IT Support for Business Process Innovation –
Architectural Choices and Design Challenges

Matthias Voigt  Kevin Ortbach  Ralf Plattfaut  Björn Niehaves
University of Münster, European Research Center for Information Systems (ERCIS)
{matthias.voigt | kevin.ortbach | ralf.plattfaut | bjoern.niehaves}@ercis.uni-muenster.de

Abstract

For many organizations, business process innovation (BPI) is a crucial factor to ensure competitiveness. BPI can be characterized as a dynamic capability, since it facilitates change in operational processes. Moreover, it involves creative activity, since new and purposeful business processes are created. In this context, choosing and implementing IT tools that are supportive to these two specifics of process innovation can be considered a key success factor for organizations. However, both characteristics lead to challenges concerning the design of a socio-technical system. Companies have to be aware of those challenges in order to make an informed decision on system design. In this paper, we derive and consolidate characteristics of the innovation process. We identify two major properties – 1) task heterogeneity and 2) collaborativeness – and derive key design challenges on both technical and organizational level that these properties pose for the development of either distributed or monolithic process innovation systems.

1. Motivation

Business process innovation (BPI) capabilities are crucial to ensure competitiveness. Today, both public and private sector organizations face the need to constantly change their business processes. On the one hand, they need to adapt existing processes [1,2]. Advances in information technology (IT) and changing customer demands both drive and require process innovation. On the other hand, rapid developments in the technology or market environment render existing processes obsolete and, thus, require the development of entirely new ones [1,3]. Organizations that want to offer the same quick reaction on invoices as competitors have to introduce new processes to be able to use this new technology. These examples of incremental as well as radical change bring to light that organizations need the capabilities to constantly innovate their processes in order to stay competitive. In this context process innovation is about adapting existing processes to the ever-changing environment and creating new processes as a reaction to environmental changes and can thus be understood as a dynamic capability [4]. Furthermore, especially in the early phases of the innovation process, creativity is required to generate novel and useful ideas as predecessor for successful process introductions into practice [5].

To support process innovation, a suitable IT infrastructure in general has been identified as one key success factor [6,7]. We specifically focus on IT support for activities in process innovation that are concerned with artifact design, i.e. design of new or improved process and the design of plans to put them into action [8]. In turn, the enactment of those processes and plans in the organization is out of scope. However, the design of BPI-supporting IT infrastructure is yet an under-researched and under-theorized field. Extant research on process innovation technologies has focused on systems for single tasks, mostly on the process modeling aspect. However, a thorough understanding of the IT artifacts supporting process innovation, especially with regards of their implementation in a socio-technical system of IT and organization is missing. In order to cope with the extant gap in the (IS) literature, this paper addresses the following research question:

What are challenges when designing a socio-technical system for process innovation?

The identification of these design challenges is a beneficial pre-step in design science research. Based on these design challenges design scientists can identify corresponding design choices and choose accordingly. In order to address the research question, the remainder of this paper is structured as follows: In the next section (two) we will give a short overview of related work on both process innovation and IT architectures in this area. Within section three, we present the methodology of our study. In section four, we derive characteristics of the innovation process, by means of a literature analysis based on both dynamic capability and creativity theory. Moreover, we aggregate our findings to come up with two key properties of process innovation. In section five we...
analyze computer science and information systems literature in order to derive challenges for the design of a socio-technical system for process innovation. Furthermore, we discuss these challenges using two exemplary scenarios. We conclude our paper with a short discussion of the implications and limitations of our research (section six).

2. Related Work

2.1. Process Innovation

Process innovation initially has been associated with business process reengineering (BPR) [9]. This management philosophy incorporated a revolutionary attitude to redesigning both the organization and its processes in a one-time undertaking. However, especially this radicalness has been quickly criticized by empirical research and countered with a more incremental approach. Today, there is a wide recognition in literature, that process innovation has to incorporate both incremental and radical aspects [10]: “both incremental change and radical change can be viewed as parts of the continuous improvement efforts in organizations [11, p. 24]”. Thus, process innovation can be seen as an integral part of other concepts and methodologies such as BPR, business process management (BPM), or total quality management (TQM) [1,3]. These three concepts can be seen as describing a continuum of process change, starting from revolutionary one-time undertakings and ending at incremental continuous change. This continuum poses challenges for a socio-technical system for process innovation.

2.2. IT Architecture for Process Innovation

IT artifacts are used to support BPI. IT is not only a major driver for process innovation (e.g. the introduction of a new ERP or CRM system), it also plays a crucial role in conducting related projects. IT systems applied to support process innovation include e.g. modeling tools [12], flexible workflow management systems [13], or generally adaptive process-aware information systems [14]. These different technologies are used to support the engineering of process innovation in one way or another, e.g. in terms of idea generation or problem recognition, solution development and modeling, or process introduction and organizational transformation. Here, especially the provision of a suitable IT infrastructure to react to changing business requirements has been a key concern among IS and business executives for quite some time [15]. While the organization needs the right set of skills and capabilities for process innovation, IT can lever process innovation capabilities to a new level. IT can also figure as a constraining factor inhibiting successful development of new or changing of existing processes [16]. Thus, organizations need to carefully think about their particular process innovation IT infrastructure. One important aspect is to consider the level of application distribution. The set of functions employed for process innovation can be implemented in different architectural settings. Generally, monolithic and distributed architectures are distinguished [17]. We define distributed applications as a set of non-integrated special purpose tools (e.g. for brainstorming, file sharing, task management, process modeling), each possibly based on different technologies (e.g. programming language and frameworks, deployment technologies), and stemming from diverse software manufacturers. Those applications are most prominently web-based applications or mobile apps for tablets and smartphones. In contrast, we see monolithic applications as consisting of an integrated set of comparably homogeneous tools (e.g. production planning, production control, warehouse management), based on the same technological platform, and provided by a single software manufacturer. Recently, there have been efforts to move “to a more modular approach in which monolithic applications are broken apart into a component-based architecture [18, p. 14]”. For process innovation, this would imply that an organization uses different tools connected via interfaces or middleware, e.g. for brainstorming, business casing, process modeling, and process implementation. However, using this approach of distributed applications is beset with certain issues as well [19]. Thus, the design challenges have to be discussed with regards to both monolithic and distributed applications.

3. Research Paradigm and Methodology

We position our work in the field of design-science research in IS [20]. More specifically, we aim to contribute to the field of design theory construction [21,22]. From the outset of two major kernel theories (dynamic capability theory and creativity theory), design challenges are identified and exemplified in two scenarios. Thus, on the one hand, we contribute to the development of an IS design theory for a system that supports process innovation. On the other hand, we aim to contribute in providing a basic understanding of the role of design challenges in design theory development and particularly address their role in transforming kernel theories to design theories [23].

In order to address our research objectives, we conduct a two-step literature analysis:
Step one. For our two major kernel theories we determine related work using a structured literature analysis [24]. Our search process includes a database search (ISI web of knowledge, Google scholar) as well as a forward and backward search with the identified articles as starting points. We employ iterative open coding [25] to identify main characteristics of the innovation process from the two theories. Here, the characteristics are first individually developed by the researchers and then consolidated in a joined effort. We end up with five distinct characteristics (two from DC theory and three from creativity theory) which are then further aggregated to two main properties of the innovation process (chapter 4).

Step two. The two main properties are combined with the previously introduced general IS architectures (distributed applications and monolithic applications) to come up with a 2x2 matrix. To derive design challenges for each of the cells within this matrix, we first perform another literature analysis. This time, a rather unstructured approach is chosen to account for the diversity of possible challenges. Again, relevant aspects are first identified individually and then discussed and assigned to matrix cells in a workshop setting (chapter 5).

4. Identification of Key Characteristics from Theory

4.1. Dynamic Capability Theory

From a theoretical perspective, process innovation can be seen as a dynamic capability. The dynamic capability framework as an extension of the resource-based view (RBV) argues that organizations are collections of assets, operational capabilities, and dynamic capabilities. Here, assets refer to anything tangible or intangible that can be used by an organization [26], e.g. a call-center. Operational capabilities are coordinated set of tasks [27] which rely on assets as inputs, e.g. the capability to operate the call-center as a service for several customers. Dynamic capabilities are “the firm’s ability to integrate, build, and reconfigure internal and external competences [operational capabilities] to address rapidly changing environments [28, p. 516].” Hence, we argue in line with Zollo and Winter that process innovation is an “activity dedicated to process improvements [29, p. 340]” and, thus, a dynamic capability.

Capability areas. Process innovation requires a set of different capabilities. In this context, dynamic capability theory identifies heterogeneous activity areas. Literature identifies three distinct capability areas: 1) sensing, 2) seizing, and 3) transformation [30]. With regard to process innovation, sensing refers to the identification of both internal needs for changing a particular process as well as external opportunities for creating completely new processes. Seizing comprises all activities related to developing possible new or changed processes, and to selecting the most promising alternative. Transformation capabilities are then needed to implement these processes within the company and ensuring their adoption by all involved stakeholders [31]. Thus, from a dynamic capability perspective, process innovation can be broken down into the three capability areas sensing, seizing and transformation which are heterogeneous in nature.

Social and collective learning. Early, it was clear that improving a process is not a task of a single person [3]. Organizational processes become increasingly collaborative and so becomes their improvement or innovation [32]. Theory states that a dynamic capability can be understood as “learned and stable pattern of collective activity” [29]. Thus, capabilities in general and dynamic capabilities in particular only exist on a collective and collaborative level. As a dynamic capability, process innovation therefore also incorporates aspects of social and collective learning [33]. From a process management perspective, process innovation tasks can be executed using assets sourced by means of different governance mechanisms, i.e. market (e.g. consultants), network (e.g. suppliers or customers), or hierarchy (e.g. employees). Hence, dynamic capability theory proposes that process innovation is, at least partially, collaborative and may include learning through actors from both sides of the organizations boundaries.

4.2. Creativity Theory

Within the innovation process, distinct intermediate artifacts of high originality (e.g. problem definitions, solution concepts, implementation plans) are created. These artifacts should be both novel and useful. As such, the sub-tasks and the whole innovation process respectively can be framed as creative [34,35]. We subsequently focus on the properties of creative processes in order to gain insights on properties of innovation processes.

Divergence and Convergence. Various models have been proposed to capture the creative process as a predefined sequence of stages, each addressing a coherent, generic set of activities [36,37]. Abstracting from the single stages of creative processes, they usually consist of two fundamental phases: On the one hand, the divergent phase is the part of the creative process, where high quantities of novel and diverse ideas are created [38]. On the other hand, in the convergent phase, ideas undergo a critical, reflective
process [39]. The individuals build on existing knowledge oriented toward deriving the single best answer. The innovation process involves phases of both divergence and convergence.

**Partially Structured.** Due to the unpredictability of activity flow in creative business processes (e.g. early conceptual product design), it is cumbersome to capture these processes in pre-defined procedures. However, “[this] does not mean that strong generic characteristics of the process cannot be modeled [40, p. 74].” Based on empirical studies in the creative industries, it has been revealed that often processes are neither completely creative nor non-creative [41,42]. Instead, they consist of 1) unstructured sub-processes, which exhibit a high intensity of creativity and are cumbersome to model and manage, and 2) structured sub-processes, to perform routine procedures of low originality. In case of process innovation, early tasks for developing ideas for new or improved processes are likely to be framed as unstructured. In contrast, later tasks in the process, such as the implementation of a ready-to-execute concept, will exhibit a higher degree of structure.

**Social Influence.** A major part of an individual’s intelligence and creativity resides in working together with others [43]. As various studies show, the involvement of teams for creative tasks is common practice in industry: in an exploratory empirical study of 44 R&D teams, Kratzer et al. [44] provide evidence that the creative performance of virtual teams is influenced by the proximity of team members, communication modes and task coordination. Business process improvement initiatives benefit from group creativity techniques (e.g. brainstorming, nominal group technique) [45], bringing together diverse competencies for different perspectives on the problem [9]. However, empirical research comparing performance of groups and individuals provides evidence that the group is not “more” than the sum of its parts, yet it appears to be “less”: an analysis of studies on the brainstorming technique has shown that for 18 out of 22 experiments “the performance of nominal groups [is] superior to that of real groups [46, p. 497].” This observation pertains to both idea quantity and quality [47]. The productivity loss was traced back to numerous group losses occurring in group processes. Amongst the most influencing loss is production blocking, i.e. that only one group member can speak at a time [46], forcing concurrent contributions to be omitted and eventually lost. Later technology related experiments prove that group losses can be mitigated by the use of technology, especially in larger groups [48]. We subsume that innovation processes benefit from social phenomena of creativity, under the premise of appropriate group support as discussed in this paper.

### 4.3. Aggregation of Properties

The derived process innovation characteristics can be subsumed to two major properties: task heterogeneity and collaborativeness (Figure 1).

**Task heterogeneity.** From a dynamic capability perspective, it was argued that several distinct capability areas (sensing, seizing and transformation) are required for successful process innovation [30]. These capabilities, as well as their sub-capabilities, are connected to a set of distinct and diverse tasks on the level of the individual employees. Similarly, creativity literature argues that within a creative process, there are structured and unstructured [49] as well as convergent and divergent [38] elements. Research identified both divergent and convergent activities in sensing and seizing [31]. Thus, process innovation contains different tasks that are heterogeneous: Task heterogeneity is one major property of process innovation.

**Collaborativeness.** Understood as a dynamic capability, process innovation was characterized as being highly collaborative and dependent on collective learning [29]. Integrating knowledge of a variety of people is necessary to master the different tasks associated with innovation capabilities. Similarly, creativity literature identifies social influence as a key factor for success within the creative areas of the innovation process. It has been found that “a competency in collaboration supports the initial stages of innovation as well as the work needed to develop and implement an innovative idea [50, p. 263]”. Thus, the second key property is collaborativeness.
5. Design Challenges for supporting IT

5.1. Task heterogeneity and distributed applications

While it has been found that using separate special purpose tools for different tasks can increase the organization’s flexibility and responsiveness in changing business environments [51], this flexibility comes along with the need for integration on all different architectural layers. For instance, different applications usually feature a diverse user interface and, therefore, vary in terms of usability. As a consequence, becoming acquainted with the different tools takes rather long (see Table 1, Chall_DA1). In addition, information has to be constantly exchanged. For instance, the output of a brainstorming to improve a particular process should be directly available within the process modeling environment. This, however, is a major issue with distributed applications. Due to the fact that data bases are decentralized, interfaces have to be established to allow for transition and reutilization of the individual task outputs (see Table 1, Chall_DA2). Central data management is generally not achievable thus leading to data redundancies, lost updates, etc. (see Table 1, Chall_DA3). From an organizational perspective, supporting a set of distributed applications is more complex and time consuming than supporting a single monolithic software block [19]. Support has to keep track of all different existing and upcoming tools in the process innovation and be aware of relationships within their utilization as well as of interfaces that are used in the process (see Table 1, Chall_DA4, Chall_DA6).

Employees will always search for easier ways to fulfill their different tasks and are likely to use light-weight applications not supported by the IT department. While this proliferation of tools is more an issue when using monolithic systems, it is still advisable to integrate useful applications into the organizational tool portfolio rather than keeping this portfolio static. However, the challenge is to balance institutional policies with individual leeway for decisions (see Table 1, Chall_DA5). Since the applications have to work together, a central guidance with regard to which tools should be used has to be given.

5.2. Collaborativeness and distributed applications

Within the innovation process, several intermediate digital outputs will be produced. In collaborative scenarios this may lead to various versions of these outputs, each produced by different users at different times with different applications. This poses the challenge of effective version management, in order to provide down-stream activities in the innovation process with the right input produced up-stream [52] (see Table 1, Chall_DA7). In addition, every application used in the innovation process will use diverse roles for managing access. For each of these roles, different rights in the applications will be defined with respect to the functionality available. The challenge arises to define comprehensive, integrated role models which are valid across all applications (see Table 1, Chall_DA8). The concept of meta-policies could serve as a starting point to cope with this issue. It has been proposed for efficient control and communication of access control policies in distributed

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Technical and organizational design challenges for distributed and monolithic process innovation systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distributed applications</td>
<td>Monolithic applications</td>
</tr>
<tr>
<td>Task Heterogeneity</td>
<td>Chall_DA1: Diverse user interfaces hinder learning effects</td>
</tr>
<tr>
<td></td>
<td>Chall_DA2: Requires implementation of interfaces to connect the different tasks</td>
</tr>
<tr>
<td></td>
<td>Chall_DA3: Data redundancies due to de-central storage</td>
</tr>
<tr>
<td></td>
<td>Chall_DA4: IT support gets more difficult</td>
</tr>
<tr>
<td></td>
<td>Chall_DA5: Policies for usage of all different applications have to be established</td>
</tr>
<tr>
<td></td>
<td>Chall_DA6: Market needs to be closely monitored</td>
</tr>
<tr>
<td>Task Collaborativeness</td>
<td>Chall_DA7: Version control of digital outputs</td>
</tr>
<tr>
<td></td>
<td>Chall_DA8: Integration of role models needs to be valid across all single applications</td>
</tr>
<tr>
<td></td>
<td>Chall_DA9: Management of security issues</td>
</tr>
<tr>
<td></td>
<td>Chall_DA10: Policy enactment to guarantee the usage of identical applications</td>
</tr>
<tr>
<td></td>
<td>Chall_DA11: Ensuring a common problem understanding</td>
</tr>
</tbody>
</table>
systems [53]. Moreover, if user accounts have to be managed for in any single application, personal account data is replicated for each of the application. Security issues arise, since the risk of data abuse is multiplied with every user account (see Table 1, Chall_DA9). Furthermore, “[m]aintaining a component based system and handling its evolution have always been a difficult task [53, p. 1]” for organizations. From an organizational perspective, the potential risk arises that users select applications (or offline tools) other than those foreseen by the organization. The same may be the case for different releases of the same application. In consequence, the necessary integration of the applications may no more be guaranteed. For that reason, the organization has to assure by organizational policy and enacting measures that the identical applications are used through the organization for the innovation process (see Table 1, Chall_DA10). Lastly, an integration problem occurs with respect to the employees’ understanding of IT support for the overall innovation process. Different contributors in the process might be specialized on performing distinct tasks and thus using distinct applications. This spotlighted view on single tasks of the innovation process through the lens of distinct applications (with different user-interfaces) may hamper a commonly shared understanding of the problems arising within the overall process (see Table 1, Chall_DA11).

5.3. Task heterogeneity and monolithic applications

As noted, some tasks within process innovation, for instance the actual implementation of the new process within the company (transformation), can be easily structured while others are more creative in nature and, thus, require a more flexible IT support. Offering ideal support for all of these structurally different tasks is challenging for monolithic systems due to their complexity. Their focus lies on combining the functionality required for the overall process. However, this goes at the expense of the “to-the-pointness” of the overall application (see Table 1, Chall_MA1). Giving an example from a different domain, Microsoft Outlook has functionality to schedule a meeting but is increasingly substituted by doodle.com polls because they are more convenient to use. In addition, monolithic tools often paralyze the organization as functionality cannot easily be replaced in favor of new, more adequate applications. As such, the monolithic architecture is comparably inflexible (see Table 1, Chall_MA2). If changes occur within the procedure of, e.g., process model generation, the changed requirements will be accounted for in the next application release cycle. Due to the high range of functions, these release cycles are usually rather long (see Table 1, Chall_MA3). However, flexibility is one of the most important aspects for software supporting business process management and innovation [54]. Monolithic applications can be replaced with considerable effort only, if they do not satisfy the innovation process requirements. In consequence, the organization has to deal with lock-in effects (see Table 1, Chall_MA5). From an organizational point of view, the ease of use is a major challenge for monolithic applications. Since they support all different tasks of the innovation process, employees have to learn how to navigate to the functions needed for the steps they are involved in (see Table 1, Chall_MA6). While this overhead may be reduced by using user roles and views on the tool, this requires a higher administrative effort than using a distributed architecture. This is strongly connected to the issue of downtimes (see Table 1, Chall_MA4). If the tool is unavailable the entire process innovation is put on hold.

5.4. Collaborativeness and monolithic applications

A recent study found that organizations “must be willing to dedicate significant resources to a broad enterprise strategy that extends their data and applications to mobile devices [55, p. 10]”. Especially for collaborative apps, the mobilization trend becomes increasingly important. Employees want to work with their synchronized data set from all possible locations. However, from a technical perspective, the facilitation of mobile access is especially cumbersome in the context of collaborativeness and monolithic application infrastructure (see Table 1, Chall_MA7). Many monolithic tools in the area of process innovation are built as stationary fat clients with a limited possibility for transferring to mobile platforms. With respect to organizational issues, especially in a collaborative scenario, inefficient features of a tool are highly influential to user acceptance. It has been found that if an “application requires collective adoption, and only a small percentage of users will be willing to tolerate its unpleasant features, creating sufficient critical mass to move toward collective adoption may be difficult or impossible [56, p. 177]” (see Table 1, Chall_MA7). Whenever the complexity of a particular system increases, the probability that some of them turn to alternative applications for quicker problem solving rises (see Table 1, Chall_MA8). Considering the long release cycles of monolithic applications, this may have severe implications for the innovation process. It is harder to satisfy individual needs, which in return creates a higher barrier for collaborative adoption. The system is more often bypassed by the employees, for instance by creating Microsoft Excel files for process analysis.
5.5. Example scenarios

START-UP is an advertising agency which develops and executes marketing campaigns in a highly competitive and ever-changing market environment. The number of key accounts and employees of START-UP and the agility of competitors to deliver service to customers have passed a threshold which requires the organization to innovate the corresponding business processes. A process innovation project is initiated, with the goal to streamline the customer requirements definition process for new marketing campaigns. START-UP has built a process innovation team which consists of internal marketing experts and external consultants with process innovation expertise. Due to the heterogeneity of tasks in process innovation, more specifically as-is process analysis and to-be modeling, different applications are needed in the project. Since START-UP has to manage the process innovation project with minimal resources, the team decided to employ distributed applications that are either free of charge or usable in a SaaS model on a monthly fee basis: the free collaborative brainstorming tool XMIND is employed to generate ideas for process improvement. The web-based application Signavio has been chosen for collaborative, web-based business process modeling. Project meetings are planned with Doodle and Google Calendar. Additional files in the project are shared using Dropbox. Communication in the team is supported with E-Mail and Skype messaging and calls. Further, it is common at START-UP that employees freely choose additional applications to manage their work processes. Different mobile task management applications are in use. As the process innovation team starts with the project, several problems arise: with respect to heterogeneity of tasks, there are technical hindrances in relating brainstorm ideas, documented in XMIND, to respective as-is and to-be business processes. Further, it is cumbersome to relate project communication via E-Mail and Skype to these business processes and to keep track of the innovation process. From an organizational viewpoint, several team members see difficulties in handling the comprehensive set of applications in the project. As to “shot-cut” XMIND, some have decided to use offline-techniques for brainstorming (brown paper). Hindrances occur in that offline models are not consistently distributed in the team. Thus, discussions emerged whether policies for application usage have to be introduced. Alternatively, XMIND could be changed for an alternative application with higher ease-of-use. However, browsing the market for appropriate tools is time consuming.

BRICKS-AND-MORTAR is a big player in the market of marketing agencies. It has grown considerably in the last 20 years, acquiring several small niche players to complement the product portfolio. However, the management realized that the potential of combining the different competencies has not reached its innovation potential. New and highly individualized services could be offered to key accounts. To that reason, internal, but cross-department business processes shall be innovated, combining diverse service portfolios. BRICKS-AND-MORTAR has documented business process in past BPM projects. The management decides to build on the existent model base, created and administered with the monolithic ARIS Design Platform. A project team is built, consisting of more than 30 marketing experts from several departments and employees from the internal BPM department. ARIS Design Platform has several integrated components to support process innovation. Modified business process can be modeled with ARIS Business Architect. They can be published and discussed by the marketing experts using the portal solution ARIS Business Publisher. The project is also managed with ARIS Design Platform, which allows managing the high number of existent models in several project packages, each assigned to project sub-teams. However, as the project team starts process analysis several challenges occur: the marketing experts have comprehensive tacit knowledge about their business process, but conveying those processes to the modeling experts is difficult. Allowing them to model the business processes themselves is equally cumbersome, since the ARIS modeling component is too complex to be used without extensive training. Given these difficulties, an increasing number of marketing experts begin to use Microsoft Visio to develop new business processes. In consequence, seamless exchange of innovated process models is hindered in the overall process innovation team. In the course of the project, members of the BPM team realize that numerous open source Web 2.0...
communication platforms are offered, which offer advanced communication features in comparison to the ARIS Business Publisher. Some of those open source solutions also offer features for mobile versions of the process modeler. However, due to a technology lock-in, this component may not be changed.

6. Concluding Discussion

6.1 Contribution to design knowledge

Our contribution to the design of IT-support for process innovation is twofold: first we develop a differentiated understanding of the characteristics of the innovation process, drawing from dynamic capability and creativity theory. On that basis, we derive the two aggregated properties of process innovation: task heterogeneity and collaborativeness. On the premise of the two basic design choices of distributed vs. monolithic applications we then develop a differentiated matrix of challenges arising for the development of socio-technical systems for process innovation. We finally illustrate the challenges with an exemplary organizational process innovation scenario. While the focus of our research was on process innovation, we acknowledge that the resulting design challenges may be valid for other innovation areas as well.

6.2 Contribution to the Philosophy of DSRIS

We propose the identification of design challenges as a beneficial pre-step for developing design theories. From a meta-perspective, we developed design challenges according to the following process (see Figure 2): we drew from kernel theories (dynamic capability theory and creativity theory) in order to better understand the problem domain (process innovation). Based on this understanding we identified design challenges with respect to basic design choices (distributed applications vs. monolithic applications). These challenges inform the development of design theories, pertaining to the selected problem domain. Incorporating this process steps in an overall design theory development process (as proposed by Hevner [57] or Sein et al. [58]) may bare the following benefits:

- Building on relevant kernel theories, challenges indicate potential pain-points that require specific design guidance. In consequence, relevance of design theories may be increased.
- Developing a sound, theory-based understanding of design challenges allows for a better understanding of the problem domain (in our case the innovation process) and thus reduce the number of iteration cycles for a stable design theory.
- Formulating a set of design challenges categorized in a multi-dimensional matrix (see Table 1) may serve as a handy means to formulate design research agendas for a specific problem domain.

In future research, the feasibility of this approach to design theory development should be revealed and compared to current approaches. Other topical issues for future research are indicated in the next section.

6.3 Issues for Future Research in IS

The identified challenges bring about a number of questions to be addressed in future IS research. We want to indicate three of them: Firstly, the governance perspective for multiple distributed applications is one potentially fruitful area of research. Here, emerging topics like “consumerization”, i.e. consumer technology usage (hardware and software) in the workplace [59], might play an important role. Secondly, monolithic applications have to be tailored to the specific needs of process innovations of different organizations, so that superfluous functionality does not induce working inefficiency. Thirdly, in this study we excluded IT support for the enactment of designed processes and action plans. Advanced project management assistance to plan and control process roll-outs is only one example that might merit future investigation.

6.4 Outlook and Limitations

In our paper, we identified challenges for the design of socio-technical systems for process-innovation, especially for artifact design for process innovation. Our outset was a theoretical perspective on the nature of process innovation from the viewpoint of dynamic capability theory and creativity theory. From the prior, process innovation can be broken down into the capabilities of sensing, seizing and transformation. From the latter perspective, process innovation was framed as a creative process, consisting of divergent con convergent phases. As such, it involves both structured, less creative and unstructured, highly creative sub-processes. Moreover, theory indicates that innovation processes require for creativity on both a group level and organizational level. We aggregated those properties of the innovation process in two major characteristics: task heterogeneity and collaborativeness. We then systematically identified several technical and organizational challenges arising from monolithic and distributed architectures with
respect to these two characteristics. These challenges are discussed in chapter 5 and subsumed in Table 1.

However, our findings are beset with certain limitations. First of all, our work is, up to this point mostly theoretical and lacks empirical evidence. While we draw on both computer science and information systems literature to derive the challenges, their specific impact needs to be further evaluated in an empirical way. This is true especially for the characteristics of process innovation, namely task heterogeneity and collaborativeness, too. Second, we indicated that collaborative creative activity is beset with limitations (group losses). Further research shall thus be concerned with approaches to leverage positive social influence on creativity in process innovation, while mitigating group related creativity losses.

7. References