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Taxonomy of Factors for Information System Application Integration

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Abstract

Application integration technology is a new class of system integration that involves the development of new strategic business solutions. These securely integrate functionality from disparate applications. In considering this, the presented paper seeks to describe the application integration arena and proposes a novel taxonomy for this new scope of technology. Furthermore, it analyses factors that are related with the impact of application integration on companies and presents a number of research questions that are associated with this area.

Keywords: *Application Integration, ERP, Legacy, e-Business*

Introduction

During the last decades many companies have implemented various applications to support business activities. These individual applications were not developed in a co-ordinated way but have evolved as a results of the latest technological innovation. The result of this has lead to incompatible systems and problems with their integration. As a result, many companies consist of a set of complex islands of technology with diverse information formats, heterogeneous computing platforms, and various programming models (Klasell and Dudgeon, 1998). However, organisations attempted to overlap this problem by interconnecting manually their disparate applications. Such myopia was fraught with problems as integration means much more than simply interconnecting all the islands of technology. In addition, connectivity was not sufficient due to the fact that islands were not designed to interoperate. Furthermore, there were two basic problems for integration: (a) each island has its own meaning of enterprise objects (e.g. customers, sales, revenue etc) and (b) each island has data that overlaps data in other islands. This partial redundancy generates a serious data integrity problem (Stonebraker, 1999).

During the 1990s, Data warehousing (Barry, 1996) and Enterprise Resource Planning (ERP) (Davenport, 1998) technology came along as approaches to integration problem. Both of these technologies using their own sets of considerations attempted to tackle the problems of un-integrated data.

Data warehousing solves the problem of integration only for information processing and it is not a solution for operational transaction integration (Inmon, 1999). Kelly (Kelly et al., 1999) define ERP systems as "*integrated software packages that automate core corporate activities such as finance, logistics and human resource management*" Kelly et al. (1999, p.785). These systems are designed to solve the fragmentation of information in large business organisations, and integrate all the information flowing through a company (Gibson et al., 1999).

Brown (1999) suggests that in many cases a sense of frustration with all these islands of technology has led companies to view ERP as the primary means to achieve enterprise integration. Although ERP technology solves the problem of operational integrated processing (Inmon, 1999), it provides only a partial solution (Klasell and Dudgeon, 1998) and it has also a lot of drawbacks (Davenport, 1998; Kelley et al., 1999). In the case of ERP systems, integration can be achieved only if a company buys all its software from one ERP vendor. Even in this case, ERP packages can not automate more than 30% of company's application (Seeley, 1999). As mentioned before ERP systems are suite of integrated applications. Nevertheless, a suite of integrated applications is not the same as building an application integration infrastructure that is flexible and extensible (Brown, 1999). Furthermore, ERP technology is not cheap or easy to implement (Kelley et al., 1999). It requires a long period of time for implementation and is famous for the cost and pain of implementation (Kelley et al., 1999; Volkoff, 1999). As a result, the recent growth of ERP systems (Smethurst and Kawalek, 1999) has not solved organisational integration problems. In addition, many companies do not abandon existing applications (e.g. legacy systems[1]) when they adopt ERP systems. Gradually, this practise increases the number of disparate applications and amplifies the need for integration (Eck and Marchetti, 2000).

[1] Legacy systems are large software systems, vital for organisations, which significantly resist modification and evolution to meet new business requirements (Bennett, 1995).

Furthermore, competitive pressures, globalisation and electronic commerce, are forcing companies to increase their efficiency through the integration of key activities.

Klasell and Dudgeon reports that to accomplish integration "*companies must not only co-ordinate functional staffs and business processes, but must also integrate the business software applications into co-ordinated application networks that can share data despite the technical difficulties*" Klasell and Dudgeon, (1998, p.3).

Building such integrated systems from beginning could be a very difficult task (Hoole, 1999) whereas companies have to develop a single system that includes the functionality of all the existing applications. In addition this integrated system should be flexible enough to incorporate all the future extensions. Since manual efforts for integration are expensive and ERP systems do not solve the problem, organisations are beginning to turn to **Enterprise Application Integration** (EAI), a new class of pre-packaged software (Linthicum, 1999).

The Enterprise Application Integration challenge

EAI is a corporate level-problem requiring a corporate level strategy (Lesley, 2000). It requires organisation to gain control on their inter and intra organisational processes (Morgenthal, 1999). EAI is a new means of system integration that uses standardised middleware frameworks and object technology. It describes the development of new strategic business solutions that securely integrate functionality from disparate applications. These applications are integrated at a functional level, not just at the user interface or data level. In addition EAI adds value by placing business logic in the applications network and creating a more dynamic IT infrastructure that can evolve with a company (Linthicum, 1999). In addition EAI provides a number of benefits. Urlocker (Urlocker, 2000) summarised these benefits as follow: EAI (a) improves organi-sational performance and operational efficiently, (b) provides an efficient centralised point of control, (c) provides value added services, (d) decreases maintenance efforts, (e) reduces the skill level required to integrate applica-tions, (f) allows faster time to market and (g) increases market share.

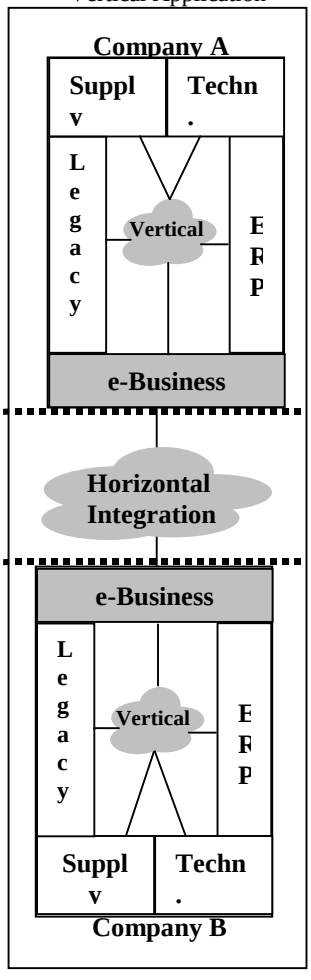
A novel taxonomy for Application Integration

EAI as a term has a limited meaning as it focuses on the integration of the company's (internal) applications. However, there are (external) applications (e.g. e-procurement) that are shared by two or more enterprises. These applications do not serve or belong to one enterprise but to a set of companies-partners. Consequently, the term Application Integration (AI), a broader term than EAI, is suggested to describe the whole application integration area. AI is a new interesting research area with scant literature. Therefore, a novel taxonomy for AI is proposed in this section to set the scene and explain the various types of AI.

Application Integration

Application Integration can be defined *as a new means of system integration that focuses on both internal (e.g. ERP systems) and external (e.g. e-Business) applications using standardized middleware frameworks and object oriented technology. AI involves the development of new strategic business solutions, which securely integrate functionality from disparate applications.* AI is divided into: (a) **Vertical** or EAI and (b) **Horizontal** or **Interorganisational Application Integration** (IAI). Figure 1 illustrates the vertical and horizontal applica-tion integration.

Figure 1: Horizontal and Vertical Application



Enterprise Application Integration

EAI can be defined as *the technology that integrates all the internal applica-tions as well as the external applica-tions that deal with business to consumer electro-nic commerce applications.* EAI is separated into two subcategories: (a) **Intranet AI** and (b) **Internet Business to Consumer AI**. Intranet AI is achieved through the internal networks (Intranet) and integrates applications such as ERP systems, legacy systems, supply chain as well as smaller islands of technology.

Intranet AI does not cover the whole EAI as there is a number of enterprise applications that are external (e.g. e-

store[2]). Internet Business to Consumer[3] (B2C) AI refers to the integration of these external enterprise applications.

It forms a subcategory of EAI, as there is no need to integrate these systems with external partners (Helm, 2000). Consequently B2C applications are part of enterprise applications and not of interorganisational applications.

Interorganisational Application Integration

During the past years many companies used EDI technology and Value Added Networks in order to exchange their documents and make business in an integrated way. However, the emergence of Internet as a global platform for e-business and the absence of open standards increase the need for integrated interorganisational applications. Moreover, Forrester Research (Forrester Research, 1998) estimates that the growth of e-business is increasing rapidly and will be more than $300 billion in 2002. As a result many companies turn to IAI. Interorganisational Application Integration can be defined as *the technology that is used for the integration of Business to Business electronic commerce applications (B2B)*[4]. In IAI the integration focuses on external processes. Helm (Helm, 2000) reports three scenarios for e-Business application integration: (a) enabling extended enterprises, (b) enabling virtual enterprises and (c) ecommerce AI. The scenarios (a) enabling extended enterprises and (b) enabling virtual enterprises can be adopted as IAI sub-categories as they refer to interorganisational applications that present integration challenges. The subcategory Extended Enterprises AI refers to integrating trading partners that form loosely coupled networks (Helm, 2000). Virtual Enterprises AI refers to interorganasational applications that are characterised by a highest degree of depentecy. If one partner fail to execute a process in this category of e-Business applications, then all the partners will fail. The proposed taxonomy is summarised in figure 2.

Research Questions and Factors

As application integration is becoming more popular and vital for companies, a number of questions arise. Like any other technology, application integration is expected to affect enterprises both on business and technical level. In any level there is a set of at least two research questions that must be answered:

a) What is the impact of application integration on enterprises and what techniques can be used to evaluate this impact?

b) What are the parameters that are related with the evaluation of this problem?

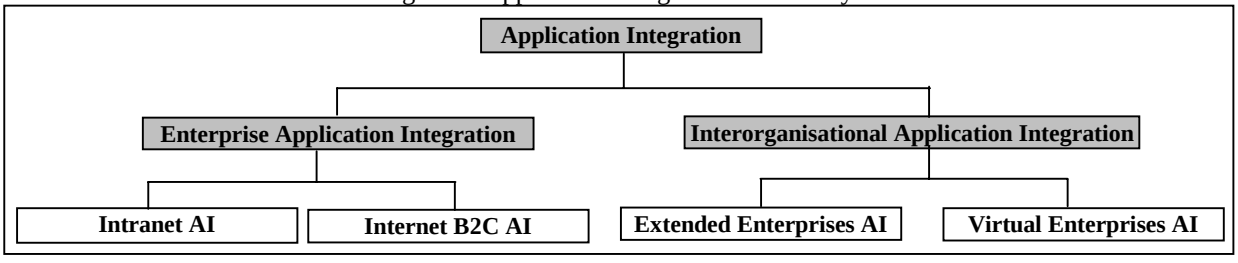
Key Factors

This section analyses on business level a number of factors that are affected by application integration. The basic key parameters are the following:

- **Organisational change.** During the 1990s information technology came up with two huge classes of business and technological solutions (ERP and Internet solutions) that influenced the way of doing business. Both of these classes forced companies to change their organisational structure and adopt new standards (Sumner, 1999). As these categories of solutions will be integrated with other islands of technology on a dynamic enterprise network of applications, it is possible to cause new organisational changes (Sumner, 1999; Volkoff, 1999).

- **Human Factors.** Enterprise integration will not only cause organisational changes and reengineering but it will also affect employees. In ERP systems adoption, the integration and automation provided by the system causes a reduction to the number of employees. In addition, many studies indicate that this fact forced employees to sabotage the development of such systems (Motsios, 1999). As result employees did not collaborate with the technical

Figure 2: Application Integration Taxonomy



[2] e-store is an electronic commerce application that runs over the Internet, provides an electronic point of sales and supports purchasing transactions (Themistocleous and Poulymenakou, 1998).

[3] Businesses to Consumer applications are business applications that run over Internet and sale products or services to the consumers (Doukidis et. al., 1998).

[4] Electronic commerce applications that serve two or more business partners are called Businesses to Business applications. B2B applications automate the processes and the transactions between partners and lead companies to gain advantages of electronic commerce technology (e.g. stocks reduction, JIT manufacturing etc) (Doukidis et. al. 1998).

team and a lot of projects may have serious delays and finally failed (Sumner, 1999; Motsios, 1999).

Furthermore, ERP systems cause a change on the control of work and on the skills (Heckman, 1998) of employees as fewer people with ERP skills increase their power by controlling more important processes. Moreover, many employees upgrade their skills through training so as to increase their efficiency. In case of AI, the integrated system will automate all the business processes and functions.

Therefore, a number of employees will be affected by this automation as many processes will be incorporated with others or abandon. Consequently, it is possible that employees will resist changing.

- **Business Environment and Competition.** Electronic commerce and globalisation established a new business paradigm by introducing new ways of doing business, creating a global market, changing the traditional business environment and increasing the competition (Kalakota and Robinson, 1999; Timmers, 1999; Doukidis et al., 1998). As the global economy is moving to the e-business era, a lot of changes are expected to happen both on business environment and competition. As application integration seeks to incorporate e-business functionality (including interorganisational applications) with the rest islands of technology, it is possible to transform the business environment. Kalakota and Robinson (Kalakota and Robinson, 1999) note that application integration is crucial for e-business as it ties together all the enterprise components. They also indicate that modern enterprises require an unprecedented amount of application integration in order to make e-business reality. Additionally, the role of the competitors will probably change. In many cases electronic commerce forces competitors to collaborate in order to solve specific problems (e.g. in retail sector companies form the ECR (Efficient consumer response) initiative to address problems that are related with the modern ways of doing business such as EDI and Internet sales). Moreover, studies show that competitors are merged or becoming partners to face the global competition. Of course there are also many cases in which competitors keep their positions and continue competing by improving their services and their technology infrastructure (e.g. adopt e-Business applications, ERP systems etc).

- **Business strategy, business models and competitive advantages.** ERP systems as well as e-business applications make companies change their business strategy and gain or loose competitive advantages. Companies that adopted ERP systems are forced to accept the logic of the package system. This means that companies are forced to follow the ERP business guidelines and adopt its philosophy and its strategy. Davenport reports that ERP systems are not common software package; *"it's a way of doing business"* Davenport (1998, p.125). In other words, if two competitors with different business strategies install ERP systems, they will have similar business strategies. Of course, this fact helps many companies to gain competitive advantages but on the other hand it leads to impoverishment in many others. On the other hand electronic commerce opens the global markets and allows companies to make business with lower cost and perform ore efficiently. This fact influenced the strategy of many companies. For example, ten years ago there were no companies that had a strategy for Internet commerce or had transactions over Internet.

Today, there is a tremendous shift of business practices to this area and a number of well known companies are based their strategy on eBusiness (e.g. Easyjet airlines sells more than 40% of their tickets on-line, Amazon sells 100% of their products over Internet etc). As a result new business models and strategies (Timmers, 1999; Timmers, 1998) are coming up and are adopted by companies.

Research questions

The integration of ERP, e-Business and legacy systems with other smaller applications on a dynamic enterprise network of applications will probably affect companies. Based on the factors presented in the previous section a number of research questions are arisen and presented below:

- How does application integration affect organisational structure and to what extent?
- What is the influence on employees and how they react to this new integrated environment?
- What is the impact on business strategy and what new business models are coming up?

Concluding Comments and Further research

The nature of technology management suggests that integration will always remain a problem for managers seeking to exploit new developments for strategic, tactical and/or operational gain. Such integration has long been a roadblock for IT departments looking to piece together the best application in each enterprise category. However, Application Integration focuses on the development of strategic business solutions that integrate functionality from disparate applications and helps organisations to gain control on their inter and intra organisational processes. The proposed taxonomy, the discussion of the factors that are influenced by application integration as well as the research questions that are derived from this initial work will help researchers to define and analyse better the impact of AI on companies.

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