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Developing the Process Innovation Laboratory a new approach to Business Process Innovation

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ABSTRACT

Most organizations today are required not only to operate effective business processes but they are required to accommodate for changing business conditions at an increasing rate. Today nearly every business relies on their Enterprise Systems (ES) for process integration and future generations of ES will increasingly be driven by business process models. Consequently business process modeling and improvement are becoming a challenge. The aim of this paper is to establish a conceptual framework for business process innovation (BPI) in the supply chain based on advanced ES. The challenge is to create a new methodology for developing and exploring process models and applications.

The paper outlines the Π-Lab as a new approach to BPI. The Π-Lab is a comprehensive framework and a collaborative workspace for experimenting with process models. The Π-Lab facilitates innovation by using an integrated action learning approach to process modeling in a controlled environment.

Keywords

Process Innovation, Enterprise Systems, Design Science.

INTRODUCTION

Innovation is inevitable tied into technology. Modern Enterprise Systems (ES) from the major vendors such as SAP, Oracle and Microsoft contains vast amounts of new concept and tools, but let's face it: quite often these wonderful tools are used (and sometimes misused) to create trivial solutions. Why is that? Maybe because we as users and as organizations are not able to grasp the enormous complexity of the task of changing inter-organizational processes spanning global supply chains, numerous organizational boundaries and countless IT-systems.

This study is fueled by the idea that there is a huge potential contribution in using advanced ES to transform an organization and create a better alignment between business and processes. This is a practice that can be described as business process innovation (BPI). Davenport, Prusak and Wilson (2003) simplify the innovation process into four steps: 1) scanning and identifying ideas; 2) packaging the idea; 3) advocating the idea; and 4) making it happened. They come up with two extreme roles: the "guru" packagers and the creative "idea practitioners". This outlines a playground for an innovator as a mediator who transforms the big ideas into practice and makes it work.

Although innovation theories often emphasize the innovators role in the process Christensen, Anthony and Roth (2004), other takes a completely different stance. Michael Schrage argues that the innovative prototype create innovations, not the innovator (Schrage, 1999). His point is quite simple that the process of working (and playing) with the prototype models is more important than the design process. His work illustrates how leading enterprises master this modeling process and are able to transform the learning into innovative products on the market. His message is simple: you need to be able to model your ideas, play with the models and learn by doing (Schrage, 2004).

This paper present a study that was intended establish a conceptual framework for a new methodology for developing business processes in a supply chain based on advanced ES. The study concluded by developing the requirements for a process innovation laboratory or Π-Lab, as a new approach to BPI. The Π-Lab is using an integrated action learning approach to process modeling in a controlled environment.

First the background of process innovation is presented and the research method of the study is discussed. Then the comprehensive framework for BPI resulting from the study is outlined. Finally the methodology is embodied into a

demonstrator model and the development and validation of this tool is discussed. In the conclusion the paper discusses the research and the educational implication for this methodology.

THE EMERGENCE OF BUSINESS PROCESSES MANAGEMENT

Process Improvement (Davenport, 1992) is business-oriented of nature and consistently focused on hard facts and value. The first wave of process improvement used continuous improvement (kaizen) techniques to empower people to solve problems. This proved to be a very successful approach and today we see the lean movement which is based on this thinking with tools such as the 6-sigma and others.

Since the beginning of the 90'ies there has been an enormous focus on business processes and business processes as a source of innovation. This marks the second wave and the understanding was that the business processes were inhibited by organizational and cultural boundaries. Consequently techniques like Business Process Re-engineering (BPR) emerged using a clean slate approach was attempted and new IT was applied as a silver bullet (Hammer and Champy, 1991).

New IT was often embodied in the first generation ERP systems (or more general ES) and after the ES technology was widely adopted, new problems emerged. First of all the implementation issues were considerably but the most prominent problem were the acclaimed inflexibility of the ES (Davenport, 1998).

All together business models required processes to be integrated across the supply chain in order to accommodate for transparency demand, and the ES technology naturally is the major component in this architecture. Consequently the information technology has become a barrier for process improvement.

These issues are also addressed by the major ERP vendors that compete to provide the next-generation ES technology as well. Recently we have seen how they approached these challenges (Møller, 2005a), and we conclude that we are facing an emerging disruptive change that will allow for future ES to be driven by process models. This is also called process aware IS (Dumas, Aalst and Hofstede, 2005).

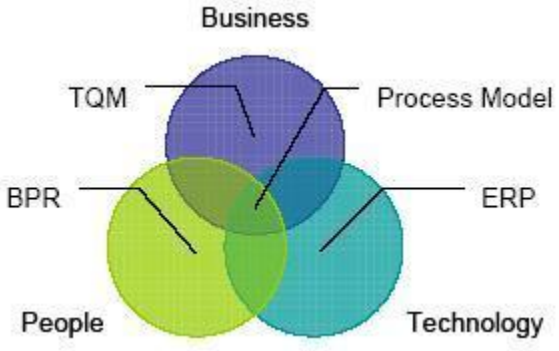

Figure 1. Integrated business processes models in context

Process models and enterprise modeling have been around for a while. E.g. several reference model architectures (ESPRIT Consortium AMICE, 1993; Scheer, 2000) have been developed aimed at one-of-a-kind enterprises requiring a high level of flexibility and agility, like shipyards and aerospace. Extended Enterprises and integration has been a major issue of industry and research, and here we use the concept of an integrated business process model to frame these enterprise models.

Meanwhile the trends and tendencies in logistics and supply chain management have reinforced the need for process integration leaving the supply chain scattered and distributed from globalization and outsourcing. Most important the need for customer driven supply chains requires new approaches to process integration across enterprises, and we use the concept of process innovation to frame these approaches.

Consequently, we need to explore and to understand the implications of this new situation and there are several research opportunities in this context.

Research method

This work is driven by the fundamental practical problem of aligning business with the new technology and the organization and people. But the study is not only driven by research questions but also a strong personal and institutional interest in exploring a particular solution based on the idea of having a laboratory for experimenting with process innovation.

An Integrated ES is a generalized class of IT systems, emerging from a new generation of ERP based systems (Møller, 2005a). Contemporary systems from the major vendors are increasingly being driven by process models. This dramatically changes the ability to align processes with business strategy, but more important, a new enterprise reference model driven architecture has enabled new business opportunities. These opportunities are often neglected based the methods available today. The practical perspective of this project is to contribute by enabling enterprises to leverage their existing and future IT investments by developing flexible effective business processes across their supply chain (Møller, 2005b).

Interdisciplinary approaches to integrated systems development that is based in conceptual modeling has previously been applied within supply chain management and logistics (Møller, 1995). The approach is not new, elements of the approach are found in many adjacent fields. This research takes the ideas to a new arena; integrated business processes development in a supply chain context and based on new advanced ES. The main contribution of this work is therefore to establish an integrated, consistent and comprehensive conceptual framework and to research the viability of the approach. Furthermore the study addresses the immense educational challenge of incorporating contemporary ES into the curriculum of business or engineering.

From an educational point of view there has been an ongoing debate about the use of IT and the role of ES in education. The argument has been made that the purpose of the business school is to teach students business rather than emphasizing the tool (Møller, Kræmmergaard and Rikhardsson, 2006). The Process Innovation Laboratory is an initiative aimed at addressing this challenge, and a step towards a more effective use of ES in the classroom.

The research we embark on is based on engineering and computer science and it is called design science. This study uses Design Research in Information Systems in an emerging "lens" or set of analytical techniques and perspectives complementing the positivistic and interpretive perspective in IS (Hevener, March and Park, 2004; Vaishnavi and Kuechler, 2004/5). The design research involves the analysis of the use and performance of designed artifacts to understand, explain and very frequent to improve on the behavior of aspects of Information Systems.

Vaishnavi and Kuechler (2004/5) explain the research process using a model that illustrates the design research cycle starting with awareness of a problem, suggestion, development and evaluation. This model also illustrates the difference in logical formalism starting with abduction in the beginning and ending with deduction.

The first part of this work is clearly based on problem awareness, which is the need for process innovation. The later parts of this work will the based on deduction and the two important feedback knowledge flows of design research suggest how development and evaluation may be used to learn from the research and inform on the problem at hand.

Output	*Process Innovation Laboratory*	*Description*
Constructs	Experimental learning Conceptual Modeling Theoretical framework	The conceptual vocabulary of a domain
Models	Framework for Business Process Innovation	A set of propositions or statements expressing relationships between constructs
Methods	Integration Mediation	A set of steps used to perform a task – how-to knowledge
Instantiations	Π-Lab	The operationalization of constructs, models and methods
Better theories	Process Innovation	Artifact construction as analogous to experimental science

Table 1 the research outputs from this study using a design research lens

March and Smith (1995) discusses design science in relation to natural science and proposes four distinct outputs from design research: constructs models, methods and instantiations. In the following table the outputs from this project will be related to their model.

So to conclude the discussion on research approach, an important step now is to plan the further research process and to specify the expected output. Not necessarily to come up with a complete implementation and test of every aspect of the, but an attempt to achieve the best possible quality given the constraints.

In this context this means to develop a demonstrator model that is testable in relation to the hypothesis: Innovation mediation is a methodology for BPI in a supply chain based on new advanced ES technology and the Π-Lab is a tool to support this process.

The conceptual framework of the Π-Lab is formulated so broad that it is necessary to reduce the scope of the first prototype development efforts. Therefore the demonstrator models will be delimited to what it is possible to validate.

A FRAMEWORK FOR BPI

The central research question is first how to establish a methodology for BPI in a supply chain based on new advanced ES technology?

The pivotal point of this methodology is based on the idea that the future systems are model driven. Consequently there are two ways the integrated models may be studied: 1) "in-vivo" that is embedded in the organizational and business context; or 2) "in-vitro", that is in a controlled environment or in a laboratory.

The relationship between a business process and the organizational context is widely debated. This work aims at leveraging on the idea of an integrated business processes as an identifiable concrete model represented in an ES, and applied in practice in a supply chain.

Consequently it, the research tasks are narrowed down to the need to create: 1) A method to innovate business processes; and 2) a tool to facilitating BPI in a controlled environment. The tool is framed as the process innovation laboratory and the method is outlined as innovation mediation to be explained in the following sections.

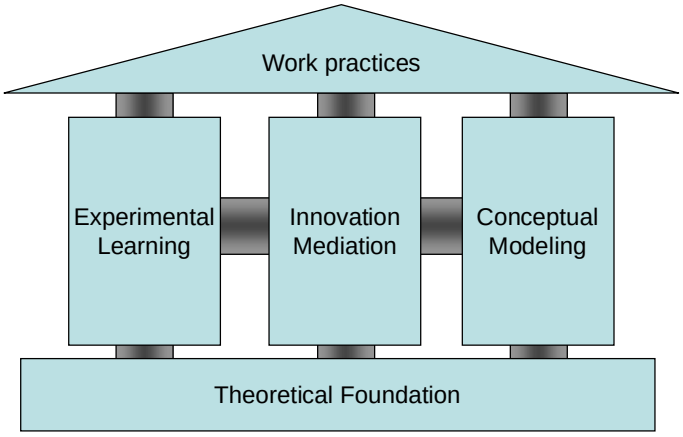

Figure 2. BPI framework

The BPI framework in figure 2 illustrates the five central elements of BPI based on innovation mediation. Innovation mediation is a method to develop integrated process models in a (1) process innovation laboratory using based on (2) the theoretical framework for process innovation. Models are established in a controlled environment using two principles: (3) conceptual modeling and (4) experimental learning. This is assumed to lead to (5) the process innovation. These elements are elaborated in the following.

Innovation Mediation

The central idea in this work is the process innovation laboratory, or the Π-Lab and the innovation mediation as a modeling method for an individual or a group of modelers

Innovation mediation is an explorative approach to study integrated business process modeling in a controlled environment embodied in the process innovation laboratory. The process innovation laboratory is a collaborative workspace for experimenting with process models. Π-Lab is a comprehensive framework for studying, for teaching and for learning practical problem solving and system design using integrated process models.

The Π-Lab facilitates innovation by using an integrated action learning approach to process modeling. We can distinguish between "in-vivo models" which means "live model" or "in-vitro models" which means models in a controlled environment. In an area where models are more significant and established, the notion of a laboratory is often central to experiment with

"in-vitro" models. In business and in particular with in a supply chain context, a laboratory is less familiar. The models we are interested in are architectural concept type of models with many aspects and the representation is close related to new IT and finally, the models spans organizational boundaries.

Theoretical foundation

The theoretical foundation for BPI is quite diverse and broad. Having narrowed the context to BPI in supply chains based on ES establishes the integrated business process as a focal point for the theoretical foundation. Here we have identified four overlapping and complementary perspectives.

The fundamental theoretical lens is the systems perspective on the business process, i.e. the business process as a work system (Alter, 2006) and business process modeling as system development process. The system development perspective is constraint by the ES and supply chains perspectives as we have discussed earlier.

The model architect is provided with access the central references, either physically or electronically. Many of the selected references are of general nature and they have been selected due to their format or supplementary contents.

System Development

System Development and in particular IS development is well-known and mature perspective. This perspective is mainly focused on software developing which is not the main issue here. However, this perspective can inform the model architect about modeling in an organizational context. This field is very rich, and in the table below, a small sample of topics and references are presented.

Sample topics and issues	Modeling Software Engineering Soft Systems Development Simulation tools
Selected references	Systems Modeling Theory and Practice (Pidd, 2004) Soft Systems Methodology in Action (Checkland & Scholes, 1999) Business Process Modeling, Simulation and Design (Laguna & Marklund, 2004) Essential Business Process Modeling (Havey, 2005)

Table 2 the Systems Development perspective (abridged)

ES are the technical and the organizational context for integrated process development. The ES and the process models are the new components of an information system. The ES has also changed from static systems towards a new generation of ES driven by process models. It is equally important to understand the old architecture as the new architecture of the systems. We need to consider the vendors, how they relate and the adoption of new technologies as well.

Sample topics and issues	ERP, ERP/II and other concepts ES Vendors Enabling technologies Technology Diffusion
Selected references	Process-Aware Information Systems: Bridging People and Software Through Process Technology (Dumas, Aalst, & Hofstede, 2005) Second-Wave Enterprise Resource Planning Systems Implementing for Effectiveness (Shanks, Seddon, & Willcocks, 2003) Concepts in Enterprise Resource Planning (Monk & Wagner, 2006) Enterprise Resource Planning (Sumner, 2005)

Table 3 the ES perspective (abridged)

The supply chain is the business and organizational context for integrated process development. The arena for process innovation has changed from the internal processes towards the external processes in the supply chain. This has many

implications, including the fact that the roles of the information systems are becoming more prominent. Many of the modern inter-organizational issues are only touched upon to some extend, and they need to be provided using various cases.

Sample topics and issues	Inter-organization Coordination and integration Reference and best practice
Selected references	Logistics & Supply Chain Management: creating value-adding networks, 3/E (Christopher, 2005) Designing and Managing the Supply Chain (Simchi-Levi, Kaminsky, & Simchi-Levi, 2003) Supply Chain Management, 2/e (Chopra & Meindl, 2004) Supply Chain Excellence - A Handbook for Dramatic Improvement Using the SCOR Model (Bolstorff & Rosenbaum, 2003)

Table 4 the Supply Chain perspective (abridged)

The Business Processes block represent is the business and the technical context of the Π-Lab domain. There is a emerging process modeling community based on mainly process model standards and workflow systems. Today the workflow community is very engaged into standards, general models and modeling and design techniques.

Sample topics and issues	Process Models Process Standards Diffusion of standards Design Patterns
Selected references	Operations and Process Management: Principles and Practice for Strategic Impact (Slack, Chambers, Johnston, & Betts, 2006) Organizing Business Knowledge: The MIT Process Handbook (Malone, Crowston, & Herman, 2003) Business Process Management: Strategic Integration in a Web-Enabled Environment (May, 2003) Workflow-based Process Controlling: Foundation, Design, and Application of Workflow-driven Process Information Systems (Muehlen, 2004) Redesigning Enterprise Processes for e-Business (Sawy, 2001)

Table 5 the Business Process perspective (abridged)

The perspective listed above should not be taken as a definitive and exhaustive list. Many more adjacent theories, tools and techniques should be added in order to establish a comprehensive framework.

Experimental Learning

Innovation mediation and modeling is mainly about gaining insight. A central idea to explore is the idea of integrated action learning. Innovation means getting new ideas, and consequently BPI need to be based on generating new knowledge on the process models. Therefore we apply a learning perspective on modeling. The ideas are often framed by Kolb's models on experiential learning (Kolb, 1984). Kolb's model explains learning as a circle with four elements: concrete experience, reflective observations, abstract conceptualization and active experimentation and testing in new situations.

David A. Kolb's model of experiential learning can be found in many discussions of the theory and practice of adult education, informal education and lifelong learning, and it has been criticized and debated. In this framework the activities are taken as a checklist for activities leading to learning. Consequently innovation mediation needs to include:

- Intervention: Planning and executing test on the models
- Experience: Observation of result of the interventions
- Reflection: Explain deviations from expected results.
- Conceptualization: Make the experiences general

The implication of this model is also that an isolated activity such as applying a solution or to study general theories is not sufficient for innovation. Rather every stage in the circle needs to be visited repetitive in a continuous process. This learning cycle is exactly the same process as the one involved in carrying out experimental work and therefore the analogy to the process innovation laboratory can be made.

The theory of learning is often connected to the action research paradigm, Here we will assume that with the inclusion of many different perspectives to a certain extend can emulate aspects of reality.

Sample topics and issues	Action Learning Experimental Learning Learning Styles
Selected references	Toward an applied theory of experiential learning (Kolb & Fry, 1975) The Theory & Practice of Learning, Routeledge (Jarvis, Holford, & Griffin, 2003). The reflective practitioner: how professionals think in action (Schoen, 1983) Reflective Systems Development (Mathiassen, 1998)

Table 6 the Experimental learning (abridged)

Conceptual Modeling

The complementary idea to learning is the idea of conceptual modeling or modeling in the large. Conceptual modeling is an overall approach to developing complex systems in a holistic organizational context. Conceptual modeling integrates Concepts and concept modeling develops links from detailed aspect models to overall holistic models and links from the current situation to the future situation. Concept modeling can also be understood in a learning perspective and the effect is based on sharing mental

At the Center for Industrial Production at Aalborg University there has been several projects based on conceptual modeling. An experimental laboratory for systems design has also been established there. This laboratory is an instance of such a laboratory.
Other areas dealing with complex systems outside industrial engineering has approached the complexity in various ways. In architecture patterns has been successfully applied as overall abstraction of designs.

Sample topics and issues	Concept Development System Architecture Design Patterns Enterprise Modeling
Selected references	Logistics Concept Development – Towards a theory for designing effective systems (Moller, 1995) The Work System Method: Connecting People, Processes, and IT for Business Results (Alter, 2006) New Concepts in Complexity: Arising from studies in the fields of architecture (Alexander, 2003) A framework for information systems architecture (Zachman, 1999) Creating a strategic IT architecture completely: Learning in stages (Ross, 2003)

Table 7 Conceptual Modeling

Patterns were originally conceived by Christopher Alexander (Alexander, 2003), A Berkeley Professor of Architecture with a background in mathematics, physics and chemistry. Alexander's work is based on the idea that nature is organized into a limited number of structures which repeats itself. He describes architectures using fifteen properties. To understand and to describe these repeating structures is a new way of generalizing design knowledge that is labeled patterns. A pattern language is just a precise way of describing someone's experience.

These ideas has spread to the object oriented development world, were patterns is used as an abstraction of a solution in a given context. Recently patterns lead to the development of a catalogue of processes (Malone, Crowston and Herman, 2003).

The pattern is a reference design and the idea of reference models has cached on in several modeling related areas, such as enterprise modeling, information systems architecture (Zachman, 1999).

In this context a pattern is expressed as: the issues concerning a solution to a problem in a certain context. Examples of models that may be considered patterns are: SCOR/CPFR models, SAP/ARIS reference models, (Scheer, 2000) or oracle accelerators, Process Handbook (Malone, Crowston and herman, 2003) or the CIMOSA Enterprise Architectures (ESPRIT Consortium AMICE, 1993).

In summary, we assume that these methods and techniques all share the same fundamental approach to the design of complex system based on systems thinking. This approach has several notions such as architecture, modeling in the large, or concept development, etc. In this context the approach is referred to as: Conceptual Modeling.

Summary of the BPI methodology

The elements of the framework for BPI have now been described. The framework summarizes the theoretical contributions and justifications on which the methodology for BPI is developed. Below is an overall explanation of the relations between the elements:

- Starting with the exiting ideas on supply chains, ES, business processes and system development (theoretical foundation)
- Design a set of conceptual models of the situation representing many conflicting perspectives (pack the ideas into patterns)
- Use an experimental learning approach to develop the conceptual process models (apply the patterns)
- Test the ideas (play), reformulate, learn, advocate the solution and make the change happen (practice)

This methodology is here defined as innovation mediation. The validity of this model is purely based on theoretical evidence; however it is necessary to provide a deeper test of these ideas. The model will be explored by developing a tool to support the innovation mediation process and an application of the tool and model is currently being tested in a new MBA course.

PROCESS INNOVATION LABORATORY

The process innovation puts much emphasis on the creative, experimental and action learning aspects of integrated process design. Therefore it is reasonable to deploy the metaphor of a laboratory to the system supporting the BPI methodology. A laboratory (often abbreviated lab) is a workplace where scientific research and experiments are conducted, according to the "wikipedia". Any building or part of a building used, or intended to be used, for scientific or technical work which may be hazardous, including research, quality control, testing, teaching or analysis. The lab thus is a controlled environment for conducting "in-vitro" experiments.

The Π-Lab and innovation mediation at this stage is an idea and a new concept. Therefore a hypothesis can now be made: Innovation mediation is a methodology for BPI in a supply chain based on new advanced ES technology and the Π-Lab is a tool to support this process.

An enterprise is due to make a change in their supply chain processes due to a large reorganization. This requires a change in their ERP system. After an ERP implementation period of three years the people who drove the implementation process is no longer in the company and the people responsible for the system are simply afraid and they do not dare to open Pandora's Box again. Sometime these requests are mandatory and cannot be ignored, like e.g. The Sarbanes Oxley act. Then a team of operations and IT peoples are given the responsibility for developing the system based on the organizational requirements.

The second case is when we teach students for ES: Take 20 student, put them in room with 20 computers, then have them follow a set of "cookbook" instructions. What we get is student who complains about technical issues and has no deep learning. And what is the alternative? To have students become PowerPoint experts with no hands on experience? Rather we want to have students learning to solve business problems using the ES technology.

In these two cases innovation mediation should be considered and the Π-Lab is a tool to support this process. Then what kind of tool is the Π-Lab?

The Π-Lab tool

Lego MindStorms is an example of a tool and playground that encourages people to defy the complexity of understanding the dynamics of control systems by encapsulating the design process into big blocks and small blocks. Why should this not be possible with Business Processes?

The prototype is build on top of a existing system. There are numerous content management and groupware systems around. The Π-Lab shares the properties of a specialized groupware category called learning management system. These systems have been deployed at many Universities as the preferred teaching infrastructure. There are several commercial systems but based on the requirement that the system must be flexible and that it is possible to extend on the functionality the Open Source Software (OSS) community is consulted and a solution is found.

Developed by an extremely active open source community, Moodle is a sophisticated course management system that's ideal for creating dynamic online learning communities and for supplementing face-to-face learning. The prototype includes three modules:

The roadmap is the central element in the process innovation lab. A roadmap is a guide and provides guidelines for process innovation. The process innovation guide provides the users with a structure methodology to solve problems based on the theory, models and recommends methods tools and techniques for process innovation. In this alpha release the only the standard Moodle features like workshops, forums, chats and choices. The first guidelines are however simple checklists.

The toolbox provides access and overview of the models in the Moodle model database. As soon as the advanced meta-information of the models is provided, the toolbox will be elaborated extensively. In this alpha release the following models are provided: ARIS, Microsoft Biztalk, Rockwell Arena and Visual Studio.

The sandbox is the test-bed where theoretical concepts and models can be executed in a controlled in-vitro environment. In this alpha release the sandbox is implemented using a simple virtual machine. The ideal would have been to find an Open Source Software virtual machine but unfortunately the maturity of these systems is up to ES. Rather a Microsoft product is used: Virtual PC 2004. This is included in the MSDN Academic Alliance library and it is also available as 90 days trial version.

Conclusions

This paper has now established a conceptual framework for BPI in the supply chain based on advanced ES. The paper has further outlined a new methodology for developing and exploring process models and applications.

This paper has document the meta-process of developing these ideas for BPI. We have summarized the issues, the models and outlined the development approach. The primary result from this paper has been to establish a documented model in order to discuss and to disseminate the study so far.

Major part of these ideas is presently being validated during an experimental course on process innovation and ES for MBA students. The lessons learned are expected to lead to a new and improved demonstrator model around summer 2006.

The study used design science as a methodological framework. The paper presents the process as a structured top down process, but the real process has been an explorative learning process. A mock up of the software is running along with an initial Π-Lab demonstrator model and many non feasible models have been attempted. The work exceeded the initial duration estimates in the research proposal. However major part of the future work has already been established and prototype development is also initiated.

There are many perspectives and implications of this work, both from a research and a practical perspective. There is a significant body of knowledge on various aspect of process innovation, e.g. on conceptual modeling, business processes, supply chains and ES. Still an overall comprehensive and consistent theoretical framework with guidelines for practical applications has not been identified.

The main educational implication is perhaps a critique of the present ES teaching methods. There is a growing need to incorporate the impact of new emerging technologies, like the RFID, on the supply chain and subsequently how the ES can be used to leverage these opportunities. The process model may be an approach and consequently BPI is an emergent discipline.

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