Improvement Framework for Buyer-Owned Electronic Trading Exchanges: Procurement at Komatsu America Corp. – Peoria Manufacturing Operations

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ABSTRACT

Application of e-business concepts and models can be successful, but anecdotal evidence has indicated numerous failures. In this paper we use a framework (the I-Frame) to analyze a best-practice implementation of a buyer-owned electronic trading exchange at Komatsu America Corp. – Peoria Manufacturing Operations (KAC-PMO). The I-Frame is derived from five existing models in the literature and describes the benefits and factors for successful implementation of Internet-based purchasing of direct materials through a buyer-owned electronic trading exchange. The I-Frame views benefits and success factors from different angles: business process, purchasing costs, product quality, technology, organization, and trust between business partners. To large extent the benefits and success factors in the KAC-PMO case can be recognized in the I-Frame. Moreover the I-Frame contains ideas for the further enhancement of purchasing at KAC-PMO. In general, purchasing managers could use the I-Frame when investigating possibilities for improvements in the procurement business function. Through future research the I-Frame can be enhanced.

Keywords: Procurement, Purchasing, Trading Exchange, E-business

INTRODUCTION

Until five years ago many organization focused on optimizing business processes *within* organizations. Vendors of Enterprise Resource Planning (ERP) software realized high turnovers. Towards the end of the decennium however, organizations more and more included supply chain management, customer relation management and e-commerce in their strategies: business to business (B2B) transactions, servicing and collaboration *between* organizations received attention. Beyond ERP, e-business, B2B, and collaborative commerce became the new terms.

A number of B2B implementations are successful or at least promising. Timmers (1999) describes some of them, all based on e-business models or combinations thereof. As an example,

the Global Engineering Network (GEN) is a B2B implementation largely based on extensive business partner collaboration. Through GEN, product designers can work with suppliers: they can search both the intranet and extranet for parts that are projected to become part of the design. The benefits of GEN are multiple, and include reduced time to market, and reduced design costs. As another example Clark and Lee (2000) show with their empirically validated framework that IT-facilitated inter-organizational process redesign, through vendor-managed inventory, can contribute to increased performance. Yet, at the same time, many of the implementations were not successful, because expectations were set too high, and assumptions were not always right (Coltman et al., 2002; Wise & Morrison, 2000; McCubbrey, 2001). Especially a pragmatic and no-nonsense approach towards e-business appears to contribute to business success. Porter (2001) and Fram (2002) state that the need for companies to have a sound business strategy that focuses on realities, and the recognition that e-business is just another component of serving customers and doing business are prerequisites for a successful exploitation of the Internet.

E-Procurement is a specific area of e-business that covers both internal processes as well as B2B processes. In general, purchasing is recognized as a value-creating business function. Better integration with other departments (product development, production), strategic yet flexible relationships with suppliers, and efficient and automated operational purchasing are essential elements for procurement today (Markham et al., 1999; Callioni & Billington, 2001; Van Weele 2001; Sawhney 2002). This is especially important for the purchasing of direct materials (those materials being part of the bill of materials of the products produced), which is part of the primary business of an organization. In our described research, we will focus on the purchasing of direct materials.

Research question and methodology

As with B2B in general, implementations of Internet-based purchasing of direct materials may be successful and may deliver strategic benefits. However, it can also happen that purchasing implementations fall short by not reaching expected goals. What are the key factors for successful implementation of Internet-based purchasing of direct materials? In this paper we will try to answer this question by analyzing a case at Komatsu America Corp. – Peoria Manufacturing Operations (KAC-PMO) in the light of a framework. We have taken five different (e-business) models from existing literature that provide information on benefits and key factors for successful implementation. A framework was derived from these five models and from an elaboration on procurement and electronic trading exchanges. This framework consists of a broad set of benefits and success factors. Here, benefits are defined as those objectives that, when reached, provide strategic advantage against competitors. Success factors are those conditions that, when met, contribute to gaining benefits. In this paper we refer to the framework as the *I-Frame*, where 'I' stands Improvement.

The discussion of the implementation of purchasing of direct materials is based on the KAC-PMO case. To keep the discussion manageable we focus on buyer-owned electronic trading exchanges and in particular on direct materials purchasing in such exchanges. In fact, many Internet-based direct materials ordering systems are versions of buyer-owned electronic trading exchanges, for example Supplier Relation Management (SRM) systems, e-procurement systems, sourcing systems, and supplier portals. Consequently, the detailed research question addressed in this paper becomes: what are the benefits and success factors of buyer-owned electronic trading exchanges for direct materials ordering? Figure 1 depicts the research methodology.

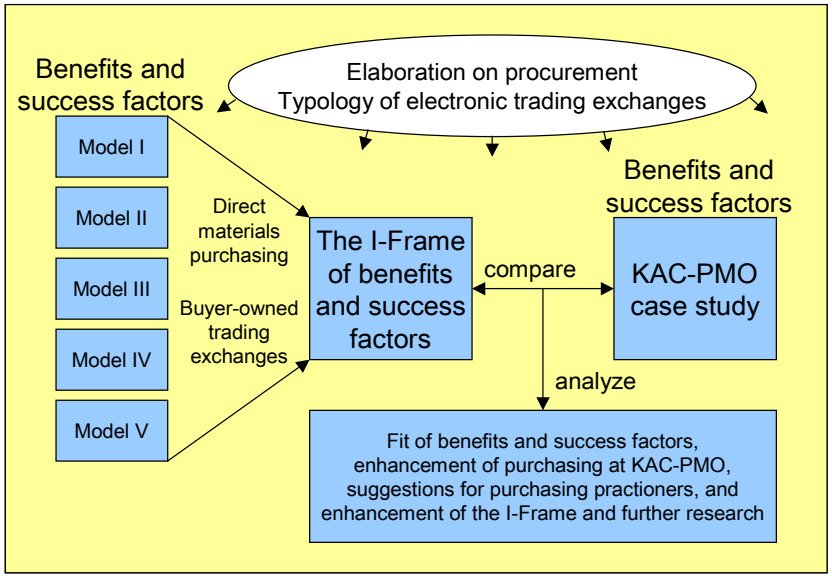

Figure 1. Research methodology

The I-Frame comprises the following models, frameworks and descriptions:

1. Sheppard and Sherman's model of trust between organizations (Sheppard & Sherman, 1998);
2. Timmers' description of e-business models (Timmers, 1999);
3. Clark and Lee's channel transformation framework (Clark & Lee 2000);
4. Weill and Vitale's description of atomic e-business models, from which e-business implementations can be built (Weill & Vitale 2001);
5. Dai and Kauffman's analysis framework for trading exchanges (Dai & Kauffman, 2002).

These five existing models have been chosen on basis of their acceptance and reference by several other research works in the e-business area, and because together they cover a broad spectrum of viewpoints: trust, business models and processes, procurement features and functions, and technology. Where each individual model has a limited scope, the used combination of models provides a wide set of benefits and success factors in the direct materials purchasing area.

The case study discussed is an implementation of a system that enhanced the purchasing of direct materials at Komatsu America Corp. – Peoria Manufacturing Operations[1] (KAC-PMO). The implementation and roll-out of this particular case was very successful; the Aberdeen Group has labeled the implementation as "best practice in e-procurement" ("KMS," 2001).

Related work

Other scholars have performed related research. In a comprehensive paper, Zwass (2003) provides a categorization of e-business. He presents a broad overview of the many aspects of e-business. With the categorization, potential benefits and innovational opportunities are listed.

[1] In 2002, Komatsu Mining Systems Inc. changed its name into Komatsu America Corp. – Peoria Manufacturing Operations (KAC-PMO)

Also other authors have focused on the potential effects and benefits of e-business in general and Internet-based purchasing in particular (Standing & Vasudavan, 2001; Icasati-Johanson & Fleck, 2003; Santema & Reunis, 2003). In their investigation of lessons learned from EDI implementations, Ratnasingam and Tan (2003) identify facilitating conditions based on institutional trust that should also be met in electronic trading exchanges. Also other authors identify factors for successful implementation of e-business. Romano for example explicitly discusses (in-)accessibility of business web sites (Romano, 2003). Koh, et al. (2000) elaborate on fail factors for ERP implementations, through an analysis of a specific case in the light of a process theory of ERP implementation success. There are other authors who take both success factors and potential benefits into account (Boyson, et al., 1999; Bovet & Martha, 2000). They describe a number of successful implementations of e-business with their achieved benefits and perceived factors that were necessary in achieving the benefits.

We position our research within the described context of related work, however, we explicitly take the perspective of direct materials purchasing. Our research is dedicated to purchasing, and therefore purchase managers and IT managers can take our results and use them in their organizations in order to improve the direct materials purchasing process.

Organization of the paper

Before discussing the I-Frame and the case, we provide background information related to direct materials purchasing and electronic trading exchanges. The background information is used in deriving the I-Frame, and in presenting and discussing the case. In the next section we characterize purchasing of direct materials, and we elaborate on electronic trading exchanges. In the subsequent section we describe the derivation of the I-Frame from the five existing models. Next, the details of a single, buyer-owned electronic trading exchange – the KAC-PMO case – is presented. We describe this case's characteristics, benefits and success factors in the light of the derived I-Frame. In the last two sections the results are analyzed, conclusions are drawn, and future research is suggested.

DIRECT MATERIALS PROCUREMENT AND ELECTRONIC TRADING EXCHANGES

In this section we define the procurement business function for direct materials and we present a categorization of electronic trading exchanges. This is used as input for the determination of the I-Frame, and for the presentation and discussion of the KAC-PMO case.

Model of the procurement business function

Procurement experts, analysts, and procurement product vendors have described the procurement business function and its business processes from several perspectives (De Paoli, 1999; Van Weele, 2001; "mySAP," 2003). From these sources we have composed the following high-level model for direct materials purchasing in Figure 2.

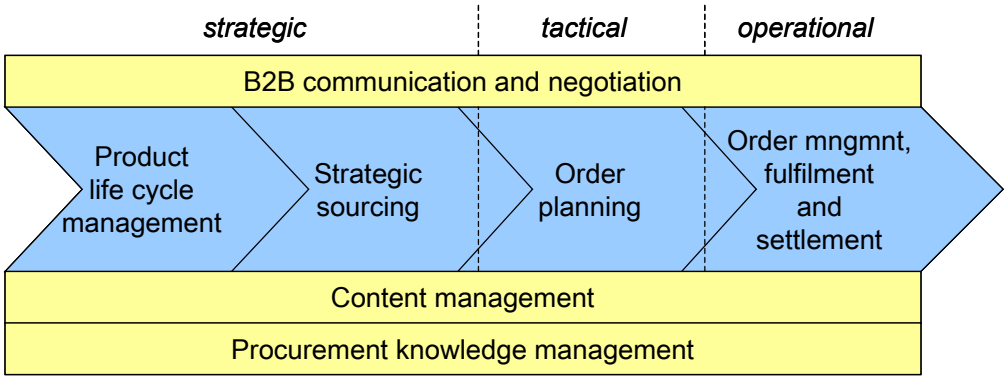

Figure 2. Model of the procurement business function for direct materials

The procurement business function for direct materials consists of four value adding sub-functions and three supportive sub-functions. First, the product life cycle management sub-function consists of activities like collaborative engineering, the review of existing products and the introduction of new products. The purchasing department, the engineering department and even suppliers can be involved in the determination of which parts to re-use, which parts to newly source, and which parts to manufacture within the organization itself. Second, the purchasing department determines suppliers for parts in strategic sourcing, possibly through a trading exchange. Third, order planning is the determination of the actual demand for parts in a certain time frame. Fourth, order management, fulfillment and settlement is the operational transaction handling, which implies supplier interaction during transaction handling.

The sub-functions product life cycle management and strategic sourcing focus on the strategic level. On this level, purchasing decisions have consequences for the market share in the long term (generally, more than twelve months). The sub-function order planning and requisitioning focuses on the tactical level. On this level, purchasing decisions influence the operations of the company in the medium term (less than twelve months). The sub-function order management, fulfillment and settlement is mainly operational and is related to transactional purchase ordering. Purchasing decisions influence the operations of the company in the short term (less than 3 months).

The supporting sub-function, B2B communication and negotiation infrastructure, covers messaging protocols, formats and technical infrastructure. Content management covers operational data management across B2B partners. Examples are taxonomy management and the maintenance of product catalogs originating from different suppliers. The procurement knowledge management sub-function covers the analysis of transactional data so that the overall purchasing process can be continuously improved.

Buyer-owned electronic trading exchanges

Electronic trading exchanges are websites on the Internet where buyers and suppliers are brought together to perform business transactions, like purchase ordering. In principle, electronic trading exchanges can provide support for every primary and supporting sub-function of the procurement business function model. For instance, procurement knowledge management can be supported, by providing procurement information on popular office supplies.

Electronic trading exchanges can be public, or private (Dai & Kauffman, 2002; Zwass, 2003), and can be supplier-, buyer-, or intermediary-owned. From a procurement perspective one can thus distinguish the following types of electronic trading exchanges.

- Public trading exchange: a website where any buyer and any suppliers can perform any procurement transaction. For example, Tradezone (www.Tradezone.com);
- Private trading exchange: a trading exchange in which preferred business partnerships hold for both buyers and suppliers. For example, Covisint in the automobile industry (www.covisint.com) and Exostar in the aerospace and defense industry (www.exostar.com);
- Buyer-owned electronic trading exchange: a private trading exchange connecting multiple suppliers to a single buying organization. The ownership of the trading exchange lies within the buying organization. For example, the trading exchange at KAC-PMO.

Our case, then, concerns a buyer-owned electronic trading exchange. A typical buyer-owned electronic trading exchange is installed at an extranet location of the buyer's infrastructure, in a safe area just outside the firewall of the corporate network. Buyers and authorized suppliers can access the buyer-owned electronic trading exchange and perform many types of procurement-related tasks. The buyer-owned electronic trading exchange can also alert the buying organization and suppliers when new orders come due or quotations are required. Following are typical characteristics of a buyer-owned electronic trading exchange ("mySAP," 2003):

- Portal to a customer listing outstanding purchase orders for a supplier;
- Support for sourcing and bidding;
- Support for collaboration and integration between buyer and supplier;
- Support for services related to purchasing, like invoice matching and reconciliation;
- Support for entry of employees and systems from the buying and supplying organization;
- Support for secure B2B interaction;
- Monitoring and analysis functions of present and historical transactions.

After this discussion of the procurement business function and electronic trading exchanges we can now present the I-Frame.

THE I-FRAME

The I-Frame was built based on five different existing models and frameworks. Those parts of the models that relate to procurement of direct materials and can be applied to buyer-owned trading exchanges were taken into account in creating the I-Frame. Subsequently we discuss the five models.

The trust model of Sheppard and Sherman

In their paper on trust, Sheppard and Sherman (1998) acknowledge two main themes that are associated with trust: "1) trust entails the assumption of risks, and 2) some form of trust is inherent in all relationships" (p. 422). Sheppard and Sherman take these as a starting point for their model regarding trust, which can be applied to individuals as well as organizations. They identify four possible forms of relationships, and state that the risks vary per form of relationship. The following table, derived from Sheppard & Sherman, shows the different forms of relationships with their associated risks (1998, p. 426).

Table 1
Risks per relationship

Form of relationship	Associated risks
Shallow dependence	Indiscretion, unreliability
Deep dependence	Cheating, abuse, neglect, self-esteem
Shallow interdependence	Poor coordination
Deep interdependence	Misanticipation

In the context of business transactions, shallow dependence means that an organization is to some extent dependent on its business partner (e.g. for the delivery of goods). Risks associated with shallow dependence are a business partner's (1) unreliability, the *trustee* (the organization being trusted) does not behave as expected, and (2) indiscretion, the trustee shares trusted information with competitors of the *trustor* (the organization trusting the trustee). Deep dependence means that an organization is to a large extent dependent on its business partner. However, often a trustee's behavior is outside the trustor's view, and therefore difficult to trace and monitor. Risks include (1) cheating, a trustee doing work in an unnecessarily costly manner, (2) neglecting, a trustee ignoring commitments, (3) abusing, a trustee forcing inordinate cost reductions on dependent suppliers, and (4) negatively influencing one's self-esteem. Shallow interdependence means that two business partners must coordinate behavior in order to perform business. The major risk here is poor coordination between the business partners: e.g. an organization does not provide production schedules on time; the supplier is not able to deliver components in time. Effective coordination is of the essence. Finally, deep interdependence implies a strategic relationship between business partners. The risk here is misanticipation due, for example, to bad communication.

A organization needs to find trustworthy business partners. Increased trustworthiness is an important objective, especially in the area of direct materials purchasing, as it is directly related to an organization's primary business and may influence not only the operational and tactical levels of the procurement business function, but also the strategic level. Further, trustworthiness is dependent on the form of relationship. Finding key factors for success in reaching trustworthiness with business partners implies reducing the risks (as outlined above) associated with trust. In their paper Sheppard and Sherman present a number of *qualities of trustworthiness* to manage the risks. As those qualities are boosted, they should increase trustworthiness between business partners. Table 2 presents the qualities of trustworthiness.

Table 2
Qualities of trustworthiness related to risks

Qualities of trustworthiness	Risks when qualities break down
Discretion, reliability, competence	Indiscretion, unreliability
Integrity, concern, benevolence	Cheating, abuse, neglect, self-esteem
Predictability, Consistency	Poor coordination
Foresight, intuition, empathy	Misanticipation

Success factors for sustaining trust now encompass the boosting and continuous support of the qualities of trustworthiness.

Timmers' e-business models

With the Internet, new or extended business designs and information technology have been introduced to support B2B processes. Timmers (1999) describes a number of business models for the e-business B2B-domain. From these only the following models directly relate to procurement of direct materials.

1. E-procurement: E-procurement is electronic tendering and/or procurement of goods and services. Electronic negotiation and contracting and possibly collaborative engineering can further enhance time and cost savings and convenience.
2. E-auction: an electronic implementation of the bidding mechanism known from traditional auctions.
3. Collaboration Platforms: Collaboration platforms provide a set of tools and an information environment for collaboration between organizations. Functions that may be provided on the platform are e.g. collaborative design, engineering and support for purchase order changes.

As for the e-procurement business model, Timmers identifies a number of benefits: a wider choice of suppliers, lower costs of the products purchased, better product quality, improved delivery, reduced cost of procurement, and reduced procurement lead-time.

With respect to the e-auction business model, Timmers mainly emphasizes on the selling perspective, not on procurement. However some of the mentioned benefits do reflect purchasing: increased sourcing and buying efficiency, global sourcing opportunities, reduced procurement process costs and reduced cost of goods purchased (pp. 37-38). Through this business model not only spot-buys can be accomplished (with the emphasis on the tactical level of the procurement business function), but also strategic contracts for direct materials can be closed. Timmers elaborates on e-auctions through the Infomar case, an electronic auctioning and services system for the fishing trade, linking fish buyers and suppliers. Success factors associated with Infomar are product quality control, standardized quality measurements, and fast economies of scale.

Collaboration platforms can often be considered electronic trading exchanges. Timmers (1999) discusses a particular implementation of a collaboration platform, called ICS (Industrial Co-operation System) (pp. 90-103). ICS is a system supporting business partners, buyers and suppliers, in collaborative work. The benefits of ICS include: reduced time to market, reduced overall transaction costs, improved product quality through knowledge pooling and collaborative communication, improved product lifecycle management, reduced design costs, and improved product innovation. As a marketing strategy, ICS is aimed at companies with a high level of awareness of Internet technology and application. Of further interest in Timmers' book is his analysis of some of the case studies that are related to collaboration platforms. Because of their high supply chain power, large purchasers will move from third party trading exchanges and become themselves operators of trading exchanges; that is, they will move towards buyer-owned electronic trading exchanges. Further, Timmers identifies the need for aligning internal business processes and human factors management with the introduction of collaboration platforms.

From these descriptions of e-business models we will list benefits and success factors in the I-Frame.

Channel transformation framework of Clark and Lee
Clark and Lee describe a framework for the relationship between performance, interdependence and coordination of firms involved in inter-organizational relations (2000, p. 90), see figure 3.

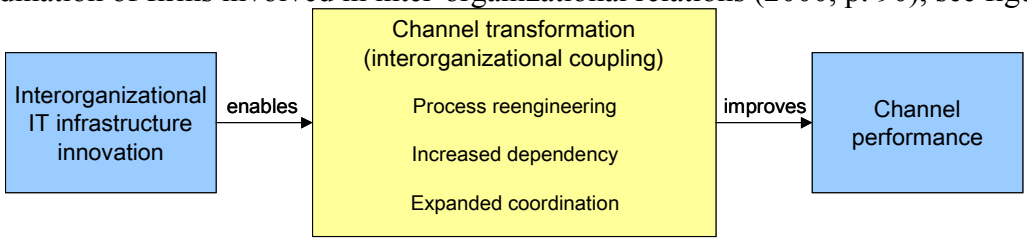

Figure 3. Channel transformation framework

The framework describes the influence of channel transformation in facilitating performance improvements enabled by technology innovations. Clark and Lee define channel performance as the rate of inventory turns versus stockout costs. Consequently, improving channel performance implies the highest inventory turn rate against the lowest stockout costs. Business process reengineering, e.g. by leveraging the Internet, results in increased interdependency between buying and supplying organizations. As Clark and Lee state however, not all firms experiencing increased interdependence are able to realize the performance benefits enabled by increased interdependency: a third area of change, expanded coordination, is defined as an important component of the channel transformation process.

The transformation framework can be applied to purchasing: Clark and Lee themselves validated the framework against vendor managed inventory, a type of inventory control. In validating the framework Clark and Lee concluded the following (2000).

- In increasing *channel performance*, *process reengineering* is perceived as an important means to achieve this goal;
- Expanded *coordination* is perceived as the primary tool enabling firms to capture *channel performance*; it is viewed as essential for enabling specific channel process innovations to occur.

Referring to the descriptions of inventory turn and stockout costs (Arnold, 1998), improving inventory turns and reducing stockout costs can be summarized under the benefit of reducing purchasing costs. This benefit and the mentioned success factors outlined in the bullet list will be listed in the I-Frame.

Analysis framework of Dai and Kauffman
Dai and Kauffman (2002) provide an analysis framework for trading exchanges: they identify three categories of features in trading exchanges (market functions, management needs, and technology adoption). When the features are available in an implementation of an electronic trading exchange, they can be considered factors contributing to the success of an electronic trading exchange implementation.
1. Market function

    a. Aggregation: ability to compile product information from many suppliers in order to provide a buyer with a normalized product view.
    b. Matching: support for bringing together buyers and suppliers by means of for example bidding.
    c. Facilitation: availability of services that help organizations to close transactions, for example financial services.
2. Management need
    a. Procurement expertise and knowledge: availability of business intelligence using operational data in the trading exchange.
    b. Business relationships and business process support: support for inter-organizational workflow management and coordination of tasks.
3. Technology adoption
    a. System integration: (technical) support for connecting organizations to the electronic trading exchange.
    b. Standard providers: support for (industry) standards that relate to communication protocols and message formats, e.g. support for XML-based RosettaNet (www.rosettanet.org).
    c. Outsourcing: availability of IT outsourcing services to overcome the adoption hurdles for the electronic trading exchange.

Dai and Kauffman's framework relates as follows to the procurement business function. (1) Market function corresponds with the operational and tactical levels of purchasing, as well as content management, (2) management need covers the strategic level, procurement knowledge management as well as the conceptual part in B2B communication, (3) technology adoption can be projected on the technical part of B2B communication. Furthermore, the framework can be applied to both public and private trading exchanges.

Regarding aggregation Dai and Kauffman state that through 'private e-cataloging' (a buyer has a predefined set of products that can be purchased from a supplier) a buyer can retain preferred buyer-supplier relationships. For this, contracts between buyers and suppliers need to be established. With the objective of operational cost reduction, private e-cataloging is favored in transactional purchasing that occurs frequently and in large quantities. Regarding the matching-feature, through mechanisms of private negotiating in electronic trading exchanges (like auctioning functionality), suppliers can be easily pre-selected and preferred supplier relationships can be easily maintained. Both buyers and supplier can negotiate more efficiently. To achieve this, Dai and Kauffman identify reliability of the supplier as important, especially for direct materials purchasing. As with facilitation, Internet based financial and delivery services can be provided, which contribute to streamlined settlement of purchasing. Dai and Kauffman suggest to partner with third party companies for these services in order to maximize benefit.

Regarding procurement expertise and knowledge, if electronic trading exchanges could provide mechanisms to analyze transactional data, as well as external data, buyers could benefit by making improved sourcing decisions, choosing the correct products and reducing search costs. Regarding business relationships and business process support, Dai and Kauffman discuss workflow management, collaborative project management, and supply chain management. First, workflow management can improve efficiency by automating the ordering process, including inter-organizational processes. Dai and Kauffman describe a business case of corporate printing,

through which they identify the need to improve information exchange between buyers and suppliers through workflow management. For example, the designs and contents of marketing brochures change often. Second, according to Dai and Kauffman, collaborative project management is the mechanism to reduce the costs of coordinating interdependent tasks among multiple business partners. The cost reduction can be achieved if information is well managed and available at the right place, on the right time. Third, synchronizing the planning and scheduling activities of buyers and suppliers can improve supply chain management efficiency. Through the Internet, real-time interactive collaboration, even more than before, can become reality. This however requires sophisticated data processing and network technology, as well as a common data model shared by trade partners.

System integration offers greater access to business partners. It is needed to effectively implement inter-organizational information systems. Once implemented, system integration allows for maximizing operational efficiency for connected business partners. Regarding standard providers, standardization can be applied on the data format level (e.g. XML-formats) and the process level (e.g. RosettaNet, www.rosettanet.org). In both cases such standardization affords enhancement of the compatibility and connectivity of network technologies, a prerequisite for effective supply chain collaboration. As with outsourcing, smooth adoption of an electronic trading exchange can be accelerated by a technology-outsourcing vendor, who can provide systems that automate the purchasing process and related services.

Through the categorization of features, Dai and Kauffman provided benefits and success factors that will be listed in the I-Frame.

Atomic e-business models of Weill and Vitale

Weill and Vitale (2001) describe a number of atomic e-business models, from which any organization can build its own e-business implementation. The atomic models that mostly reflect direct materials procurement in an electronic trading exchange context are "Value Net Integrator: coordinates activities across the value net by gathering, synthesizing, and distributing information … [and] Intermediary: brings together buyers and sellers by concentrating information." (p.21).

The key benefit for value net integrators is the increased coordination of information between business partners. The following critical success factors for the value net integrator business model are identified (p. 234):

- Reducing ownership of physical assets while retaining ownership of data;
- Owning or having access to the complete industry virtual value chain;
- Establishing a trusted brand recognized at all places in the value chain;
- Operating in markets where information can add significant value, such as those that are complex, fragmented, regulated, multi-layered, inefficient, and large with many sources of information, and that require specialized knowledge;
- Presenting the information to customers, allies, partners, and suppliers in clear and innovative ways that provide value;
- Helping other value chain participants capitalize on the information provided by the value net integrator.

According to Weill and Vitale the key benefits for buyers and suppliers using intermediaries are lower search costs and lower transaction costs (2001, p. 180). Critical success factors to achieve these benefits for intermediaries are

- Attracting and retaining a critical mass … [of business partners];
- Building up infrastructure just quickly enough to meet demand as it increases;
- Owning the … relationship and producing a site with a high degree of "stickiness" (need or desire to return to the site) (p. 181).

All above benefits and success factors by Weill and Vitale will be listed in the I-Frame.

The I-Frame for buyer-owned electronic trading exchanges

The different source models encompass a broad spectrum of benefits and success factors. We propose the following categorization: (business) process-related, cost-related, product quality-related, trust-related, and organization-related benefits. Table 3 contains the list of benefits and related success factors of buyer-owned electronic trading exchanges.

Table 3
The I-Frame of benefits and success factors of buyer-owned electronic trading exchanges

Potential benefit	Related success factors	Referred business characteristics of potential benefits
Process-related		
Improved product innovation and reduced time to market for newly developed products	High supply chain power of the buying company; business-IT alignment applied; high level of awareness of Internet technology and application	Collaboration platform (Timmers)
Improved product life cycle management	High supply chain power of the buying company; business-IT alignment applied; high level of awareness of Internet technology and application	Collaboration platform (Timmers)
Easier to pre-select suppliers	Private negotiating mechanisms available; in case of a shallow interdependence form of relationship: predictability and consistency continuously supported	Matching (Dai and Kauffman)
Improved sourcing decisions	Availability of mechanisms to analyze transactional data; availability of mechanisms to analyze external, industry specific data	Procurement expertise and knowledge (Dai and Kauffman)
Streamlined settlement of purchasing	Partnering with third party for financial and delivery services	E-procurement (Timmers), facilitation (Dai and Kauffman)
Increased coordination between partners	High supply chain power of the buying company; operating in markets where information can add significant value; reduced ownership of physical assets while retained ownership of data; correct information provided at the right time in a value-adding way; business partners aided in capitalizing on information; standardization on data format and process level	Value net integration (Weill and Vitale), standard providers (Dai and Kauffman)

Potential benefit	Related success factors	Referred business characteristics of potential benefits
Improved process efficiency	Private negotiating mechanisms available; in case of a shallow interdependence form of relationship: predictability and consistency continuously supported; quality control, with standardized quality measurements; quickly reached economies of scale; sophisticated data processing and network technology; correct information provided at the right time in a value-adding way; synchronized planning and scheduling activities of buyers and suppliers; common data model shared by business partners; automated ordering process through workflow management; organizational need for improving efficiency; high degree of systems integration	E-procurement, and e-auction (Timmers), business relationships and business process support, matching, and system integration (Dai and Kauffman)
Increased compatibility and easy connectivity	Standardization on data format and process level; technology outsourcing vendor involved	Standard providers (Dai and Kauffman), outsourcing (Dai and Kauffman)
Costs-related		
Reduced design costs	High supply chain power of the buying company; business-IT alignment applied; high level of awareness of Internet technology and application	Collaboration platform (Timmers)
Lower costs of products purchased	Quality control, with standardized quality measurements; quickly reached economies of scale	E-procurement, and e-auction (Timmers)
Reduced costs of coordinating interdependent tasks among multiple business partners	Sophisticated data processing and network technology; correct information provided at the right time in a value-adding way; synchronized planning and scheduling activities of buyers and suppliers; common data model shared by business partners; automated ordering process through workflow management; organizational need for improving efficiency	Business relationships and business process support (Dai and Kauffman)
Reduced product search costs	Availability of mechanisms to analyze transactional data; availability of mechanisms to analyze external, industry specific data; ability to build up an infrastructure just quickly enough to meet demand as it increases; high supply chain power of the buying company; critical mass of business partners attracted and retained	Procurement expertise and knowledge (Dai and Kauffman), intermediary (Weill and Vitale)
Wider choice of suppliers	Private negotiating mechanisms available; in case of a shallow interdependence form of relationship: predictability and consistency continuously supported; quality control, with standardized quality measurements; quickly reached economies of scale; high degree of systems integration	E-procurement, and e-auction (Timmers), matching, and system integration (Dai and Kauffman)

Potential benefit	Related success factors	Referred business characteristics of potential benefits
Reduced purchasing costs	High supply chain power of the buying company; business-IT alignment applied; high level of awareness of Internet technology and application; quality control, with standardized quality measurements; quickly reached economies of scale; ability to build up an infrastructure just quickly enough to meet demand as it increases; critical mass of business partners attracted and retained; expanded coordination with business partners; BPR applied in association with IT-introduction; private e-cataloging; established contracts with suppliers; transactional purchasing occurring frequently and in large quantities	E-procurement, e-auction, and collaboration platform (Timmers), channel performance (Clark and Lee), aggregation (Dai and Kauffman), intermediary (Weill and Vitale)
Product quality-related		
Correct products chosen	Availability of mechanisms to analyze transactional data; availability of mechanisms to analyze external, industry specific data	Procurement expertise and knowledge (Dai and Kauffman)
Better quality	High supply chain power of the buying company; business-IT alignment applied; high level of awareness of Internet technology and application	E-procurement, and collaboration platform (Timmers)
Trust-related		
Increased trustworthiness	In case of a shallow dependence form of relationship: discretion, reliability and competence continuously supported; in case of a deep dependence form of relationship: integrity, concern and benevolence continuously supported; in case of a shallow interdependence form of relationship: predictability and consistency continuously supported; in case of a deep interdependence form of relationship: foresight, intuition and empathy continuously supported	Trust between business partners (Sheppard and Sherman)
Organization-related		
Effective roll-out of the trading exchange	High degree of systems integration	System integration (Dai and Kauffman)
Smoother adoption of purchasing systems	Technology outsourcing vendor involved	Outsourcing (Dai and Kauffman)
Retention of preferred supplier relationships	Private negotiating mechanisms available; in case of a shallow interdependence form of relationship: predictability and consistency continuously supported; private e-cataloging; established contracts with suppliers; transactional purchasing occurring frequently and in large quantities	Aggregation, and matching (Dai and Kauffman)

CASE STUDY: PROCUREMENT AT KAC-PMO

With the I-Frame and its categorization in hand, along with a description of the procurement business function and a typology of electronic trading exchanges, we will now analyze the case at KAC-PMO. The data of the case have been taken from the Aberdeen Group ("KMS," 2001), Baan ("iBaan," 2001), and Ryburn (2002), and have been verified by the Director of IT Development at KAC-PMO and the Director of Product Management for Supply Chain Management at Baan. We begin with a brief introduction of KAC-PMO, its former way of purchasing direct materials, and the development process of the purchasing system. Subsequently, we will discuss the implemented trading exchange using the categorization of the I-Frame. Lastly, we will analyze the results.

The KAC-PMO organization, its former purchasing business process, and the development of the buyer-owned electronic trading exchange

Komatsu is a global supplier of capital equipment, especially construction and mining equipment. Worldwide, Komatsu employs 28,000 employees. Komatsu America Corp. - Peoria Manufacturing Operations (KAC-PMO), located in the US, is a world-leading producer of special, heavy mining equipment. KAC-PMO employs 450 employees. Annual sales are $300 million and the annual purchasing volume is $200 million.

KAC-PMO has a range of about 350 direct materials suppliers. Referring to the Kraljic-matrix (Kraljic, 1983), the majority of the products purchased are strategic items and leverage items. Strategic items are those items for which the supply market is complex (few suppliers, complex logistics) and for which the financial impact of the items is high. The supply market for leverage items is less complex, but the financial impact is high. KAC-PMO strives for accurate demand forecasting, development of long-term supply relationships, and logistics control for strategic items. Careful vendor selection, pricing negotiations, and order volume optimizations are part of the strategy to optimize the purchase of leverage items.

Originally KAC-PMO and their suppliers used traditional means in the purchasing process:

- Forecast reports and purchase orders were printed and faxed to suppliers;
- Suppliers keyed-in order data when receiving a purchase order fax;
- Suppliers provided fulfillment dates to KAC-PMO on paper or by phone;
- KAC-PMO entered promise dates of supplier fulfillment manually;
- Purchase order change proposals needed to be approved manually.

Being a heavy equipment manufacturer, KAC-PMO's business is characterized by delivering high-value products with long production cycles, many parts, unique product configurations, and many customer order changes. Raised customer demands and increased competition were forcing KAC-PMO to make equipment faster and at lower cost than before. The IT organization initiated a discussion for improving the purchasing process, which was welcomed by the head of procurement and plant manager. KAC-PMO realized that improvement in how the direct materials supply base was managed was required. Purchasing cost savings, internal process improvements, reduced order lead-time, and successful connection of a number of suppliers at short notice were defined as the major objectives.

Weekly sessions with the IT manager, IT-people, head purchasing, the purchasing department (buyers), and the manager of cost management were instantiated, during which the improvement

of the purchasing process was brainstormed and examined. Consequences for the procurement process, employees and suppliers were investigated. The basic technique used in these sessions was Root Cause Analysis (Latino & Latino, 2002). Involving buyers in this early stage using RCA has been identified as a success factor in receiving commitment from buyers, and consequently in making improvements of the purchasing process accepted. This is in contrast with top-down driven implementations of new systems, which as a result may be less successful. See for example the implementation of ERP in Revel Asia as described by Koh, et al. (2000), where user acceptance was wrongly taken for granted. Also, in the RCA sessions much time was dedicated to how to convince suppliers to join the electronic trading exchange. To anticipate on this issue, striving for optimal support for suppliers became one of the spearheads in the project. Ken Ryburn, the director of IT Development at KAC-PMO says: "We recognized early that if we were going to get our supplier partners to participate in this electronic trading exchange, we would need to provide them with some value in return. This realization has been key to why our trading exchange is so successful in gaining supplier adoption and trust."

The RCA sessions continued for about 5 weeks. In the second phase, Rapid Application Development techniques were used to develop the software (Martin, 1991). In this phase mock-ups of user interfaces and the new workflow process made the intended purchasing process very visible for the participants: buyers, and suppliers. IT-people received fast and profound feedback on the mock-ups and improved the designs. This phase took about 9 weeks, and was followed by about 14 weeks of testing and modifying. Once the trading exchange was developed, increasingly suppliers were connected. Within twelve months, all of the major suppliers used KAC-PMO's trading exchange.

KAC-PMO's electronic trading exchange for direct materials was implemented using Baan's B2B Server standard software product, which has a pre-built integration with the Baan ERP system. As a result the new software could be easily integrated with the existing back-end system of KAC-PMO, Baan ERP. Baan's standard software, given sufficient hardware, allowed connection of the majority of KAC-PMO's suppliers to the trading exchange in a year's time.

We will now discuss the KAC-PMO's trading exchange further characteristics and results (achieved objectives and perceived success factors) per I-Frame category.

Process-related

Following is the full set of business scenarios supported by the electronic trading exchange.

1. Web-based purchase ordering. All purchase orders are sent electronically through the buyer-owned electronic trading exchange. Electronic order acknowledgements are sent, received and processed through the electronic trading exchange. The purchase order contains the items and their specification details. The electronic trading exchange also determines possible joining of purchase orders for leveraging price breaks.
2. Supplier shipping portal. The electronic trading exchange provides dedicated entry for suppliers to KAC-PMO. Suppliers are optimally supported because they can at any time inspect a list of all open purchase orders. Suppliers can also open or convert the list into an Excel-document and enter the order acknowledgement dates and return the list to KAC-PMO. Suppliers can create an electronic Advanced Shipment Notice (ASN) from an open purchase order, from which they can then print shipment and packing labels.

3. Automated re-scheduling of purchase orders. The buyer at KAC-PMO can create rules through which changes in purchase orders can automatically be sent to suppliers.
4. Web-based forecasting. Item forecasts can be sent to suppliers.

KAC-PMO has reported successful achievement of the initial objectives: purchase order process improvement, shortened purchase order lead-time, and successful connection of a number of key-suppliers at short notice. Within a year's time, KAC-PMO linked 90% of their direct material suppliers to the buyer-owned electronic trading exchange. With the implementation of the trading exchange, KAC-PMO was able to simplify the purchase ordering process dramatically. For instance many efficiencies were achieved in the administrative process, leaving out much of this manual handling:

- Separately print and fax purchase orders;
- Manually determine price break optimizations;
- Manually associate documents with purchase items;
- Manually approve purchase orders.

Quantitatively KAC-PMO has reported the following process-related benefits from their trading exchange implementation:

- Reduction of core supplier lead times from 60 days to 20 days through regular posting of item forecast reports;
- Reduced purchase order placement from 5 days to a matter of hours.

Also KAC-PMO's suppliers gained benefits from the electronic trading exchange, as Ryburn explains: "In the past suppliers received our plans by fax and had to re-key these into their own systems. Now they can download plans and order directly from the Web in for example an Excel format, for their own analysis of the data." The supported business scenarios expanded the coordination between KAC-PMO and its suppliers through inter-organizational workflow management and a high degree of automation. The right information is available at the right time, and scheduling activities are being synchronized by sending item forecasts to suppliers. Data format and databases are now shared through the supplier shipping portal and B2B-messages. The shipping portal and B2B-messages provide suppliers with information, on which they can capitalize: forecasts can be fed into the supplier's ERP-system, shipping and packing labels no longer have to be created, etc.

Cost-related

With the software support of the mentioned business scenarios, KAC-PMO wanted to achieve reductions in purchasing costs. The cost objectives at KAC-PMO were reducing inventory costs, and minimization of other transaction-related purchasing costs. Once the electronic trading exchange was implemented, KAC-PMO reported the following benefits:

- Approximately 100 to 150 man-hours per week saved; some procurement personnel has been appointed to other tasks;
- Printing and faxing paper savings of about 3000 papers a month;
- Significant reduction of inventory of purchased goods.

Also the supported business scenarios reduced the coordinating costs between KAC-PMO and its suppliers. Although not quantified, fewer errors are occurring, due to less manual involvement,

better support of exception handling, and increased automation of standard processes. For example, the label printing process reduced the number of errors in packing slips.

Organization-related and technology aspects

Figure 4 depicts the high level architecture of the KAC-PMO owned electronic trading exchange using the e-business model schematics introduced by Weill and Vitale (2001, p. 38):

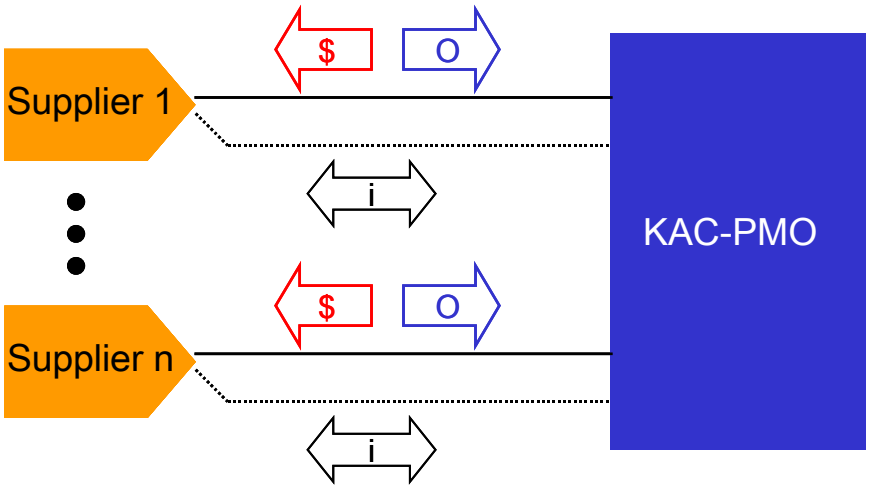

Figure 4. High level architecture of KAC-PMO owned electronic trading exchange

In figure 4 the information flow (i) runs from KAC-PMO to supplier, and from supplier to KAC-PMO. From KAC-PMO to supplier the following information flows: purchase orders (including specification details of the required item), purchase order changes, list of all open purchase orders for a particular supplier, shipment and packing slip data, and item forecast information. From supplier to KAC-PMO the following information flows: purchase order acknowledgement, acknowledgements for purchase order changes, and advanced shipping notices.

Messages are send in XML-format and follow a standard flow, resembling RosettaNet to major extent. The goods flow (O) represents the delivery of purchased goods (with their associated shipment and packing slips). The dollar flow ($) represents the money sent to the suppliers.

For supplier convenience the electronic trading exchange allows for two ways of connecting, (1) fully automated, in which XML messages can be sent from and to the supplier's back-end system; (2) through a supplier portal in a browser environment, from where e.g. purchase orders can be downloaded in XML- or Excel-format. This makes the electronic trading suitable and easy connectable for highly Internet-experienced suppliers as well as less experienced suppliers.

Product quality and trust

As for product quality KAC-PMO did not report any new achievements due to the implementation of the electronic trading exchange. Quality standards were already in place and defined in contracts, which are managed and maintained in KAC-PMO's back-end ERP system. However, quality in messaging has improved: the successful implementation of KAC-PMO's trading exchange reduced communication errors. The reduction was possible because of the high

level of automation of the business scenarios, and the minimizing of manual handling. Because most purchased items are strategic items and leverage items, and change orders occur frequently, there exists mainly shallow and deep interdependence relationships between KAC-PMO and its suppliers. The implemented business scenarios web-based purchase ordering, supplier shipping portal, and automated re-scheduling of purchase orders at KAC-PMO and the usage of technology standards (XML, standard B2B workflow) caused improved predictability and consistency between KAC-PMO and its suppliers, improving the shallow relationships. The business scenario web-based forecasting caused increased foresight, improving deep interdependence relationships.

ANALYSIS OF THE KAC-PMO CASE USING THE I-FRAME

Table 4 shows the detailed analysis of the KAC-PMO case through the I-Frame.

Table 4
Detailed analysis of the KAC-PMO Case through the I-Frame

Benefit achieved through the electronic trading exchange	Related success factors met
Process-related	
Improved product innovation and reduced time to market for newly developed products - *Not achieved nor strived for, however, some collaborative engineering is applied through other systems and procedures*	High supply chain power of the buying company - N/A, also, KAC-PMO has medium supply chain power; business-IT alignment applied - N/A, however, already met; high level of awareness of Internet technology and application - N/A, however, met for KAC-PMO, mixed for suppliers
Improved product life cycle management - *Not achieved nor strived for, however, some collaborative engineering is applied through other systems and procedures*	High supply chain power of the buying company - N/A, also, KAC-PMO has medium supply chain power; business-IT alignment applied - N/A, however, already met; high level of awareness of Internet technology and application - N/A, however, met for KAC-PMO, mixed for suppliers
Easier to pre-select suppliers - *Not achieved nor strived for, however, KAC-PMO has pre-selection of suppliers available in other systems and procedures*	Private negotiating mechanisms available - N/A, however, already met; in case of a shallow interdependence form of relationship: predictability and consistency continuously supported - N/A, however, already met
Improved sourcing decisions - *Not achieved nor strived for, however, KAC-PMO supports sourcing in other systems and procedures*	Availability of mechanisms to analyze transactional data - N/A, however, met to some extent; availability of mechanisms to analyze external, industry specific data - N/A, however, met to some extent
Streamlined settlement of purchasing - Achieved	Partnering with third party for financial and delivery services – met, already before the implementation of the trading exchange
Increased coordination between partners - Achieved	High supply chain power of the buying company - *KAC-PMO has medium supply chain power*; operating in markets where information can add significant value - met; reduced ownership of physical assets while retained ownership of data - *not met*; correct information provided at the right time in a value-adding way - met; business partners aided in capitalizing on information - met; standardization on data format and process level - met

Benefit achieved through the electronic trading exchange	Related success factors met
Improved process efficiency - Achieved	Private negotiating mechanisms available – met, and already available before the trading exchange implementation; in case of a shallow interdependence form of relationship: predictability and consistency continuously supported - met; quality control, with standardized quality measurements - met; quickly reached economies of scale - met; sophisticated data processing and network technology - met; correct information provided at the right time in a value-adding way - met; synchronized planning and scheduling activities of buyers and suppliers - met; common data model shared by business partners - met; automated ordering process through workflow management - met; organizational need for improving efficiency - met; high degree of systems integration - met
Increased compatibility and easy connectivity - Achieved	Standardization on data format and process level -met; technology outsourcing vendor involved - met
Costs-related	
Reduced design costs - *Not achieved nor strived for, however, some collaborative engineering is applied through other systems and procedures*	High supply chain power of the buying company - N/A, also, KAC-PMO has medium supply chain power; business-IT alignment applied - N/A, however, already met; high level of awareness of Internet technology and application - N/A, however, already met for KAC-PMO, mixed for suppliers
Lower costs of products purchased - *Not achieved nor strived for, however, KAC-PMO supports sourcing in other systems and procedures*	Quality control, with standardized quality measurements - N/A, however already met; quickly reached economies of scale - N/A, however, already met
Reduced costs of coordinating interdependent tasks among multiple business partners - Achieved	Sophisticated data processing and network technology - met; correct information provided at the right time in a value-adding way -met; synchronized planning and scheduling activities of buyers and suppliers - met; common data model shared by business partners - met; automated ordering process through workflow management - met; organizational need for improving efficiency - met
Reduced product search costs - *Not achieved nor strived for, however, KAC-PMO supports sourcing in other systems and procedures*	Availability of mechanisms to analyze transactional data - N/A, however, already met to some extent; availability of mechanisms to analyze external, industry specific data - N/A, however, already met to some extent; ability to build up an infrastructure just quickly enough to meet demand as it increases -N/A, however, already met; high supply chain power of the buying company - N/A, also, KAC-PMO has medium supply chain power; critical mass of business partners attracted and retained - N/A, however already met
Wider choice of suppliers - *Not achieved nor strived for, however, KAC-PMO supports sourcing in other systems and procedures*	Private negotiating mechanisms available - N/A, however, already met; in case of a shallow interdependence form of relationship: predictability and consistency continuously supported - N/A, however, already met; quality control, with standardized quality measurements - N/A, however, already met; quickly reached economies of scale - N/A, however, already met; high degree of systems integration - N/A, however, already met

Benefit achieved through the electronic trading exchange	Related success factors met
Reduced purchasing costs - Achieved	High supply chain power of the buying company - *KAC-PMO has medium supply chain power*; business-IT alignment applied - met; high level of awareness of Internet technology and application - *met for KAC-PMO, mixed for suppliers*; quality control, with standardized quality measurements - met; quickly reached economies of scale - met; ability to build up an infrastructure just quickly enough to meet demand as it increases - met; critical mass of business partners attracted and retained - met; expanded coordination with business partners - met; BPR applied in association with IT-introduction - met; private e-cataloging - met, and already available before the trading exchange implementation; established contracts with suppliers - met, and already available before the trading exchange implementation; transactional purchasing occurring frequently and in large quantities - *occurs frequently, but often in lower quantities*
Product quality-related	
Correct products chosen - *Not achieved nor strived for, however, KAC-PMO supports sourcing in other systems and procedures*	Availability of mechanisms to analyze transactional data - N/A, however, met to some extent; availability of mechanisms to analyze external, industry specific data - N/A, however, met to some extent
Better quality - *Not achieved nor strived for, however, quality assurance is defined in contracts with suppliers*	High supply chain power of the buying company - N/A, however, KAC-PMO has medium supply chain power; business-IT alignment applied - N/A, however, already met; high level of awareness of Internet technology and application - N/A, however, met for KAC-PMO, mixed for suppliers
Trust-related	
Increased trustworthiness - Achieved	In case of a shallow dependence form of relationship: discretion, reliability and competence continuously supported - N/A; in case of a deep dependence form of relationship: integrity, concern and benevolence continuously supported - N/A; in case of a shallow interdependence form of relationship: predictability and consistency continuously supported - met; in case of a deep interdependence form of relationship: foresight, intuition and empathy continuously supported - met
Organization-related	
Effective roll-out of the trading exchange - Achieved	High degree of systems integration - met
Smoother adoption of purchasing systems - Achieved	Technology outsourcing vendor involved - met
Retention of preferred supplier relationships - Achieved	Private negotiating mechanisms available - met, and already available before the trading exchange implementation; in case of a shallow interdependence form of relationship: predictability and consistency continuously supported - met; private e-cataloging - met, and already available before the trading exchange implementation ; established contracts with suppliers; transactional purchasing occurring frequently and in large quantities - *occurs frequently, but often in lower quantities*

As mentioned before, the KAC-PMO owned electronic trading exchange has been awarded by the Aberdeen Group as a “best practice in procurement system implementation” (“KMS,” 2001; “iBaan,” 2001). The impressive benefits in terms of process efficiencies and cost reductions for

KAC-PMO, as well as the support for suppliers, have made KAC-PMO's electronic trading exchange successful. KAC-PMO was able to realize the success emphasizing the operational and tactical aspects of purchasing: actual purchase ordering, purchase settlement, and purchase order forecast are major features in the trading exchange. Sourcing and product life cycle management were not part of the development scope of KAC-PMO's electronic trading exchange. Per using table 4, the KAC-PMO implementation of the electronic trading exchange was successful in achieved benefits that correspond with tactical and operational procurement. All trust-related benefits and all organizational benefits were achieved. As for the process-related benefits, those benefits not achieved correspond to sourcing and product life cycle management. Likewise, all cost-related benefits are achieved except for the sourcing and product life cycle related ones. As for the product quality type of benefits, no new benefits were achieved: these also refer to sourcing and product life cycle management.

Although sourcing and product life cycle management were not in the scope of the first version of the electronic trading exchange, to some extent they are already part of KAC-PMO's business. Sourcing and product life cycle management are currently "supported by other systems and procedures." These are not associated with the electronic trading exchange, yet.

Can we explain the success of the KAC-PMO case by table 4? The degree to which the success factors have been met for achieved benefits is high. However, some success factors were not mediated by the electronic trading exchange, but were already available through existing systems and procedures, for example private e-cataloging. There are also success factors that have not been (completely) met. (1) KAC-PMO has medium supply chain power. This is probably a generic characteristic for Original Equipment Manufacturers (OEMs) in this type of industry, special heavy equipment. OEMs, like KAC-PMO have strategic (interdependent) relationships with their suppliers. An OEM with medium supply chain power cannot dictate suppliers to connect to a buyer-owned electronic trading exchange, therefore KAC-PMO has wisely invested in implementing features for suppliers in the trading exchange. (2) Not all KAC-PMO's suppliers have high awareness of Internet technology and application. To manage the risk that these suppliers would not connect to the trading exchange, KAC-PMO has implemented features that make it easy to connect to and use the electronic trading exchange. For example, suppliers can download the list of purchase orders via the Internet-browser in an Excel-format. (3) Transactional purchasing occurs frequently (per month, many purchase orders are sent), but often in lower quantities (the number of items purchased per order is not very large). According to Ryburn "it is the dollars and the length of the forecast (6-9 months) that determines the amount." This is not likely to change on short notice. (4) Finally, reduced ownership of physical assets while retained ownership of data is a success factor that is not met. In some industries outsourcing of manufacturing is becoming standard, for example in the mass electronics industry, where contract manufacturers take over production from OEMs. We are unsure whether the heavy machinery industry will become a contract manufacturer industry.

The case at KAC-PMO shows that involvement of key-users in the beginning and during the development of the electronic trading exchange was considered essential for user acceptance. This factor has not been mentioned in the I-Frame. Also the development techniques used, RCA and RAD, seemed to have a positive influence on the success of the implementation of the electronic trading exchange.

Overall however, the similarity between the KAC-PMO case and the I-Frame is remarkable.

CONCLUSIONS AND FURTHER RESEARCH

We have created the I-Frame, which is based on five existing models. The I-Frame consists of benefits and success factors of buyer-owned electronic trading exchange for direct materials. Because it is based on several existing models the I-Frame covers a broad spectrum, which each individual model does not encompass. Subsequently, we have presented the case of direct materials procurement at KAC-PMO through a buyer-owned electronic trading exchange.

> *The description of the KAC-PMO case and the subsequent discussion has shown that (1) the benefits are achieved, and (2) the success factors are largely met for the operational and tactical levels of the procurement business function.*

This refers to our research question: what are the benefits and success factors of buyer-owned electronic trading exchanges for direct materials ordering? However, we cannot conclude that the I-Frame is valid, yet. Some success factors are not met. The above analysis on the success factors "high supply chain power of the buying company", "high level of awareness of Internet technology and application", "transactional purchasing occurring frequently and in large quantities", and "reduced ownership of physical assets while retained ownership of data" identifies an area of further research. Are the success factors *industry-specific*? Is the I-Frame for the heavy equipment industry different from the I-Frame for, say, the electronics or automotive industry?

Nor is the I-Frame is complete. The case at KAC-PMO mentions for example user involvement during development. We encourage further research for investigating more cases in order to validate the I-Frame and find additional benefits and success factors.

Since the KAC-PMO case did not cover the strategic aspects of the procurement business function, related benefits and success factors could not be validated. In table 4 we described that to some extent the success factors were already met by existing systems and procedures. Also the sub-functions of procurement knowledge management and content management could not be covered in the electronic trading exchange at KAC-PMO, but were available in existing systems. An area of further research is studying new cases that do cover sourcing, product life cycle management, analysis and content management. While we congratulate KAC-PMO on this successful implementation, we also encourage them to further look at the success factors of the I-Frame, when further rolling out features in the strategic area of the procurement business function.

We have contributed to the research in e-business by exploring benefits and success factors of e-business implementations in the niche of direct materials purchasing. Although direct materials purchasing is an important niche that is directly related to a company's main business, it is only one part of purchasing. We encourage similar research in the area of indirect materials, like office supplies, and capital goods purchasing. In these situations the procurement business function needs to be redefined for indirect goods (e.g. incorporating 'requisitioning' on the tactical level), or capital goods (e.g. including preventive asset maintenance on the tactical level).

In our opinion, the I-Frame can be used as a checklist for organizations that consider improving their direct materials purchasing: which possible benefits can be gained, and what are the associated possible success factors. These organizations can use the lessons learned from the KAC-PMO implementation. We trust that further research in other types of industry and in different project situations will further detail and validate our I-Frame.

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