirable effects that may impede future modifications of IS or integration with other business partners.

In the next section we outline a framework for assessing inter-organizational integration of IS. One objective of this framework is to investigate and to assess the level of business-to-business integration.

Details of the Framework for Assessing Inter-organizational Integration of Business Information Systems

Inter-organizational integration of IS can be structured in various ways. Our framework presents a generic approach to categorize fundamental integration options. It is generic in the sense that is not specifically dedicated to integration technologies, e. g. enterprise application integration / middleware or web services. It is also not focused on specific business applications, e. g. electronic commerce, supply chain integration, or collaborative engineering. We attempt to explain inter-organizational integration of business IS on a more fundamental level.
Our framework consists of two basic dimensions, because integration of IS usually has positive and negative effects [34]. Positive effects of IS integration are benefits that can be achieved by integrating IS. These benefits are - among others - to reduce the demand of resources needed to process information, to avoid or control redundancies, to improve data accuracy, to enhance the consistency of IS, and to improve productivity [17, 32, 35]. Negative effects are costs which arise when new IS are integrated with legacy systems or when an organization wishes to switch to a different integration partner [12, 34]. These costs are sometimes referred to as switching costs [17, 33].

We subdivide the integration of inter-organizational IS into intensity of integration and flexibility of integration. Intensity of integration describes the extent and strength of IS integration. It may be used as an indicator to assess the degree to which integration objectives can be achieved. We assume that the higher the intensity of integration is the better integration objectives can be achieved.

Flexibility of integration denotes the ease with which integration solutions can be redesigned and new integration solutions can be implemented [12]. This might be necessary when legacy systems have to be integrated with new systems, in case of outsourcing or mergers and acquisitions, and when a company wishes to replace collaborating partners. High flexibility of integration ensures that the expenses to adjust the integration and the costs of switching to another integration partner may be kept at an acceptable level.

Figure 1 shows these dimensions and relevant criteria that we use to specify the two dimensions. We will describe these criteria in more detail in the following sections.

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**Figure 1: Structure of the Framework for Assessing Inter-organizational IS Integration**

### Intensity of Integration

Intensity of integration describes the extent and strength of IS integration. It may be used as indicator that helps to assess the extent to which integration objectives can be achieved. We use two criteria to specify integration intensity; scope of integration and type of integration.
Scope of Integration

Scope of integration denotes the number of integration items. Integration items are elements of IS which may be integrated with corresponding elements of other IS. Examples are networks, software components, or data structures. In the literature integration items are often categorized in different layers [4, 14, 15, 18, 22]. We use a model that arranges items relevant for business-to-business integration in six layers. These layers are shown in Figure 2.

![Figure 2: Layers of Inter-organizational IS Integration](image)

The first layer includes the integration of IT infrastructure components and systems software, e. g. servers, networks, communication protocols, middleware, and operating systems.

The second layer comprises application data, which are shared or transferred among IS, e. g. product catalogues, order management data, business documents, or payment details.

The third layer represents the integration of software functions supporting business tasks that may be integrated in an inter-organizational context. Examples are software components for information retrieval, order management, or payment transactions.

The business process layer covers the integration of inter-organizational processes, i. e. related, structured activities that produce specific services or products [6, 31]. Examples for business processes are electronic procurement, supply chain management, or collaborative engineering.

The fifth and the sixth layer cover the integration of business models and corporate strategies of organizations that wish to integrate their businesses. “A business model is ... a description of the value a company offers to one or several segments of customers and the architecture of the firm and its network of partners for creating, marketing and delivering this value and relationship capital, in order to
generate profitable and sustainable revenue streams.” [24] Corporate strategy is concerned with a company’s choice of business, markets and activities. It defines the overall scope and direction of the business [29].

In this paper we focus on the integration of application data, software functions and business processes. Each of these layers comprises various categories of integration items. We assume that the more items are integrated on each layer the higher is the scope of integration and accordingly, the higher the scope of integration is the higher is the intensity of integration.

**Types of Integration**

The criterion types of integration describes how elements of IS are integrated. We distinguish two types of integration: interconnection and unification. Interconnection may be specified in more detail by the degree of automation used to integrate items. Figure 3 shows the types of integration.

![Figure 3: Types of Integration](image)

**Interconnection**

Interconnection is the creation of links between previously separate computer systems, applications, services or processes. Interconnection also describes a state where integration items are distinct, but links have been established to connect these items. We speak of interconnection if, for example, two customer databases in cooperating companies are integrated with database middleware. Another example is linking two software functions with remote procedure call mechanisms. We distinguish two types of interconnection. Fully automated interconnection is achieved when the interaction between integration items is completely executed by software. If manpower is needed to initialize or control the interaction, we call this partially automated interconnection. Fully automated interconnection leads to a higher intensity of integration than a partially automated interconnection.

A fully automated interconnection yields higher benefits than a partially automated interconnection. It reduces transaction times, the amount of media breaks and potential input errors. A fully automated interconnection - compared to partially automated solution - helps to reduce cost, to avoid redundancies and to improve productivity.
Unification

The second type of integration is unification. Unification means that two or more integration items are merged into one. We speak of unification if, for example, two engineering databases with product specifications in cooperating companies are merged into one unified database. Another example is replacing two software components that support trading goods in two different companies are replaced by one software function on an electronic marketplace platform.

Unification helps to remove redundancy. Unification leads to a higher intensity of integration compared to integration by interconnection. The highest intensity of integration is achieved when all relevant integration items are integrated by unification. Integration items are relevant when they are used by at least two integration partners in the context of an inter-organizational cooperation.

Flexibility of Integration

Flexibility of integration describes to what extent integrated IS may be adapted to another context, for example in case of outsourcing or when replacing one collaborating partner with a new partner. Flexibility of business-to-business integration is mainly governed by the use of appropriate standards [4]. We specify flexibility of integration by two criteria; scope of standard usage and type of and compliance with standards. A standard in this context is “a technical specification to which products must conform in order to be compatible.” [11]

Scope of Standard Usage

When two organizations integrate IS they may choose a proprietary implementation or they may adopt a standards-based approach to business-to-business integration. When many items are integrated on the basis of standards, it is much easier to adapt the integration to a different context. Imagine a situation where two collaborating organizations have used widely accepted standards for data, software, and process integration. Such a standards-based approach to integration will facilitate replacing one business partner with another company that uses the same standards for business-to-business integration.

The criterion scope of standard usage describes how many items are integrated on the basis of standards. The higher the scope of standard usage is the higher is the flexibility of integration. If all items are integrated with the help of standards, the highest scope of standard usage is achieved.

Standard usage alone, however, does not guarantee flexibility. Flexibility may only be achieved if (a) widely accepted standards are used and (b) if the implementation adheres to the standard specifications.

Type of and Compliance with Standards

There are various standards to choose from when integrating inter-organizational IS [4, 11, 20]. When adopting a standard, users may closely adhere to the standard specifications or they may deviate more or less from it. If users adhere to the
standards closely, this will facilitate redesigning integration implementations or replacing collaborating partners with other business partners. For these reasons we include the standard type and compliance with standard specifications to describe flexibility of integration in more detail.

**Type of Standards**

The criterion type of standards describes which particular standards are used when integrating inter-organizational IS. In the literature [2, 8, 33] three major characteristics are put forward to distinguish different types of standards, namely, standard dissemination, standard specification, and standard compatibility.

Standard dissemination describes whether the standard is widely accepted. In other words, it describes how frequently the standard is used in a given context. The higher the dissemination of a standard, the higher is the flexibility of the integration. If a standard is widely used, the adoption of this standard will enhance flexibility and reduce switching costs.

Standard specification addresses the scope of regulations that specify the application of a standard. It also describes how detailed these regulations are specified. If a standard has diverse and detailed regulations that provide users with specific guidelines of how to use the standard, this will increase adherence to the standard specifications. If the majority of standard adopters adhere to the standard specifications, this will lead to a situation where many users apply a standard in a similar way. If they do so, this will facilitate replacing collaborating partners with other business partners.

Standard compatibility describes whether a standard is compatible with other versions of the same standard and with other standards. Compatibility is the result of a coordinated standard design. We call standards compatible when their design is coordinated in some way, enabling them to work together [8]. If the standard used is compatible, adopters can use other standards or different versions of the same standard to interact. The higher the compatibility of the standards is the higher is the flexibility of integration.

**Compliance with Standard Specifications**

The criterion compliance with standard specifications describes how closely users comply with the specifications of the standard. If users deviate from the specifications of the standards, this will complicate the options to adapt the integration to another context. If users comply with the specifications this facilitates switching to other integration solutions without having to bear significant switching costs. The higher the compliance with standard specifications is the higher is the flexibility of integration.

**Synopsis: Dimensions and Criteria of the Framework**

Our framework to assess inter-organizational integration of business IS is organized along two dimensions, intensity of integration and flexibility of integration.
Intensity of integration describes the extent and strength of IS integration. We specify intensity of integration by the scope and type of integration. The more items of IS are integrated and the more of them are integrated by unification, the higher is the intensity of integration. We assume that the higher the intensity of integration is the better integration objectives can be achieved.

Flexibility of integration denotes the ease with which integration implementations can be redesigned, and collaborating partners can be replaced by other organizations. We specify flexibility of integration by two criteria; scope of standard usage and type of and compliance with standards. The highest flexibility of integration is achieved when all integration items are implemented on the basis of standards, when these standards are widely accepted, intensively specified, highly compatible and when users strictly adhere to the specifications of the standards.

Figure 4: Impact of the Criteria on the Level of Integration

Figure 4 illustrates the essential criteria for assessing the level of integration. We assume that a high level of integration is characterized by a high intensity and a high flexibility of integration. However, a high level of integration might not always be useful. It depends on the objectives and circumstances which particular level of integration seems to be adequate. One should also bear in mind that intensity and flexibility of integration are not completely separate concepts. However, the interdependencies of intensity and flexibility of inter-organizational IS integration have not yet been explored in detail.

Conclusion

We have outlined a comprehensive, yet generic framework for assessing inter-organizational integration of business IS. It is comprehensive in the sense that it (a) comprises different integration layers and (b) includes integration intensity as indicator for positive integration effects and integration flexibility as indicator for the extent to which switching costs might arise from business-to-business
integration. It is generic because it is not tailored to specific technologies or business applications. We believe the results presented here give many interesting insights for researchers who wish to explore inter-organizational integration more thoroughly. Our framework will also be useful for practitioners who wish to assess the efficiency and flexibility of business-to-business integration options. We have organized our framework along two dimensions, namely, intensity of integration and flexibility of integration. Scholars wishing to extend the framework might think of adding a third dimension: cost of integrating inter-organizational IS. There are a number of interesting directions for future research. One area is to practically evaluate our framework in different contexts and industries. Another area is to further detail and tailor the framework for specific technologies, e.g. web services and service oriented architectures, or business applications, e.g. collaborative product development on collaboration platforms or electronic commerce on B2B-marketplaces. A third area is to detail and to empirically test the interrelationships between (a) the intensity of integration and the extent to which integration objectives can be achieved as well as (b) the flexibility of integration and switching costs related to business-to-business integration. This would facilitate quantifying the degree of inter-organizational IS integration. We have only indicated different levels of integration. A fourth direction might therefore be to define different levels of business-to-business integration in more detail.

References


Biography

Dirk Stelzer is Professor of Information and Knowledge Management at the Faculty of Economic Sciences at Technische Universitaet Ilmenau, Germany. He received a diploma degree (Diplom-Kaufmann) and a doctorate degree (Dr. rer. pol.) in Business Administration from the University of Cologne. He has published more than 50 papers on IS security, software quality management, and information management. His recent research interests include integration management of inter-organizational information systems, information management for digital goods, and knowledge management.

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