# How Do Procurement Networks Become Social?
# Design Principles Evaluation in a Heterogeneous Environment of Structured and Unstructured Interactions

*Completed Research Paper*

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## Abstract

*Expanding procurement networks involving many countries, organizations and people impose challenges on procurement e-business systems. Firstly, the classic document exchange based connection approach across company borderlines is still both time consuming and costly. Secondly, today's systems provide limited support for people networking dimensions, combining structured and unstructured activities as part of the entire business process. We argue that the potential for accelerating the intra and inter firm procurement processes by addressing the challenges of integration and heterogeneous activities is not sufficiently leveraged at present. In this paper, we present the results of our design science research focusing on the evaluation of design principles along a software artifact, towards effects on procurement network performance.*

**Keywords:** E-business, Business network(s), E-procurement, Collaboration

# Introduction

The core purposes of traditional procurement software systems as part of Enterprise Resource Planning (ERP) solutions are to provide spending transparency, optimize internal purchasing processes, and ensure compliance across a company's multiple departments and functions (Davenport 1998). E-business systems like e-procurement or supplier relationship management (SRM) extended this original scope and focus on business process optimization beyond company boundaries by providing semantic standards and integration technology that structure and harmonize business data, enable message exchange between systems of related business partners, and provide access to external information sources via the Internet (Swaminathan and Tayur 2003). However, looking at the first main challenge of Total Cost of Ownership (TCO) (Ellram 1993) this approach still results in high integration cost, both in terms of integration technology and resources (Tarn et al. 2002). In addition, procurement systems today are primarily focused on streamlining structured business processes. Unlike unstructured business interactions, structured business processes operate on well-defined data objects and follow a predetermined set of activities. Many activities that happen before and after the actual execution of structured process steps are not supported so well, for example the initial supplier identification, qualification, and on-boarding as well as communication with respective contact persons (Calisir 2004). The diversity of interaction types (structured, semi-structured, and unstructured) therefore is the second main challenge to increase procurement performance. In this respect, procurement solutions might need to match the advancing collaboration features of modern customer relationship management (CRM) systems (e.g., blog features in e-commerce shops) in handling unstructured interactions (Moeller et al. 2006). Another important evolvement is the use of social media (e.g., social network sites) by procurement professionals, both in their private environments and increasingly also in the context of their professional purchasing tasks. This raises the question how to make use of social networks' capabilities and to link them with professional procurement processes more tightly in order to unleash additional performance potential in the highly collaborative area of procurement. In this regard, the extension of user roles from operational, vertical activities to cross-horizontal responsibilities for strategy setting and execution is still ongoing (Hammer and Champy 1994). For example, the role of a category manager extended from rationalization of the supply base for a certain set of categories to even sales oriented responsibilities. Such tasks also include the optimization of customer satisfaction and category margins. We argue that the resulting potential for further increasing the performance of procurement networks and accelerating the intra and inter firm business processes is not sufficiently leveraged at present. Furthermore, we suggest that the challenges of integration and the support of unstructured interactions are major sources of respective potentials.

In this paper we present the results of our design science research addressing the two main challenges of (1) integration and (2) diverse interaction types (from structured to unstructured) by the empirical identification, implementation, and evaluation of design principles, instantiated in a software artifact.

Assuming that performance improvements of individual users in a networked procurement scenario also lead to an improvement in the aggregate procurement network performance overall, we derive the following key research question of our design science project:

*What are the design principles for improving the procurement network performance of business professionals by enabling integration and seamless combination of unstructured activities and structured data contained in procurement systems?*

To answer our research question, this paper presents our research and its results as follows: Section two lays the theoretical and terminological foundations, while section three introduces our research method and design. Section four presents the results, including problem definition, derivation of preliminary design principles, and the explanation of the artifact's build and evaluation cycle. Section five discusses the results. Towards the end, section six reflects upon limitations and future research opportunities before section seven concludes the paper by discussing its contributions.

# Theoretical and Terminological Foundations

## Current State of Research

Prior research investigated the effects of Internet utilization on procurement processes and performance (Rai et al. 2006, Barua et al. 2004, Davila et al. 2003), in particular in the context of e-procurement (Mishra et al. 2007), e-marketplaces (public exchanges) (Grey et al. 2005), business-to-business procurement (Subramaniam and Shaw 2002) and supplier relationship management (private exchanges) (Brenner and Wenger 2007).

However, the ever closer network relationships in procurement create challenges which need to be addressed beyond these seminal works. For instance, Tanner et al. (2008) examined 68 companies and their problems associated with using IT in procurement. Slow integration was named by more than 50% of the participants as the second most significant issue after the high introduction costs for new solutions. More than 20% of the participants also criticized the deficits in integrating solutions into other software. Other main issues are the lack of quality of master data, the difficulty in judging the usefulness and potential of new IT solutions, and the fact that they only address some of the procurement processes or cannot address the processes holistically.

A further topic that is not discussed in the study of Tanner et al. (2008) – but which according to Blumeberg and Atre (2003) represents one of the major unsolved problems in information technology – is the management of unstructured data in terms of the lack of support for unstructured interactions before or after structured process steps. Fan et al. (2006) therefore use a text mining approach to gain information from unstructured data, while Baars and Kemper (2008) discuss different approaches concerning the integration of structured and unstructured data into a business intelligence system. These studies showed the positive impact on management efficiency by systems supporting both structured and unstructured processes and data.

While considerable insight has been generated in these fields, our research addresses domain knowledge gaps to understand, explain, or predict performance increases in procurement networks, utilizing recent software paradigms, in particular concepts of social networks and their potential for information systems as suggested by Oinas-Kukkonen et al. (2010, p. 61), "[to find] new ways to generate and maintain connections within and between social units, and new social connection-focused IT capabilities."

## The Degree of Structure in Data and User Interaction

Structured data is commonly defined as data with fixed coded meaning and format from the beginning until the conclusion of business transactions, normally stored in database fields and easily to be computed. In contrast, unstructured data and interactions have no fixed format, mostly derive from human interactions and can rarely be computed without any prior transformation. Semi-structured data stands for unstructured textual data enriched by metadata and are normally difficult to compute (Baars and Kemper 2008). The specific characteristics and differences of structured, semi-structured, and unstructured data and user interactions are reflected in Table 1 below.

Semi-structured data can be interpreted as a sub-type either of structured or un-structured data. For the remainder of this paper, we will therefore refrain from making an explicit distinction between semi-structured data and interactions explicitly, as this does not support the purpose of our research. Also from the procurement professional interaction viewpoint, for example, there clearly is a difference in capturing structured or unstructured data, but little to none difference in the case of semi-structured data.

## Procurement Networks

Business networks in general can be defined as a set of connected relationships, going beyond dyadic relations between business partners, capturing the business context they are embedded in and the connections between relationship (Anderson et al. 1994). We consider a procurement network to be a specific instance of business networks. We base our work on the business network research carried out by Camarinha-Matos (2004). He investigates opportunities for new information technology usage in the context of Collaborative Networked Organizations (CNOs) and Virtual Organizations (VOs) to enable advanced collaboration forms.

| Table 1. Structured, Semi-Structured, Unstructured Data and User Interactions | | | |
|---|---|---|---|
| | *Structured* | *Semi-Structured* | *Unstructured* |
| **Characteristics** | fixed coded meaning and format of data from the beginning throughout completion of business processes; derived from transactions, assigned to data fields; easy to compute | unstructured textual data enriched by meta-data; transformation of meaning into code possible; difficult to compute | no fixed format; transformation of meaning into coded format complex; mostly derived from inter-actions; cannot be (directly) computed |
| **Data** | mostly numeric | numeric & non-numeric; mostly textual | mostly non-numeric; textual & text-analogs |
| **User Interactions** | data entry in fixed formats | data entry in non-fixed format | data entry in non-fixed format; focused on communication, collaboration, and interaction |
| **Examples** | purchase order data with product ID, supplier ID, quantities, conditions, etc. | XML files, web pages, spreadsheets, text documents, technical specifications, etc. | images, colors, sounds, shapes, blogs, forums, emails, calls, chats, social networking, recordings, transcripts, etc. |

In Camarinha-Matos et al. (2009) a holistic definition with regard to networking, coordinated networking, cooperation, collaboration, and different CNO types is established. Based on this work, we define procurement networks as virtual collaborative environments of business professionals, covering all types of activities and processes to fulfill the procurement goals of organizations like supply base consolidation, requirement fulfillment in time and quality, as well as price and process optimization. Closely related to procurement networks are electronic marketplaces, which emerged extensively in the early 2000s. We reflect on the interrelation, challenges, further developments, etc. by building on studies on the different types of e-marketplaces (Matook and Vessey 2008), their role in supply chains (Chang 2008; Park and Suresh 2005), and their challenges in collaborative business (Grey et al. 2005). In particular, the approaches of e-marketplaces to address the integration and collaboration issues in procurement networks informed the problem awareness and exploration of the design principles in our research.

## Research Method and Design

Our research project follows a design science approach, as we are convinced that optimal convergence of complex systems like procurement networks with a large number of heterogeneous performance drivers and collaborating entities can only be achieved by means of iterative cycles of design, intervention, evaluation, and improvement. Design Science "seeks to extend the boundaries of human and organizational capabilities by creating new and innovative artifacts" (Hevner et al. 2004, p. 75). Based on the seminal works of Simon (1996), March and Smith (1995), and Takeda et al. (1990), the research design we have compiled follows the principal ideas and concepts of Kuechler and Vaishnavi (2008) and Vaishnavi (2008). Accordingly, design science research starts with the "Awareness of a Problem" phase. Along the same lines, the subsequent phases - "Suggestion", "Development" and "Evaluation" - are performed iteratively during the course of the research project. By looping back to the "Awareness of Problem" phase, new requirements and constraints can be identified and introduced into the design project, and the subsequent suggestion process can incorporate those.

Based on this approach, our overall research process can be divided into three phases: (1) conceptualization of design principles, (2) design of the artifact, and (3) empirical evaluation of the artifact. This chapter will briefly introduce each of these steps. In summary, our research design can in part be mapped to the action design research strategy suggested by Sein et al. (2011), which is depicted in Figure 1. The highlights and numbers of the phases are added to reflect our project.

**Figure 1. Artifact Build, Apply, and Evaluate Cycle of our project (based on Sein et al. 2011)**
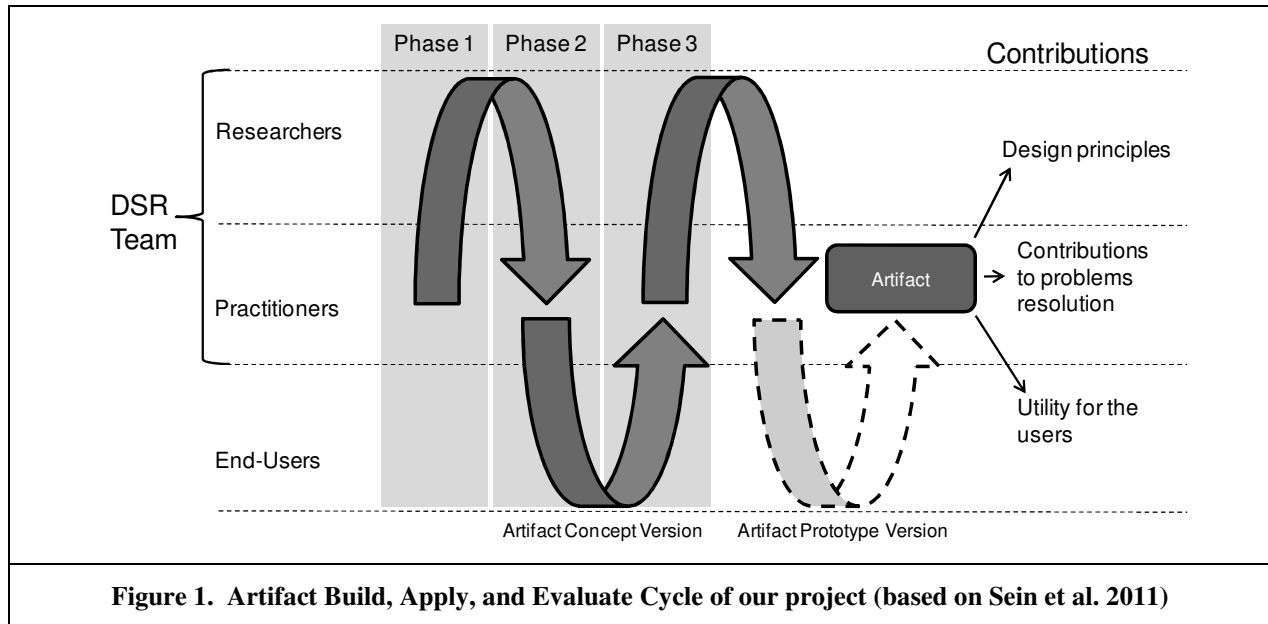
## *Phase 1 – Conceptualization of Design Principles*

As highlighted in Figure 1, the initial conceptualization of the problem and the derivation of according design principles are performed in phase 1 by the design science research (DSR) team. In accordance with Kuechler and Vaishnavi (2008) and Vaishnavi (2008), the awareness of the problem arose from the current field observations in the e-procurement and e-marketplace space, where still major challenges exist in terms of integration, unstructured data handling and complete process coverage which lead for instance to the fact that only a few e-marketplaces reached solid profitability, and companies still struggle to exploit the full potential of e-procurement solutions despite promising value propositions.

To substantiate this perceived problem and to gain a more detailed understanding of the underlying sources causing the problem, we conducted an exploratory study using open interviews. We chose interviews as they provide the researchers with a mean of generating data that provides insight into people's experiential life (Schultze and Avital 2011). Leveraging the seven guidelines for conducting interviews suggested by Myers and Newman (2007), the analysis of the interviews were done bottom-up (Schmidt 2003, 1997). This made it possible to identify the problems the participating procurement professionals currently perceive in the conduct and tool support of their tasks. In total, we gathered detailed domain and problem descriptions from 28 experts either serving as procurement professionals for various companies in the field or having demonstrated substantial subject matter expertise (e.g., through consulting experience or respective management positions). These unstructured, exploratory interviews lasted an average of 60 minutes.

In this context, we were able to study practitioners and subject matter experts from a diverse set of industries (high-tech, chemical, pharma, telecommunication, utilities, consumer products, retail/wholesale, and trade). By enfolding current studies and research results, their comments have been compiled into requirements which, in turn, have been further aggregated and finally abstracted into design principles. This phase of our research, along with the design principles we derive, will be described in more detail in the subsequent section of the paper.

## *Phase 2 – Design of the Artifact*

Based on the design principles developed in phase 1, we deducted design decisions which resulted in the artifact features. The derived features have been implemented in the artifact concept version (ACV) which covers a complete procurement use case identified as success critical by the majority of the respondents during their interviews in phase 1. The use case involves several key procurement roles across the entire procurement process (e.g., connecting lead buyers and sales representative from various companies). The

implementation of the ACV followed the lean software development methodology of SAP AG including iterative scrum cycles and feedback loops. The subsequent section highlights core features of the ACV and the artifact build and apply cycle in more detail.

## Phase 3 – Empirical Evaluation of the Artifact

In the empirical validation, we used the ACV to conduct a field test. In accordance with the overall idea of action design research (Sein et al. 2011), we facilitated the principles of action research (Baskerville 1999; Checkland and Holwell 2007; Lau 1999) in a small-scale, controlled field setting. The aim of this phase was twofold: First, introducing the artifact's concept version into a real-life setting and watching how actual users react to its capabilities allows us to make inferences about the artifact's usability, utility, and viability in practice. Second, practitioners' feedback will highlight strengths as well as needed improvements of the artifact in its current version, thus supplying us with input for the next iterative design cycle.

Between February and April 2011, we visited two companies[1] who wanted to understand options for increasing procurement network performance by holistic information systems support - especially in the context of unstructured interactions - and to comprehend the impact of social networking capabilities on their procurement processes in particular. At each company in this convenience sample, a team of professionals from the company's purchasing, supply, and IT divisions was assembled. The teams were composed of an equal number of professionals from each division. The companies freely chose the designated team members. We conducted one-day workshops at each company. These consisted of five aspects:

(1) Each individual team member was asked to characterize her/his current position in the context of selling/purchasing, identify problems with the current approach, and to reflect on tool support of their task. We used a brief pre-questionnaire with open questions that was submitted to the designated team members, filled out by them, and collected by us before the workshop.[2]

(2) The team as a whole was familiarized with the idea of networked procurement and the terminological foundations used to define and describe the problem setting underlying the project. This part was based on the insights we generated during phase 1 of our study.

(3) Each team was split up into sub-teams, each comprising a purchasing professional, a supply professional and an IT professional. Each of these sub-teams was introduced to the artifact concept version and asked to perform a quote-to-invoice process using the new artifact. The supply and purchasing professionals were asked to perform their respective roles, while the IT professional was asked to watch and assess the artifact's characteristics.[3]

(4) After the scenario had been completed, each professional was interviewed individually. Interviews lasted an average of 40 minutes and were semi-structured using an interview guideline.[4] All the interviews were recorded and transliterated verbatim. Completed transcripts were submitted to the informants for correction, extension, and approval. All field settings were performed with two of the authors as facilitators and observers present on site. These also gathered observations and impressions that were used to discuss the emerging results with the entire team of authors. The rationale for interviewing each of the participants of any team as well as in addition to their participation in the scenarios rests in our intention to allow for data and investigator triangulation (Mayring 2001, Flick 2010, 2009) using our observations, the participant's experiences, and their performance. In doing so, we hope to be able to "[…] readily assess the completeness and plausibility of the participant's account, thus making inconsistencies and contradictions more visible" (Schultze and Avital 2011, p. 5). We believe this to be an important contribution to our study's validity and reliability.

(5) After completion of the field studies, all qualitative material gathered was coded, analyzed, and theoretically abstracted following established methodological principles (Corbin and Strauss 1990, Myers 2010, Strauss and Corbin 1990, Thomas 2006). Atlas.ti 6 supported the respective data coding and analysis process. First, a code was allocated to every important part of the interview. Second, the

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[1] Further details on the companies participating in the field study are available from the authors on request.

[2] The questionnaires are available from the authors on request.

[3] The workshops agenda as well as a more detailed description of the scenario setting are available from the authors on request.

[4] The interview guides are available from the authors on request.

code list was checked for duplicates or similar entries, which were merged into one code. Finally, the remaining codes were synthesized into core categories which describe the interview's main issues.

The insights generated by these field studies were then used to assess how well the artifact performed in the live scenario, how well the design principles employed actually match the problems relevant to practitioners, and what additional design choices would be needed to build a more useful and better performing artifact. The evaluation's results will be introduced and discussed in the results section below.

# Results

## *Conceptualization of Design Principles*

A scenario central to networked procurement is the 'quote-to-invoice' use case as schematically depicted in Figure 2. Initiated by the buyer, the scenario starts with the creation of a request for quotation. This is responded to by quote(s) from the supplier or suppliers, followed by the purchase order on the buyer site if a quote meets the buyer's requirements. This is followed by the creation of the sales order by the supplier. Further intermediate information such as purchase order response and advanced shipping notification (ASN) could also be exchanged (optional), followed by goods issue by the supplier and the corresponding goods receipt by the buyer. The scenario is completed with the financial transaction triggered by the supplier's invoice and verification of the invoice by the buyer organization.

This describes the standard scenario, depicting the direct interactions between one buyer and one or more suppliers. In our explorative studies, we learned that a large amount of unstructured content such as graphical specifications, text documents etc. are exchanged alongside the transfer of heterogeneous structured business objects. Heterogeneity appears on the syntactic as well as on the semantic level. Complexity increases exponentially in procurement networks (Madlberger and Roztocki 2008) by involving cross-organizational (e.g., in multi-tier quality assurance in the automotive industry) and cross-border (e.g., foreign trade global risk and compliance) collaboration as well as by using unstructured interactions (e.g., business contact initialization, document collaboration, emails, instant messages and calls).



**Figure 2.  Quote-to-Invoice Procurement Scenario**
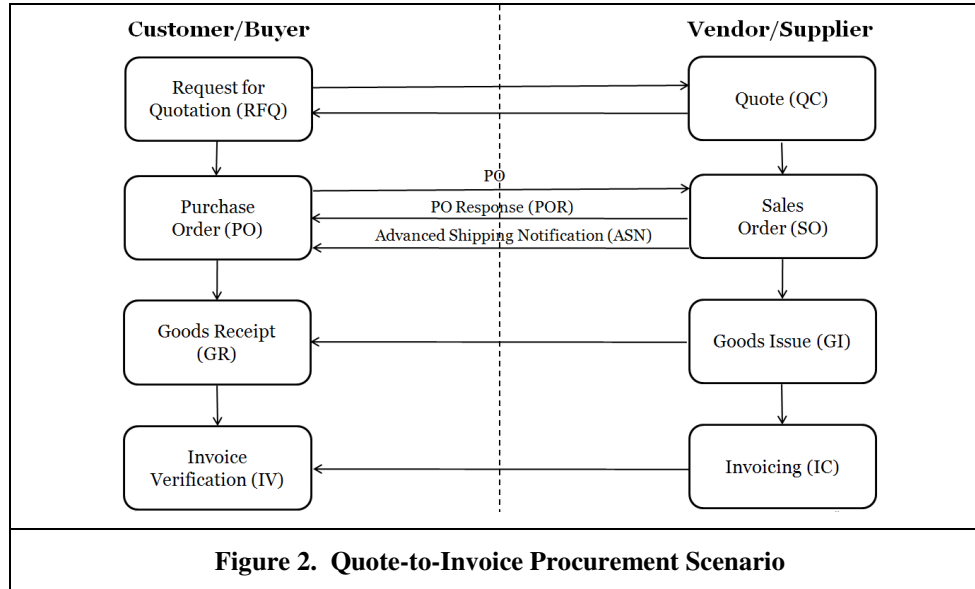
Our studies further detailed those challenges, namely that heterogeneous on-premise solutions behind firewalls which are connected via diverse and complex point-to-point connectivity infrastructures and protocols lead to high on-boarding and integration costs for all parties involved. Because of lacking self services to efficiently connect business users, it is also quite difficult to extend the network quickly and with sufficient collaboration qualities.

Heterogeneous and inflexible collaboration models lead to low transparency in terms of business performance and slow business opportunity adoption, especially in multi-tier supply chains. This is tied with

the issue of diverse collaboration tools from the intra-organizational and inter-organizational perspective, as well as from the people role/task perspective: disparate collaboration experience increases as the network and the people tasks are not constant, for example where a category manager who is in a buyer position in some use cases but in a supplier position in others, and is forced to switch collaboration tools when changing roles even though the business context remains the same.

Asynchronous data exchange is a key achievement for processing large data volumes and to increase fault tolerance, both of which are highly necessary for example in the retail, wholesale and trade industry. However, as the demand for actual transactional data for ex post analysis and ex ante simulations rises, synchronous data utilization is required, in particular in light of the increasing speed of supply chain execution in the global economy.

Interoperability with social networks is lacking at present, resulting in limited linkage between unstructured and structured interactions, and therefore between people networks and the procurement business context.

Making these findings operational for our design science project, we focused on increasing procurement network performance from 'quote to invoice', as a core procurement use case, applied in many organizations around the globe. The two main challenges above are therefore explicitly addressed along the business network procurement scenario, starting with quotations and concluding with the financial transactions. From our explorative studies, we condensed the following key requirements: i) holistic coverage of procurement process and avoidance of system disperse, ii) reduction of document exchange, iii) avoidance of information inconsistency, iv) very tight connection of structured and unstructured interactions, v) use of social networking elements (e.g., tweet, feed, connect features), vi) possibilities for easily adopting use cases and vii) a fast, flexible collaboration environment (e.g., project rooms, chat).

In our ideation activities to generate new innovation approaches, the abstraction of design principles out of these key requirements can be put into context to business reengineering (Hammer and Champy 1994) as we tried to fundamentally rethink and innovatively redesign current approaches, bearing in mind characteristics of reengineered cooperation according to Hammer and Champy (1994).

Through several iterations, the design principles have been derived by aggregation and abstraction where several key requirements supported multi-intermediate principles which have been further aggregated to the three preliminary design principles as listed in Table 2.

| Table 2. Design Principles | | |
|---|---|---|
| DP1 | Prevent document exchange between users and between systems | Primarily addressing key requirements: i), ii) and iii) |
| DP2 | Enable collaboration on networked/shared business object types (n-BO) | Primarily addressing key requirements: i), ii), iii) and vi) |
| DP3 | Ensure seamless interaction flow for end users between unstructured and structured content without losing business context | Primarily addressing key requirements: i), iii), iv), v), vi) and vii) |

According to design principle 1 (DP1), digital documents (e.g., structured business objects like orders, text documents like contract papers) should not be transferred anymore between systems and use case steps. Instead, they should be kept on the same platform.

Extending DP1, design principle 2 (DP2) supports networked business partners to collaborate on shared data of so called 'networked business objects' (n-BOs), which are instances of n-BO types. We derived five necessary n-BO types to efficiently support the use case: (1) *BUSINESS PARTNER*, which summarizes diverse persona and roles in business networks like category manager, buyer and sales manager. These could be natural or non-natural persons, e.g. organizations, plants, distribution centers, stores or departments. (2) *ITEM*, which describes all entities that could be the subject of collaboration in a business network like products, articles, material, stock keeping units (SKUs), services, investment goods, etc. (3) *ORDER* reflects the legally binding agreement of the business partner in the network. It also incorporates both traditional purchase or sales order and predecessor or successor states of a classical order, e.g. quote, delivery and invoice. We call the latter design feature 'object evolution'. Specific instances of an *ORDER* in networked procurement could also be a contract. (4) *PROJECT* defines activities, combining resources

and tasks along common business purpose, time lines and milestones. It also comprises programs that can be defined as a higher level projects, hierarchically linking multiple projects to a common business context. (5) *DOCUMENT* stands for all unstructured content like text documents, spreadsheets, presentations, technical specifications and so on, which the networked users could collaborate on.

Design principle 3 (DP3) enables navigation between unstructured and structured data and interaction without flaw, e.g. identify and qualify fast new contacts, interact efficiently with already connected business partner and combine unstructured interactions with structured business data avoiding media breaks.
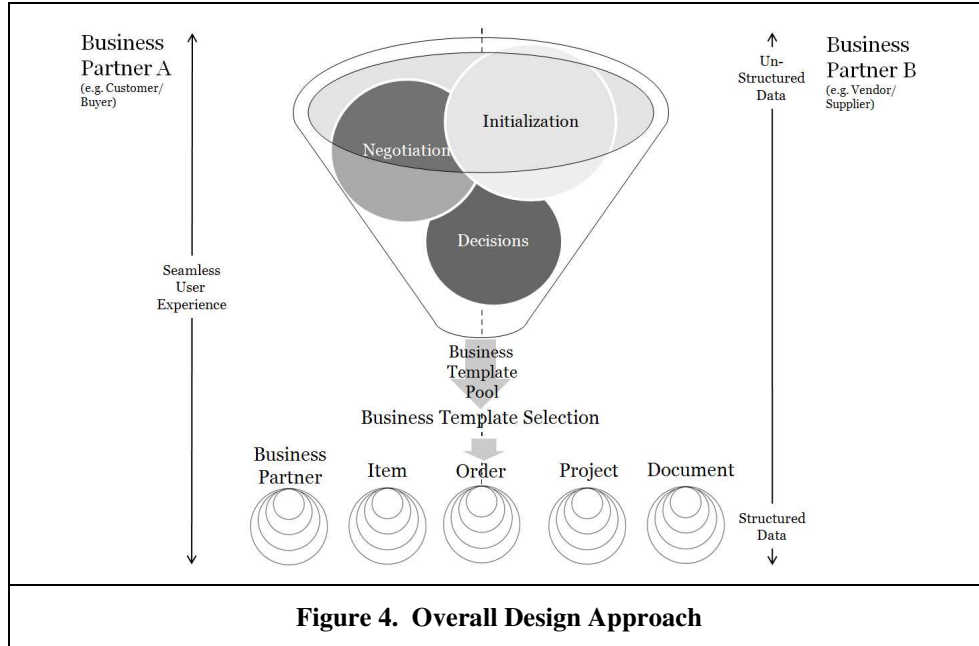
## *Design of the Artifact*

The design principles guided the artifact design decisions and have been fed into the research process for incremental refinement with each design cycle.

DP1 and DP2 institutionalize our newly introduced artifact design paradigm of 'networked Business Object Sharing (n-BOS)'. Along the procurement use case depicted in Figure 2, Figure 3 presents an example where the buying and supplying business partners collaborate on a networked business object instance of the type *ORDER* which, according to the specific use case, could evolve from a quote to an order, to goods issue/receipt and to invoice, also incorporating intermediate information like purchase order responses and advanced shipping notifications. This follows an object attributes and methods (including interfaces) evolution of the n-BO as the business relationship becomes more mature.



**Figure 3. Networked Business Object (n-BO) ORDER**
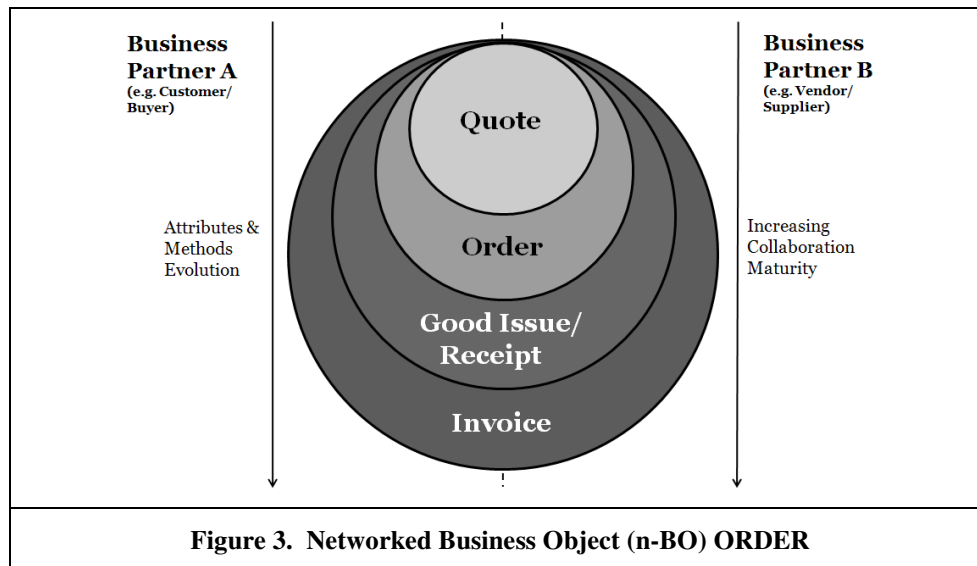
The overall design approach as illustrated in Figure 4. In the proposed procurement networked concept, customer (buyer) and vendor (supplier) are working on the same collaboration platform, share common structured and unstructured information and experience a similar seamless user interface, navigating between structured and unstructured context. The proposal follows a natural people interaction pattern, starting with contact initialization as well as sharing common user and optional company related information.

From there, the collaboration partners could move to a kind of high-level negotiation about what kind of business they intend to conduct and, finally, they could arrive at a decision about a concrete business use case, such as quotation, contract negotiation, order, a joint project or just exchanging further business data or documents about their companies, products, service offerings, opportunities etc. By moving to a joint business use case, both collaboration partners select one or more 'business templates' from a 'business template pool' to detail their business interaction. Business templates can be pre-defined (not modifiable), created by the network, extended by the network or from external sources like other partners in the network. Moving along the use case, the business relations become increasingly mature, moving for example from generic discussions to contract negotiations, placing orders, exchanging invoices and joint projects. The networked business objects would thus evolve accordingly.

**Figure 4. Overall Design Approach**

To design the user interaction flow and user interface of the artifact, we applied user-centered design methodologies, starting with persona descriptions and use case definitions (Garrett 2011). The 'category manager' persona for example describes a person who normally acts at both the buying and the selling site, being responsible end-to-end and across different use cases, like supply base and risk management, contract management, planning and forecasting as well as operational procurement and supply execution - therefore being accountable for the overall business performance of a certain set of products or services.

Relating to DP3 in particular, the research team made the design decision to utilize social network interaction patterns and controls for the overall user experience and interlinking both unstructured and structured interactions.

Following the design decisions outlined above, our research results in development activities for the procurement network artifact, called 'Business Zone (B-ZONE)'. The development was carried out in collaboration with the labs at SAP AG. Starting with the people-centered user interface (UI) design (Constantine 1999), including persona definitions and use case descriptions - the latter along the classical procurement scenario from quote to invoice - we added unstructured process steps on top, like supplier identification, communication and negotiation functionalities. From there we built draft screen sketches, also called 'wireframes' and visual designs which build the first tangible artifact.

In addition to the 'category manager' persona above, we introduce the 'sales representative', a typical persona in the networked procurement business environment, who is strongly driven by sales figures, and interacts with an extended network of customers and service providers to achieve her/his goals.

Figure 5 shows an example of a visual design, where the category manager is able to exchange the business template s/he wants to use for the particular use case in the middle business section of the screen. In this example, the category manager who wants to buy a certain quantity of IT equipment for two subsequent delivery dates, replaces the simple order template in the middle section with a more complex one by selecting the one with schedule lines from the right business template panel and dropping it to the middle section. On the left, the business log panel informs the category manager about the use case history and related people interactions.
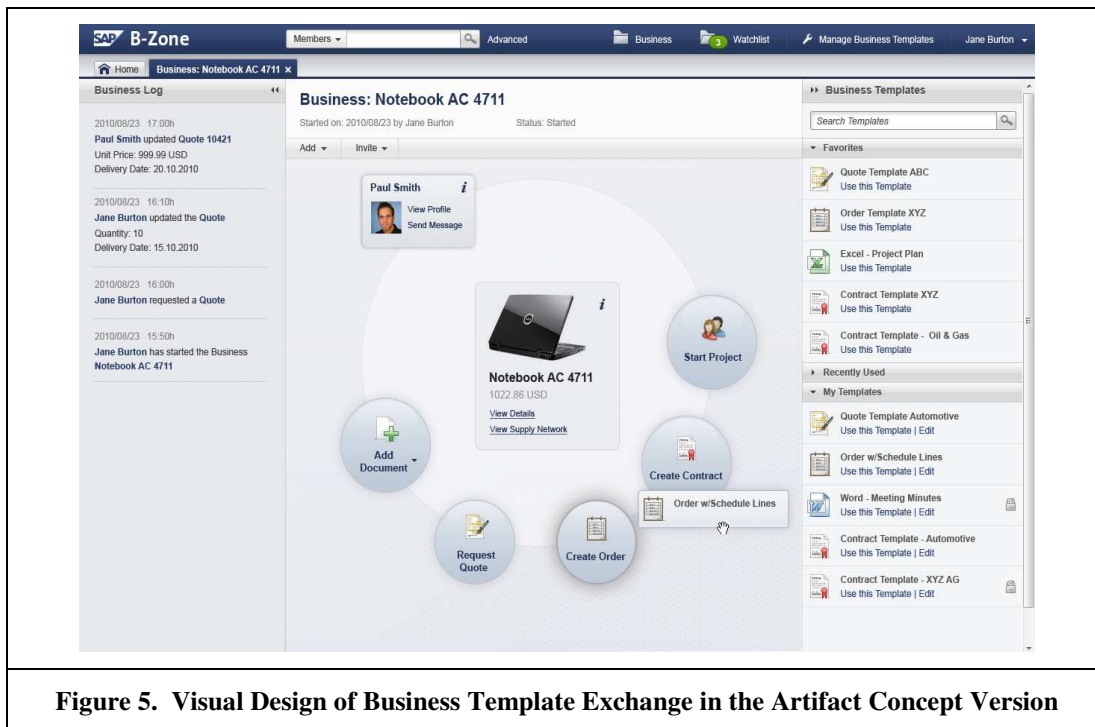
**Figure 5.  Visual Design of Business Template Exchange in the Artifact Concept Version**

The people-centric designs resulting from the iterative application in further qualitative research have been successively built into a working software artifact. This 'artifact concept version (ACV)' is functional throughout the defined use case but still restricted in terms of variations beyond the defined quote-to-invoice scenario. Collaboration, role simulation and innovative user controls are already available however. Consequently, the research team decided to use the ACV to conduct early in-depth qualitative research to prove feasibility and validity regarding user performance improvements in procurement networks.

## Empirical Evaluation of the Artifact

To do this, we conducted workshops in globally operating companies from the chemical and high-tech sector with 12 IT and procurement experts. In the pre-questionnaires, the participants were asked to name and prioritize three main problems occurring in the general procurement process and in procurement software they currently use to support their processes. The current main issues described by procurement experts with the highest rankings were missing automation, non-existing sourcing support, absence of software covering the entire procurement process, absence of a supplier lifecycle platform, and poor supplier integration.

We also wanted to know which procurement software is used in the chosen companies and saw a predominance of standard procurement software. It also became clear that external tools, subsystems, integration hubs, and in-house developments were deployed to meet the specific requirements of procurement departments.

To achieve a more targeted view on the design principles in the final section of the pre-questionnaire, we formulated six statements and asked for ranking by every participant on a five point Likert scale (1= do not agree to 5 = fully agree). The results are presented in Table 3.

While there was strong agreement with statements 1, 2 and 3 and partial agreement with 4, statement 5 and 6 were not accepted as important design principles for procurement software by the majority. Nevertheless some participants fully agreed with the last two statements, which produced to controversial results expressed in the high variance seen in Table 3. The high approval rate for the first three statements also motivated the need for software that covers the entire procurement process and supports networking possibilities with the supplier.

| | Table 3. Pre-Questionnaire Results related to Design Principle Statements | | |
|---|---|---|---|
| *Rank* | Statement | Mean | Variance |
| *1* | The software should include networking possibilities with suppliers. | 4.92 | 0.08 |
| *2* | The software should support a process starting with the initial contact up to relationship management after a transaction. | 4.58 | 0.63 |
| *3* | The software should support the quote-to-order process. | 4.50 | 0.45 |
| *4* | Manual document exchange should be avoided. | 3.67 | 1.88 |
| *5* | It should automatically inform me about changed prices of interesting products. | 2.82 | 1.76 |
| *6* | It should automatically inform me about interesting product offers. | 2.40 | 1.82 |

The workshop itself started with a 30-minutes introduction to the topic. The participants were then divided into groups of three persons, each person taking on a specific role: category manager (purchaser), sales representative (supplier), and cross functional observer (mainly an IT professional) as described above. The vendor and purchaser were given a detailed instruction manual to conduct the defined use case with the ACV and were assigned to separate work stations. The cross function person observed execution of the process without intervening. After completing this session, personal semi-structured interviews were conducted to evaluate the opinions of the participants.

The main categories from the interview analysis are: prevention of document exchanges, networked business objects, full procurement process coverage in one system, sourcing and social networks. We start detailing the results with the first two categories directly related to the design principles 1 respectively 2, followed by the remaining three categories, primarily related to design principle 3 but also supporting design principles 1 and 2.

**Prevention of document exchange**. An issue enabling potential performance benefits is document exchange. Currently lots of information is exchanged beside the system, as described by a procurement team leader:

*"At the moment, the way documents are exchanged is highly heterogeneous. This means that you are constantly switching from one medium to another. You might have an order from the standard procurement system for example, which is then sent on by fax. We then get the confirmation back as a hard copy and have to enter it in the system again manually."*

Based on DP1, the networked procurement approach prevents external document exchange and supports document consistency within the system. According to the interviewed procurement experts, expected effects would facilitate the daily work for example in ensuring harmonized data and thereby avoid misunderstandings caused by unsynchronized document versions. Further impacts on the procurement process were described by a purchasing manager:

*"Higher transparency, speed, quality, bringing greater clarity in terms of responsibility and assignments, [...] all of which further speeds up the process."*

Also mentioned were the reduced need for interfaces and the positive environmental effect achieved by supporting a paperless office. Resulting from the qualitative data analysis, Figure 6 shows the effects of the category document exchange prevention on the dependent variables (codes).



**Figure 6.  Category Prevention of Document Exchange**
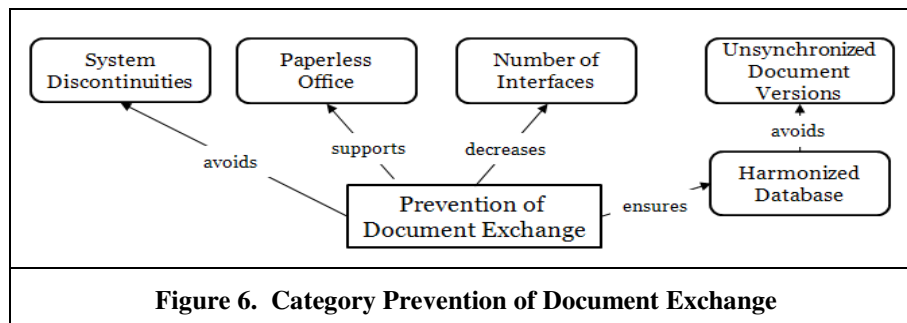
**Networked business objects**. Closely connected to the previous category is the n-BO approach described in DP2. According to the experts interviewed, n-BOs could help to avoid information redundancy, standardize the supplier collaboration and could lead to the creation of a more transparent procurement process across structured and unstructured interactions. A marketing purchasing specialist answered the question after expected effects of n-BO:

*"No system discontinuities, enhanced time-efficiency, you have transparent processes und can check the status at any time without jumping from one system to another. You have a consistent data base for everyone. These are the advantages I see."*

On the other hand, many participants mentioned potential legal difficulties of n-BO, for example in providing a legally binding signature for the invoice. Figure 7 shows the effects of the networked business objects category on the dependent variables (codes).

**Full procurement process coverage in one system**. A problem that was aired in the personal interviews was the lack of software covering the whole procurement process, resulting in a large number of interfaces, costly integration of external solutions, and the need for mapping tools. The following statement by one of the interviewees illustrates this requirement:

*"[…] there are still too many interfaces for certain areas. Supplier evaluation has its own development for example. We have a tender platform, and that has its own software too […]"*

This demand for a seamless interaction flow in one system was received to be supported by DP3, which also supports following category of sourcing.



**Figure 7.  Category Networked Business Objects**
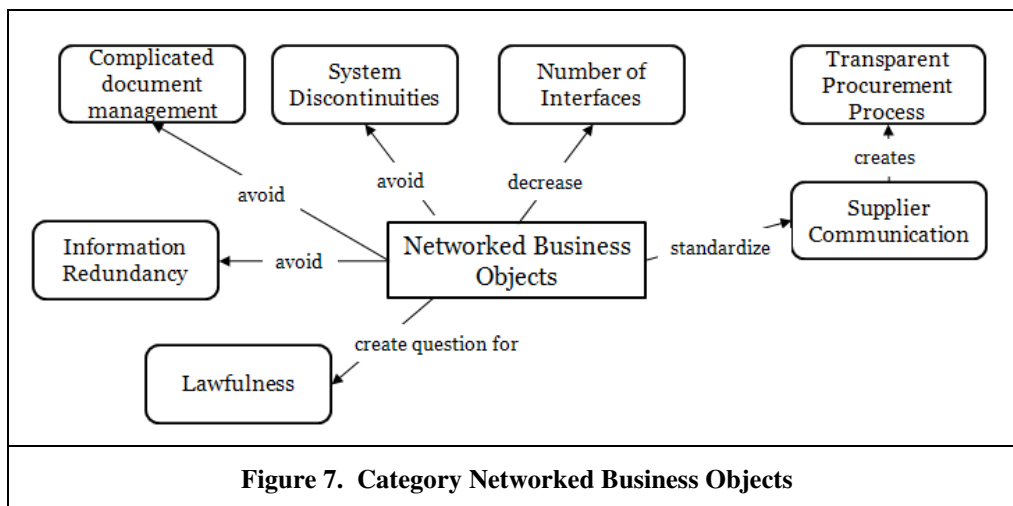
**Sourcing**. The process complexity of sourcing involving many different parties (e.g., buyers, suppliers, sub contractors, bidders) and use case variations imposes great challenges in terms of providing complete procurement process coverage by a single software solution, in particular for finding, qualifying, and continuously evaluating suppliers. All participants therefore described problems and time loss in the sourcing process caused by unstructured process steps with disparate data sources, particularly well illustrated in two quotations by procurement experts:

*"Currently, it's like this: When you are looking for a supplier, you have to go back to old contacts or official databases where you usually don't find what you need."*

*"[…] we have the utmost difficulties in the purchasing department with topic sourcing. We currently do not use any platform at all. [our company] does not have any established networks […]"*

This led to a strong desire for a structured sourcing platform as expressed by a head of purchasing marketing:

*"Ever since I started working here, I have seen the need to create a platform as an utmost priority."*

**Social networks**. The approach to address the above issues and to ensure the seamless interaction flow described in DP3 with social network components into the ACV was well received. For example, a team

leader responsible for the strategic supply of the procurement processes described the expected effects of our approach:

*"In our company I could imagine that networked procurement would significantly simplify the whole area of suppliers, registration and sourcing."*

The social network patterns can therefore act as a sourcing platform by providing a more efficient, accurate way of contacting and managing partners. At the same time, it can also support the subsequent process steps, as mentioned by the same team leader:

*"If I say though that I have a business network where I maintain contacts to suppliers [...], I can get a general overview significantly faster, can faster establish the contact and - depending on the supported functions of the network - can also simplify processes by carrying out order processes here and not in another system."*

Further improvements resulting from the use of social network components mentioned by participants are the possibility to communicate with the supplier using a chat function and the usability that is very similar to popular online networks. A purchasing strategy manager also specified a supplier lifecycle management that could easily be implemented into a network platform.

While younger participants in particular see social networks as essential to future procurement systems and welcome the personalization of the procurement process, older interviewees criticized the missing focus on the business process compliance. Many participants also considered the information overflow in a social network critical and emphasized the need for an effective filtering system. Concerns were also expressed regarding data security and privacy in social networks. In the words of one purchasing specialist:

*"The question of data protection is always a bit critical, and when personal data is exchanged, I am concerned that my data might go somewhere it shouldn't."*

From our qualitative data analysis, Figure 8 depicts the relation between the categories social network, sourcing and full procurement process coverage and their effects on the dependent variables (codes).



**Figure 8.  Categories Social Network, Sourcing and Full Procurement Process Coverage**
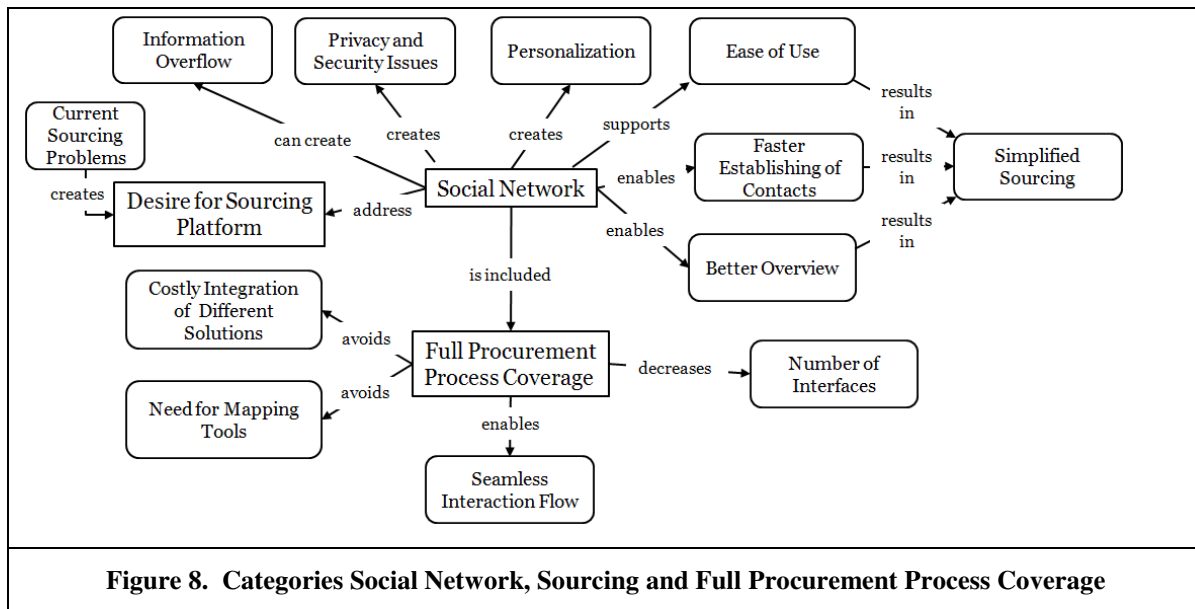
## Discussion of Results

Comparing the initial questionnaire-based pre-study with the results from our field workshops and interviews, we generally find a high degree of consistency between the study participants' perception of problems and challenges in the field and the envisioned merits of our artifacts. In particular, both highlighted similar issues in procurement and, thus, indicate the validity of the three defined design principles re-

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garding potential performance benefits. In particular, DP1 received greater support in comparison with the pre-questionnaire. Preventing document exchange between users and systems has been mentioned as a means to avoid system discontinuities, support paperless business transactions, reduce the number of necessary interfaces between systems and ensure a harmonized information base, which leads to the avoidance of unsynchronized document versions. All the dependent aspects have been named as key factors for performance increases.

Regarding DP2, collaboration on networked business objects, firm evidence has been found that DP2 helps to avoid information redundancy, complicated document management, system discontinuities, reduce the number of necessary interfaces and standardize the supplier collaboration, leading to a more transparent procurement process. Nevertheless the question of compliance with current financial and tax laws has been raised by no longer creating several documents for an ordering process and storing them in each involved on-premise procurement and supply system landscape. This general concern of transactional data in on-demand system landscapes needs further clarification, compliance investigation, and research. Further challenges have been mentioned by the procurement experts regarding the implementation of DP1 and DP2 in productive system environments. Despite interviewees agreeing in general with the benefits of the design principles DP1 and DP2, some expressed a need for extensive change management with this new approach.

The most significant indications from our research were found regarding DP3. The results revealed that the design decision for social network elements have been very well perceived as providing strong performance potential, especially in sourcing and addressing the need for full procurement process coverage. From the user-centered perspective in particular, the interviewees anticipated significant performance improvement by seamless navigation from unstructured activities, like contact initialization, communication, supplier qualification and on-boarding to activities around structured business objects like quotes and orders. They also confirmed the potential to comprehensively support their heterogeneous activities and extending responsibilities without being hindered by process breaks and defragmented system landscapes. In this respect, privacy and data protection played an important part in the interviews, especially challenges about who is allowed to access which personal data, including relationship data (not everyone should know who a person is in contact with), attrition issues in terms of who owns the relationship information when an employee leaves the company. The suggested three level privacy concept of public, group/team and business transaction (for instance one-on-one relations between buyer and supplier in concrete business transactions) has been quoted as sufficient in the first place.

## Limitations and Future Research

In order to be able to correctly assess the implications of our research, it is necessary to reflect our study's limitations. First, sampling of organizations to participate in our field studies was limited by the opportunity to gain access to the host company's specific knowledge and resources. Second, while results provide a first indication, a larger sample would help to better understand relevant contingencies. At present, we can only assess the artifact's usability, utility, and viability with respect to the two companies studied in phase 3. Also, the scenarios presented to the participating procurement professionals did abstract to certain extend from the daily context they conduct their work in. While thus losing contextual information, we feel that the degree of control this methodological choice gave us actually increases the comparability of the results. Third, as most of our analysis is based on qualitative data analysis approaches, the results are prone to a potential bias arising from the individual interpretation of data. To mitigate this challenge, all field studies were conducted with two investigators on site, coding was based on verbatim transliterations of interviews which was presented to the interviewees for approval and correction, and analysis of data and development of results was done iteratively in a discourse among the researchers conducted in meetings and workshops (Gibbert et al. 2008).

The implications of these aspects are twofold, meaning that they concern the theory as well as the artifact related results of our study. Concerning the former, the fact that we are limited to a convenience sample impact our study's generalizability beyond the immediate observations we have made. However, Lee and Baskerville (2003) have shown that this is a likely trait of all qualitative research. To mitigate this effect, we incorporate multiple stages into our research design and paid particular attention to enabling triangulation as discussed earlier. While we hope that these methodological provisions help us increase the validity and reliability of our study's theoretical contribution, the design process bears potential biases for the

resulting artifact. Beyond the fact that our artifact's DPs rest on the observations and analyses made with our sample, the close collaboration with a commercial software provider can impact the resulting artifact. To overcome this potential implications, design choices and development have been made together with external design firms and development staff, which are explicitly not part of the standard software engineering department. In addition to that, two of the authors became heavily involved in the development process to ensure genuine implementation of the DPs.

Notwithstanding the current quality of the artifact, future evaluation and artifact improvements in the next design cycles are certainly warranted and provide plentiful opportunities to extend or refine the research approach. As depicted in Figure 1, we intend to continue our action design research process towards a functionally enriched artifact prototype version (APV). While the research of the first three phases reported in this manuscript completes a first design research cycle (Hevner 2007), the next step will now bring along an enfolding of relevant theoretical literature based on the evaluation results from our field studies. Prospects for the theoretical enrichment of the artifact's design are the Actor-Network Theory (Sarker and Sidorova 2006) for the investigation of group/organizational performance as well as utility aspects like discussed in the research of Benbasat and Lim (1993). Moreover, we want to enhance the design principles, especially in the areas of privacy and security aspects. We will also extend the current use case with focus on advanced unstructured interactions steps, such as in the area of supplier identification, contact initialization, and supplier qualification activities. Obviously, the findings could be further investigated in terms of generalization potentials to other e-business domains like customer relationship management, supply chain collaboration, foreign trade and business intelligence.

## Summary and Conclusion

We have presented our design science research project focusing on the evaluation of design principles along a software artifact that addresses the two challenges of integration and high interoperability needs between structured and unstructured interactions. We look at these two challenges specifically in the domain of procurement, where the large number of connected business partners results in significant integration effort and involves an extensive number of unstructured activities. In our study, we find strong evidence that the design principles are having a positive impact on business performance of collaborative procurement networks. From the theoretical standpoint our research contributions are primarily in deeper understanding the of success-factors in procurement networks, the translation of requirements form a behavioral context (e.g., structured and unstructured data) into design principles and respective design decisions, informing the development of an artifact that helps overcome the challenges faced by procurement professionals in the field. Beyond the topical aspects of our paper, we hope to also contribute to the ongoing methodological discussion in the design science context. Relying on the action design framework suggested by Sein et al. (2011), we designed a multi-phased research project to develop a both viable and valuable artifact. For each of the phases, we suggest a methodological set-up, each contributing unique empirical insights and design recommendations towards a final version of the artifact. Potentially the methods we have chosen can inform other design researchers to develop their own approaches, supporting the construction of relevant artifacts. From the practical relevance perspective we perceive a timely issue and a high relevance for practice, to collaborate effectively through information systems in the global economy. Furthermore, the evidence that the design principles and decisions of networked business objects, the prevention of document exchange and the utilization of social network elements reflect success factors for networked procurement professionals and the empirical evaluation of the artifact also allow for a reflection on these success factors, thus bearing the potential to inform procurement research.

This evidence needs further research however. We therefore plan to extend our research program with additional phases along the action design process, further elaborating the proposed design principles with procurement professionals and subject-matter experts. A particularly apt illustration of what can be achieved was expressed by the chief procurement office of one of the firms, who stated that the anticipated effects of potential networked procurement software on process performance would be: "more efficient work, faster communication, higher document quality and standardized processes". While hoping that these perceived potentials will hold true for the finalized version of the artifact, we consider them encouraging indications with respect to the design principles viability.

# References

Anderson, J.C., Håkansson, H., and Johanson, J. 1994. "Dyadic Business Relationships within a Business Network Context," *The Journal of Marketing* (58:4), pp. 1-15.

Baars, H., and Kemper, H.-G., 2008. "Management Support with Structured and Unstructured Data - An Integrated Business Intelligence Framework," *Information Systems Management* (25:2), pp. 132-148.

Barua, A., Konana, P., Whinston, A. B., and Yin, F. 2004. "An Empirical Investigation of Net-Enabled Business Value," *MIS Quarterly* (28:4), pp. 585-620.

Baskerville, R.L. 1999. "Investigating Information Systems with Action Research," *Communications of the Association for Information Systems* (2:19), pp. 1-31.

Benbasat, I., and Lim, L. H. 1993. "The effects of group, task, context, and technology variables on the usefulness of group support systems: A meta-analysis of experimental studies," *Small Group Research* (24:4), pp. 430–462.

Blumberg, R., and Atre, S. 2003. "The Problem with Unstructured Data", *DM Review* (13:2), pp.42-49.

Brenner, W. and Wenger, R. 2007. "Anforderungen an Electronic Sourcing Systeme," in *Elektronische Beschaffung*, W. Brenner and R. Wenger (eds.), Berlin, Heidelberg: Springer Verlag, pp. 1-21.

Calisir, F. 2004. "The relation of interface usability characteristics, perceived usefulness, and perceived ease of use to end-user satisfaction with enterprise resource planning (ERP) systems," *Computers in Human Behavior* (20:4), pp. 505-515.

Camarinha-Matos, L. 2004. "Collaborative networked organizations: a research agenda for emerging business models," Boston: Kluwer Academic.

Camarinha-Matos, L. M., Afsarmanesh, H., Galeano, N., and Molina, A. 2009. "Collaborative networked organizations – Concepts and practice in manufacturing enterprises," *Computers & Industrial Engineering* (57:1), pp. 46-60.

Chang, G. 2008. "Analysis of supply chain procurement strategy in e-marketplace," in *Proceedings of the 7th World Congress on Intelligent Control and Automation*, June 25 - 27, 2008, Chongqing, China, pp. 6631-6635.

Checkland, P., and Holwell, S. 2007. "Action Research: Its Nature and Validity," *Information Systems Action Research,* N. Kock (ed.), New York, NY, USA: Springer, pp. 3-17.

Constantine, L. 1999. "Software for use: a practical guide to the models and methods of usage-centered design," Reading Mass.: Addison Wesley.

Corbin, J., and Strauss, A. 1990. "Grounded Theory Research: Procedures, Canons, and Evaluative Criteria," *Qualitative Sociology* (13:1), pp. 3-21.

Davenport, T.H. 1998. "Putting the enterprise into the enterprise system," *Harvard Business Review* (76:4), pp. 121-132.

Davila, A., Gupta, M., and Palmer, R. 2003. "Moving Procurement Systems to the Internet: the Adoption and Use of E-Procurement Technology Models," *European Management Journal* (21:1), pp.11-23.

Ellram, L. 1993. "Total Cost of Ownership: Elements and Implementation," *The Journal of Supply Chain Management* (29:4), pp. 2-11.

Fan, W., Wallace, L., Rich, S., and Zhang, Z. 2006. "Tapping the power of text mining", *Communications of the ACM* (49:9), pp. 76-82.

Flick, U. 2009. "Triangulation in der Qualitativen Forschung," in *Qualitative Forschung: Ein Handbuch*, U. Flick, E. von Kardorff and I. Steinke (eds.), Reinbek, Germany: Rowohlt, pp. 309-318.

Flick, U. 2010. "Triangulation," in *Handbuch Qualitative Forschung in der Psychologie*, G. Mey and K. Mruck (eds.), Wiesbaden, Germany: VS Verlag für Sozialwissenschaften, pp. 278-289.

Garrett, J., 2011. "The elements of user experience: user-centered design for the Web and beyond," 2nd edition, Berkeley CA: New Riders.

Gibbert, M., Ruigrok, W., and Wicki, B. 2008. "What Passes as a Rigorous Case Study?," *Strategic Management Journal* (29:13), December 2008, pp. 1465-1474.

Grey, W., Olavson, T., and Shi, D. 2005. "The role of e-marketplaces in relationship-based supply chains: A survey," *IBM SYSTEMS JOURNAL* (44:1), pp. 109-123.

Hammer, M., and Champy, J. 1994. "Reengineering the Corporation: A Manifesto for Business Revolution," New York, Harper Collins Publishers Inc.

Hevner, A.R., March, S. T., Park, J., and Ram, S. 2004. "Design Science in Information Systems Research," *MIS Quarterly* (28:1), pp. 75-105.

Hevner, A.R. 2007. "A Three Cycle View of Design Science Research," *Scandinavian Journal of Informa-tion Systems* (19:2), pp. 87-92.

Kuechler, B., and Vaishnavi, V. 2008. "On Theory Development in Design Science Research: Anatomy of a Research Project," *European Journal of Information Systems* (17:5), pp. 489-504.

Lau, F. 1999. "Toward a Framework for Action Research in Information Systems Studies," *Information Technology & People* (12:2), pp. 148 - 176.

Lee, A.S., and Baskerville, R.L. 2003. "Generalizing Generalizability in Information Systems Research," *Information Systems Research* (14:3), pp. 221-243.

Madlberger, M., and Roztocki, N. 2008. "Cross-Organizational and Cross-Border IS/IT Collaboration: A Literature Review," *14th Americas Conference on Information Systems (AMCIS)*.

March, S.T., and Smith, G.F. 1995. "Design and Natural Science Research on Information Technology," *Decision Support Systems* (15:4), pp. 251-266.

Matook, S., and Vessey, I. 2008. "Types of Business-to-Business E-Marketplaces: The Role of a Theory-Based, Domain-Specific Model," *Journal of Electronic Commerce Research* (9:4), pp. 260-279.

Mayring, P. 2001. "Combination and Integration of Qualitative and Quantitative Analysis," *Forum: Quali-tative Social Research* (2:1), pp. 1- 14.

Myers, M.D., and Newman, M. 2007. "The Qualitative Interview in IS Research: Examining the Craft," *Information and Organization* (17:1), pp. 2-26.

Myers, M. 2010. "Qualitative Research in Business & Management," (2. ed.), London, UK, et al.: Sage.

Mishra, A. N., Konana, P., and Barua, A. 2007. "Antecedents and Consequences of Internet Use in Pro-curement: An Empirical Investigation of U.S. Manufacturing Firms", *Information Systems Research* (18:1), pp. 103-120.

Moeller, S., Fassnacht, M., and Klose, S. 2006. "A Framework for Supplier Relationship Management (SRM)", *Journal of Business-to-Business Marketing* (13:4), pp. 69-94.

Oinas-Kukkonen, H., Lyytinen, K., and Yoo, Y. 2010. "Social Networks and Information Systems: Ongoing and Future Research Streams," *Journal of the Association for Information Systems* (11:2), Article 3.

Park, S., and Suresh, N. 2005: "An Investigation of the Roles of Electronic Marketplace in the Supply Chain," in *Proceedings of the 38th Hawaii International Conference on System Sciences.*

Rai, A., Patnayakuni, R., and Patnayakuni, N. 2006. "Firm Performance Impacts of Digitally Enabled Supply Chain Integration Capabilities," *MIS Quarterly* (30: 2), pp. 225-246.

Sarker, S., and Sidorova, A. 2006. "Understanding Business Process Change Failure: An Actor-Network Perspective," *Journal of Management Information Systems* (23:1), pp. 51-86.

Schmidt, C. 2003. "Analyse Von Leitfadeninterviews," in *Qualitative Forschung: Ein Handbuch*, U. Flick, E. von Kardorff and I. Steinke (eds.), Reinbeck, Germany: Rowohlt, pp. 447-456.

Schmidt, C. 1997. "Am Material: Auswertungstechniken Für Leitfadeninterviews," in *Handbuch Qualitative Forschungsmethoden in der Erziehungswissenschaft*, B. Friebertshäuser and A. Prengel (eds.), Weinheim & Munich, Germany: Juventa, pp. 544-568.

Schultze, U., and Avital, M. 2011. "Designing Interviews to Generate Rich Data for Information Systems Research," *Information and Organization* (21:1), January, pp. 1-16.

Sein, M. K., Henfridsson, O., Purao, S., Rossi, M., and Lindgren, R. 2011. "Action Design Research," *MIS Quarterly* (35:1), pp. 37-56.

Simon, H.A. 1996. "The Science of the Artificial," (3. ed.), Cambridge, MA, USA: The MIT Press.

Straub, D.W., RAI, A., and Klein, R. 2004. "Measuring Firm Performance at the Network Level: A Nomol-ogy of the Business Impact of Digital Supply Networks," *Journal of Management Information Sys-tems* (21:1), pp. 83-114.

Strauss, A.L., and Corbin, J.M. 1990. "Basics of Qualitative Research: Grounded Theory Procedures and Techniques," (1. ed.), Newbury Park, CA, USA: Sage.

Subramaniam, C. and Shaw, M.J. 2002. "A Study on the Value of B2B E-Commerce: The Case of Web-based Procurement," in *E-Business Management,* M. J. Shaw (ed.), Boston: Kluwer Academic Pub-lishers, pp. 439-461.

Swaminathan, J. M., and Tayur, S. R. 2003. "Models for Supply Chains in E-Business", *Management Science* (49:10), pp. 1387-1406.

Takeda, H., Veerkamp, P., Tomiyama, T., and Yoshikawam, H. 1990. "Modeling Design Processes," *AI Magazine*, pp. 37-48.

Tanner, C., Woelfle, R., Schubert, P., and Quade, M. 2008. "Current trends and Challenges in Electronic Procurement: An Empirical Study," *Electronic Markets* (18:1), pp. 6-18.

Tarn, J.M., D.C.Y., and Beaumont, M. 2002. "Exploring the rationales for ERP and SCM integration," *Industrial Management & Data Systems* (102:1), pp. 26-34.

Thomas, D.R. 2006. "A General Inductive Approach for Analyzing Qualitative Evaluation Data," *American Journal of Evaluation* (27:2), pp. 237-246.

Vaishnavi, V., 2008. "Design science research methods and patterns: innovating information and communication technology," Boca Raton: Auerbach Publications.