Understanding ISD and Innovation through the Lens of Fragmentation

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Abstract: Information systems development (ISD) and innovation is a complex and challenging endeavor. In this paper we inquire into the process of ISD and innovation to shed light on the ambiguous nature of such processes. This was done in an interpretive study of 10 governmental ISD projects where 14 interviews with key persons were conducted. In addition 11 interviews with senior IT consultants were conducted. Based on this study we propose an analytical lens to understand ISD and innovation. This lens is based on a metaphor grounded in the empirical material. This metaphor, *fragmentation*, mediates a deeper understanding of ISD and innovation regarding three aspects of complexity: knowledge, culture and discourse, and time and space.

Keywords: ISD, Innovation, Process ambiguity, Knowledge fragmentation.

1 Introduction

Ever since IT artifacts became strategic resources in organizational practices, information systems development (ISD) and innovation has been a challenging endeavor. As a consequence, there are seemingly never ending reports of projects not delivering on time, to budget or scope. Given this erratic practice, there are reasons to challenge our assumptions and theoretical understanding of ISD and innovation.

Digital technology has progressed to support many aspects of human life including social activities (Yoo, 2010). Our field is widening to untraditional settings, where ISD can make a difference that matters (Walsham, 2012). For example, information technology and IS research has an important role for environmental sustainability (see e.g. Elliot, 2011; Watson et al., 2010). Widened and global settings, bringing with it societal complexity gives rise to new challenges for ISD – ISD is increasingly engaging in emergent design domains and emergent design solutions.

In this paper, we refer to ISD coping with emergent design domains and emergent design solutions as ISD and innovation. Innovation is a term that widely refers to an outcome perceived as new, whether it is an idea, object, or process, as well as to the process of creating this newness (Slappendel, 1996). Digital innovation refers to innovations enabled by digital technology (Yoo et al., 2009). The newness may also be a recombination of old solutions changing established domains in such a way that it is new to the people involved (Van de Ven, 1986).

We conclude that ISD and innovation is an increasingly complex and challenging endeavor. The question we address in this paper is; *How can the ambiguity of ISD and innovation be understood and gestalted?* We inquire into this and propose an analytical lens to understand the nature of ISD and innovation processes. This lens is based on a metaphor grounded in our analysis of 10 public sector projects, and interviews with senior IT consultants. Our aim is to contribute to the understanding of success and failure of ISD and innovation.

The paper proceeds as follows. First we present literature on ISD and innovation followed by a description of the research design. Thereafter we present the empirical accounts and the metaphor of fragmentation. The paper is concluded with a discussion on the findings.

2 Background on ISD and innovation

For decades we have been guided by a variety of design ideals when developing IT artifacts. These ideals are reflected in different ISD paradigms. Hirschheim et al. (1995) identify seven generations of traditional approaches ranging from formal and structured approaches, through socio-technical, to emancipatory approaches. ISD is an ever-changing practice. Over time new models, methods, techniques, and tools have been introduced to support development processes. For example, agile development has emerged as an evolutionary approach (Abrahamsson et al., 2002; Highsmith and Cockburn, 2001). This evolution leads to new generations of approaches. These generations have been classified according to inherent structures and their paradigmatically rooted assumptions (Iivari et al., 1999).

In structured and formal approaches design domains and design solutions are considered as well established. One underlying assumption or logic underpinning traditional approaches is that systems development is a coherent and rational process in established domains, and thus can be managed to have quality, be predictable and productive (see e.g. Paulk et al., 1993; Herbsleb et al., 1997; Aaen et al., 2001; Mathiassen et al., 2007). A dominant theoretical foundation of traditional approaches is grounded in an ideal, prescribing solutions to be well organized, efficient, reliable, and esthetically pleasing.

In traditional approaches, system requirements are regarded fundamental for successful ISD. Requirements engineering is a well established line of research in IS, reaching back to when ISD became an academic subject. Much focus was put on meeting complex requirements (Larman and Basili, 2003), which among other things resulted in numerous techniques for requirement documentation. Later, from the 70´s, experimental techniques and iterative approaches were introduced. Ever since then, new techniques to identify, specify, prioritize, etc. have been suggested, as well as new approaches to risk and complexity management in ISD (see e.g. Mathiassen, et al., 2007; Taylor et al., 2012).

There is extensive literature in IS recognizing that ISD and innovation has emergent properties. Orlikowski (1996) propose an alternative perspective of organizational change related to ISD as emergent from situated actions. This perspective acknowledges that actions can be intentional, initiated improvisations to meet contextual circumstances or inadvertent slippage. Truex and Baskerville (1998) outline a theory of emergence in ISD. They suggest that there are underlying structures, which can, if they are uncovered be of guidance in ISD and recognizes change and flexibility and requirements as emergent. Truex et al. (1999) propose that organizations can be regarded as emergent rather than stable. In emergent organizations, social features (e.g. culture, meaning, social relationships, decision processes) are continuously emerging, not following any predefined pattern. These features are a result of constant negotiations, redefining the organization. Given this emergent nature of design domains and design outcomes, Truex et al. (1999) suggest a continuous redevelopment perspective on ISD.

The emergent nature of design domains is accompanied with emergent properties of ISD and innovation (Aydin et al., 2005). There are unpredictable factors that have implications for ISD that need to be continuously managed. Truex et al. (2000) describe ISD as a result of a myriad of activities that emerge more or less independently. The ISD and innovation process is described as disconnected and fragmented, and as a sequence of activities determined by emergent events. ISD and innovation has also been described as culturally differentiated, temporal and spatial, having restricting implications for knowledge sharing (Bresnen et al., 2003). These ambiguities of ISD have also been highlighted in research on project risk management (see e.g. Taylor et al., 2012). In this research ISD projects are described as having a number of dimensions linked to project risks such as uncertainty, incomplete information and complexity. Taylor et al. (2012) conclude that research findings can only be utilized in practice if they are transformed to cope with these dimensions.

In recent literature on digital innovation, processes are recognized as networked spanning organizational boundaries, and traditional industry boundaries (Yoo et al., 2012). Process coordination and control is distributed, and the nature of knowledge resources is heterogeneous (Yoo et al., 2009). Adding to the complexity is the conflicting goals of co-opetition in digital innovation (Vanhaverbeke and Cloodt, 2006). This results in highly dynamic processes, characterized not only by technical complexity, but also complex social processes within the associated networks (Van de Ven et al., 2008). Yet, the ambiguity of IDS and innovation has been recognized to be of value. In a study on digital innovation projects, Austin et al. (2012) found that accidents such as breakage, malfunction, movement outside of intention, and accepted chain of logic can be of value to achieve novel design outcomes.

Drawing on the literature review, we suggest that ISD and innovation can be regarded as ambiguous (see fig. 1). Design solutions can be established and thereby possible to prescribe with requirements, such as a replicated standard solution. However, design solutions can also be emergent, and thereby not possible to foresee or plan for in advance. This is the case with, for example, a not yet existing novel solution. Design domains can be established with well-known needs, for example a standardized governmental practice. Design domains can also be emergent, meaning that problems and needs are unknown or rather evolving, and thereby impossible or even undesirable to pre-define. This could for example be the case in novel practices or organizational environments under rapid and radical change.

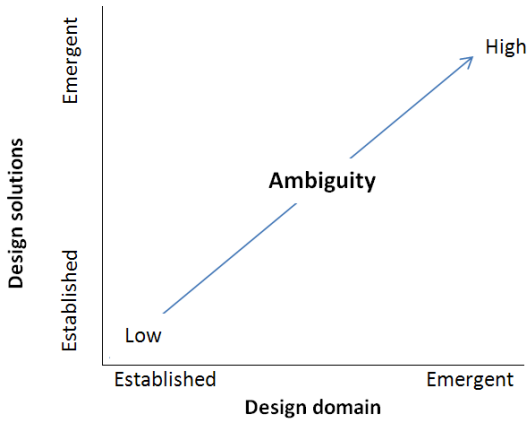

Fig. 1. ISD and innovation ambiguity

ISD of established design solutions, in established design domains, we argue is less ambiguous, while ISD of emergent solutions in emergent design domains is highly ambiguous. This argument has implications for how ISD project success and failure can be understood. With an understanding of the process as stable, predictable and thereby manageable it seems reasonable to deem projects as failures when not delivering according to budget, schedule, and scope expectations (see e.g. Sauser et al., 2009). This would be the case for ISD of established solutions in established design domains. However, understanding the process as highly ambiguous, with emergent properties not predictable and definable, the conventional assessments of delivering according to budget, schedule, and scope expectations can be inequitable.

3 Research design

In this research we studied 10 cases of ISD projects in the Swedish public sector, and IT consultants´ experiences from public sector projects.

In the10 public sector projects the main goal was to develop novel, tailored, or fully developed (IEEE 1062 1998) systems. The systems were all realized with aid of external IT consultants, and aimed at supporting governmental core operations. The projects lasted a minimum of 6 months, and the budgets ranged from half a million to several hundred million SEK. They were initiated around the Millennium and the last project was finalized by 2011. 8 of the 10 projects were finalized, one was abandoned and one was absorbed by a following ISD initiative. The majority of the projects can be regarded as failures in terms of not delivering on budget, schedule, or to scope expectations. In more than one case, systems lacked functions that were added post implementation. Documentation and testing were in some cases not completed. However, as mentioned above, 8 governmental organizations got their new and tailored systems implemented, even though the projects exceeded budgets or schedule.

The projects were studied through interviews with key project members employed by the governmental organizations and in leading positions such as project leaders, department managers, and senior consultant. Interviewees were selected with initial assistance of each governmental organization, suggesting individuals with deep insight into the projects. In sum, 14 key project members were interviewed. The interviews were semi-structured and lasted approximately 1.5 hours. Topics guiding the interviews were background information about the interviewee, project details, interviewee´s role in the project and cooperation, project organization, scope and outcome. The interviews also inquired into the interviewees' project experiences, accounts for problems and challenges as well as lessons learned in the projects.

In order to get external consultants´ perspective on and experience from governmental ISD projects, interviews with 11 IT consultants were conducted. The consultants were selected by the aid of management in three major IT consultant firms. Management was asked to selectively choose senior consultants with relevant experiences. Nine of the consultants were interviewed in groups by three, and two were interviewed individually. The group interviews lasted 1.5 to 2 hours and, the individual interviews 1 to 1.5 hours. The interviews were guided by the following topics: consultant roles in governmental projects, cooperation, common and reoccurring problems in ISD projects, experiences and important learnings. In total, 25 people were interviewed. All interviews were recorded with informed consent, transcribed, summarized and sent back to the interviewees for confirmation.

This research was guided by Klein and Myers (1999) principles for hermeneutic research. We initiated the analysis by organizing the empirical material according to the themes informing the inquiry into the process of ISD and innovation. The material was then interpreted to understand the ambiguity of ISD and innovation. The interpretation was done iteratively to seek patterns arising from the material as a whole. This resulted in three conceptualized themes (Walsham, 2006): *knowledge, culture and discourse* and, *time and space*. These conceptualized themes opened for a re-interpretation of the empirical material that we chose to represent in a metaphor, *fragmentation.* Metaphors are important tools for how we interpret, understand and act upon reality (Morgan, 1998; Morgan, 1980), and are powerful to help us understand complex phenomena (Lackoff and Johnson, 1980). In research, metaphors are also useful in exploration, analysis and interpretation of empirical material and for theory construction (Inns and Jones, 1996). Walsham (1993) uses the metaphors culture and political system in order to widen perspectives on development and implementation of information systems.

4 Empirical accounts

In this section we establish the rationale for the proposed metaphor. The quotes illustrate common patterns in the empirical material – accounts of knowledge fragmentation related to culture and discourse, and to time and space.

4.2 Knowledge

ISD and innovation is knowledge intensive. On the subject of knowledge the interviewees described the challenges of satisfying the needs for knowledge on different subject areas. They also described that knowledge and competence is spread on several persons, and on different organizational levels within and outside of the government. When identifying knowledge and competence needs in a project, a holistic view was emphasized. One interviewee described it as follows:

> *One has to consider the whole process, It is not enough to have a god business lawyer, it is not enough to have a good requirement specification, it is not enough to have a committed project leader, it is not enough to have the technical competence, and it is not enough to hire a competent consultant.*

Further, the knowledge need concerning the specific governmental application area was emphasized. One interviewee put it like this:

> *Apart from knowing what you want to develop, which data to store, which output and the effects for the customer, you must also master the rules for the governmental operation…. You also need to know the organization if you as we did, also change the organization.*

Another theme that appeared in the interviews was the need to match knowledge and competence to decide if a suggested design solution was feasible or not, as illustrated by this quote:

> *As a manager of operations you are not able to decide whether a suggested design solution is feasible or not. You know the conditions related to your field of competence and for example clarify what rules that might change during the process and how that affects the coming system. … That in turn requires that you have sufficient dialogue with the IT people so that they can help one understand and explain what the consultants are speaking about.*

Even if knowledge needs seemed to be clear in the beginning of projects, they changed when projects were confronted with problems. One interviewee described this as:

> *It was very vulnerable because they were programming continuously. We also exchanged consultants a few times, with more adequate programming skills. The consultants thought they were doing the right things, and we thought they were on track. However, after a while when we tested it became apparent that we all were wrong about the correctness of calculations.*

One of the experienced consultants described how the complexity of knowledge needs in ISD is increasing:

> *25 years ago you knew everything after 2-3 years in IT business. Today, you only manage to keep up and stay competent in a niched area, so you have to cooperate with a lot of other people to be able to accomplish things. Reality is so much more complex today…. there are hundreds of things you need to know, and if you don´t have support for that you will miss out of things and make mistakes, that´s just the way it is.*

Regarding different types of knowledge, the interviewees described the need for a blend between practical, theoretical, and social skills and knowledge. Interviewees made statements relating to explicit knowledge (regulations, rules etc.), individual knowledge (e.g. personal insights), conditional knowledge (e.g. knowing when to make a decision), relational knowledge (e.g. knowing who can help), and procedural knowledge (e.g. on project management).

As illustrated, quotes reflect the need for knowledge in different areas, and the need for different types of knowledge. One consultant claimed that:

> *As a customer you cannot know everything, but you have to know where to get help and what is needed, and be able to take it in.*

For example, social or relational knowledge is needed for the identification and involvement of people with essential knowledge on different subject areas:

> *Anita, the project leader, managed to recruit skilled people working in different areas. Some from our head office with competence on general operations, some from our regional offices, the end users, and our own specialists holding specific knowledge required for the system.*

Interviewees stressed the need for social skills and ability to coordinate. One governmental official described this as:

> *In most projects there are relationships to two and maybe three stakeholders that needs to be coordinated. They can be for example an external consultant, an internal IT department, and governmental officials. Somebody needs to have the competence to manage and coordinate these different stakeholders. Such a person has to be flexible and responsive, and must really be know some about each area, and also be a skilled negotiator between the involved stakeholders.*

Another example is externalizing tacit knowledge on governmental operations important to design solutions according to expectations and needs. One consultant described it as:

> *The problem is that it is very difficult to describe what is in the head of the managers, and then design it. It is really all that is in their head that they actually want.*

A final example of need for different types of knowledge is exemplified is the need for explicit knowledge related to the specific design domain. One governmental official gave the following example:

> *I have to know the European regulations for this government to be able to sort and clear out what to include in the system. I must be able to organize that in order to show the consultants what rules that could be of value and can be built into the system.*

The quotes illustrate that ISD and innovation span over several and different knowledge areas, for example, knowledge on requirement specifications and competence to communicate operational needs, and to describe operations and existing IT systems. Some other examples are knowledge to formulate project goals, ability to express specific domain knowledge, knowledge on project management, legal requirements, and on being a competent negotiator.

4.2 Culture and discourse

Regarding culture and discourse, interviewees described that lack of understanding of different cultures and differing vocabularies caused problems in the projects. One example of a cultural collision that one interviewee described was between seniors from the internal IT department and external consultants in one of the projects:

> *Young people between 25 and 30 were supposed to discuss and solve problems together with the COBOL-people in their 50´s and 60´s. None of them understood each other, and there I was in the middle trying to over bridge the gap.*

Another example of a cultural collision leading to miscommunication was between department staff and consultants as described by one interviewee:

> *It was quite an irritated situation here for about 6 months before we got things to work. The governmental department staff reacted on the consultant being to technically orient in the dialogues. I think so too, but after a while I understood that it was his way of communicating. To understand that we speak different languages was an important insight for me. However, at the department they thought he was difficult to deal with. For example, when something went wrong in the system, he started to draw tables and stuff to explain, but the department staff was totally uninterested, they did not understand.*

Differing vocabularies between stakeholders and the ability to deal with that in ISD was another distinct theme in the interviews. One interviewee described how there is a risk of misconceptions if this is not dealt with.

> *It is always an advantage in the relation between people, clients and consultants, if you have the same vocabulary. When we sit and talk there might be words that mean one thing for us, and another for somebody else, that is, we use the same word for different things. Since I have a broad education I realize this. I sometime think that this guy is probably talking about this and not that. He is not talking about the same thing as I, and then you realize hey, now we are talking about different things, even though we use the same words.*

Incomprehensible vocabulary was portrayed by one governmental official in terms of:

> *There is a certain jargon. Sometimes I had to stress, hey now you are talking to me you know… It was Greek to me when they were talking about their packages, tables and whatever they talk about. The system models are really designed for someone who knows a lot about systems development.*

These quotes illustrate that interviewees talked about cultural gaps and clashes, language barriers, disruptive jargon, lack of mutual understanding, misconceptions, unfamiliar work practices, etc. To sum it up, the majority of interviewees expressed that differences in culture and discourse is problematic.

4.3 Time and space

Regarding time and space, a common pattern in the interviews was that the coordination of time between the project and everyday business was challenging. One interviewee said that this was the most pressing about participating in the project. The interviewee gave the following advice on the subject:

> *One advice is to make sure your closest manager realizes how much time your engagement in the project will take, and make sure that you are given that time to do it. That is what I think has been most pressing. I have spent hundreds of hours on this project during these years, but these hours have never been part of any plan.*

Another interviewee described the dilemma as follows:

> *This was one of the first really large projects we started and we really did not have the time required to do it. It is always difficult to allocate time when you are in the middle of every day operations.*

During the time a project is ongoing, unexpected things happen. This has implications for how the project proceeds. One interviewee told a story about how key people left the project, and the consequences it had for the project.

> *We started with a small project organization where I was project leader with four department staff. After a while they quit, one by one. In the end, there was only me and the consultant left, and then we had come so far in the project that it was no use trying to recruit someone else. So it was very heavy. I was in a situation where I had to manage business as usual full time as well as to run this project. There was no one with IT skills in those days, and thus no understanding for this taking time.*

Time pressure was also a source for communication problems in the projects. One interviewee expressed the difficulty of finding time to communicate with people not engaged in the process.

> *The time pressure sometimes made I difficult to find time to inform about project progression, and to find time to discuss with other colleagues not directly engaged in the project.*

The majority of interviewees stated that they wished more time for dialogue and interaction, and that the governmental organizations would have allocated more time for those engaged in the projects.

Another distinct theme in the interview material was the distribution of knowledge and competence between locations. This was considered to have consequences for the availability of resources when needed, as illustrated by this quote:

> *The consultancy firm we hired was taken over by a competitor, and consultants were exchanged, and that really did not make things better you know.*

Another example related to time and space is that experiences from one project, had implications for the project at hand. This was exemplified as follows by one of the interviewees:

> *We had difficulties cooperating because the consultant had worked with the tax authorities, and I think he made many parallels from that experience. Sometimes I had to remind him that now you are in this government and you cannot transfer things just like that.*

One of the consultants shared the following reflection on IT projects from a general point of view:

> *IT projects is like everything else in society. It is not like you can state in the beginning how things are going to be and decide how it is going to be. It is not like you will never make mistakes along the way. It is constantly under change. We work in a changing world, we learn, we learn to be attentive to problems. We work with people, some people structure their thoughts in certain ways, others in other ways. You design something and some think the design is good. A new person starts and says it not possible to use.*

In sum, the quotes illustrate how people described aspects of time and space. Interviewees described how people were occupied with other things, spread on different locations, moved around, were exchanged, not having access to competence, being under time pressure etc. Experiences developed over time, in other spaces, was also a theme that interviewees talked about having implications for the ISD and innovation process.

5 The metaphor of fragmentation

In gestalting our interpretations we propose the metaphor of *fragmentation*. Fragmentation embraces three conceptual themes identified in the empirical material: *knowledge, culture and discourse* and, *time and space*. We acknowledge that knowledge, culture and discourse, time and space are interdependent phenomena, but for the sake of clarity of our interpretations we treat them separately.

The analysis of the empirical material led us to three notable interpretations concerning knowledge:

- the need for knowledge and competence on different subject areas, and the need for different types of knowledge
- client respectively consultant incapacity to span over all relevant knowledge domains
- knowledge and competence specialized and inherent in one or a few key persons, knowledge and competence split between several persons, inherent in people in different locations, and on different organizational levels within as well as outside the organizations

To sum it up; we identified design domains and situations dependent on a blend of skills, capabilities, explicit knowledge including tacit knowing. The latter created by and inherent in the individual, in contrast to (social) knowledge created by and inherent in ISD-project members collective actions (see e.g. Alavi and Leidner, 2001).

The aim here is not to penetrate or to discuss categorization or labeling of knowledge, it is merely to illustrate that ISD and innovation requires complex and multifaceted knowledge and competence that challenges interorganizational and organizational systems.

The analysis of the empirical material led us to three notable interpretations concerning culture and discourse, and three interpretations concerning time and space.

Our interpretations concerning culture and discourse point out:

- cultural clashes and discursive gaps,
- communication breakdowns,
- asymmetries of knowledge and diverging expectations.

Our interpretations concerning time and space reflect:

- project members having a hard time to keep up with project tasks and their every day work
- project members, consultants and competent colleagues that were too busy to aid when problems emerged, or competent people that were moved to solve non project specific problems in other locations,
- knowledge spread over time and space, and thereby not activated in projects problem solving.

Our study portrays ISD and innovation as temporal, spatial and culturally differentiated. The study also point out that the knowledge required in ISD and innovation is multifaceted, heterogeneous and too complex to hold for an individual, possibly even for an organization (compare e.g. Bresnen et al., 2003; Yoo et al., 2009). The empirically grounded metaphor – *fragmentation* – captures critical characteristics of ISD and innovation. Moreover, the metaphor mediates an understanding of three sources of complexity and ambiguity: knowledge, culture and discourse and time and space. We believe *fragmentation* to be useful as an analytical lens to understand the nature of ISD and innovation.

6 Discussion and conclusions

The overall aim of this paper is to contribute to the understanding of success and failure of ISD and innovation. In particular, this research contributes to our understanding of the nature of such processes. While many studies have focused on for example software process improvement, requirement engineering, critical success factors, heuristics or best practices, limited research has been devoted to frameworks (see e.g. Sauser et al., 2009) that provide us with deeper understanding of ISD and innovation. In this paper we propose the metaphor of fragmentation as an analytical lens to understand the nature of ISD and innovation processes. The metaphor provides a tool to interpret, understand and act upon process ambiguity.

In this paper we argue that processes in emergent design domains aiming at emergent design solutions are highly ambiguous. This implies that conventional assessments of delivering according to budget, schedule, and scope expectations can be misleading. If we recognize ISD and innovation processes as fragmented, we need to explore other dimensions of assessments; assessment dimension that are not based on the dominant logic that processes and design outcomes are predictable, rational and standardizable between design domains. Alternative or complementary dimensions of assessments could for example be more focused on the innovativeness of design solutions and implications in the design domain. This being said, we of course recognize that there are limits to how much resources that organizations are willing to risk and spend on ISD and innovation.

If we accept the gestalt of ISD and innovation as of nature fragmented, it has implications for ISD practice. Firstly, it is of significance for how we design and evaluate ISD models, methods, techniques and tools. Secondly, it is of significance for how we contextualize these to emergent design domains. It seems reasonable that we need approaches that on one hand can reduce destructive fragmentation, and on the other hand enhance valuable ditto to reach emergent design outcomes (see e.g. Austin et al., 2012). The latter is important to reflect on, given a future where ISD and innovation is widening into emergent design domains and emergent design solutions. In this paper we have argued that this direction is accompanied with increased process ambiguity. In our future research, we

aim to investigate the explanatory capacity of the metaphor on novel digital innovation initiatives in public transport and health sectors.

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