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SYSTEMS OF IT INNOVATION – TOWARD A RESEARCH FRAMEWORK FOR INTEGRATED ANALYSIS AND INTERVENTION

Completed Research Paper

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Abstract
For more than 20 years, interdisciplinary innovation research utilizes systems of innovation (SI) as a valuable core concept for analyzing innovation phenomena at large scale. Until today, this concept has not been referred to widely in information systems (IS) research. In this paper, we argue that SI may serve as a useful study subject for IS research. For analyzing and intervening into systems of IT innovation, a conceptual and methodological foundation is required. Therefore, we developed the outline of a conceptual and a methodological research framework. This framework has initially been used in a research project on the system of IT innovation for hospitals in Germany. Insights from this study were used to further improve the framework.

Keywords: Systems of Innovation; Framework; Intervention; Grounded Theory; Action Research
Introduction

By definition, innovation includes at least two involved actors: Someone who develops the innovation and someone who uses the innovation. In information systems (IS) research, we often focus on one of these two actors and their individual perspectives. However, interdisciplinary research on innovation, the diffusion of innovations and systems of innovation reminds us of far more actors and factors influencing innovation processes (Edquist 2005; Rogers 2003). When turning the focus to the broad level of sectoral, regional or national systems of innovation, IS research does not offer an appropriate theoretical or methodological framework until now. As the development and implementation of IT innovations is considered to be crucial for societal and economic development, IS research should support these tasks with an appropriate research stream. This is especially true, as many IT innovations have the potential for influencing and changing whole industries. In our research project, we strive for answering the question of how a framework for analyzing and intervening into systems of IT innovation should be structured in its conceptual and its methodological dimension. This framework should be used for gaining an overview of a system of IT innovation, to identify weaknesses hindering innovation and to inform researchers and other actors how the system should be changed to overcome these weaknesses. Though we have already conducted an analysis and intervention based on this framework, it is still in an initial stage and needs to be improved by further theoretical foundation and empirical evaluation. Due to the limited space, the following description of the framework already includes the changes made after reflecting its first use in the study described in this article. In the following section, we describe the concept of systems of innovation (SI) as a focus of interdisciplinary innovation research. In the third section, we argue for using the term ‘intervention’ instead of ‘design’ for projects aiming at changing systems of IT innovation. The following sections describe the framework’s theoretical and methodological parts for analyzing and intervening into systems of IT innovation. In the sixth section, we present an overview on the use of this framework in a first study. We close with a conclusion and a plan for our next steps. References Ackoff, R. L. 1961. “Management Misinformation Systems,” Management Science (14:4), pp. 147-156. Benbasat, I., and Zmud, R. W. 2003. “The Identity Crisis within the IS Discipline: Defining and Communicating the Discipline’s Core Properties,” MIS Quarterly (27:2), pp. 183-194. Bonini, C. P. 1963. Simulation of Information and Decision Systems in the Firm, Englewood Cliffs, NJ: Prentice-Hall. Broadbent, M., Weill, P., O’Brien, T., and Neo, B. S. 1996. “Firm Context and Patterns of IT Infrastructure Capability,” in Proceedings of the 14th International Conference on Information Systems, J. I. DeGross, S. Jarvenpaa, and A. Sririnivasan (eds.), Cleveland, OH, pp. 174-194. Carroll, J. 2005. “The Blacksburgh Electronic Village: A Study in Community Computing,” in Digital Cities III: Information Technologies for Social Capital, P. van den Besselaar and S. Kiozumi (eds.), New York: Springer-Verlag, pp. 43-65.

Systems of IT innovation as a research subject for IS research

For more than 20 years, researchers have explored innovations from a system perspective. During this time, several variants and perspectives on systems of innovation were developed. National systems of innovation (NSI) were the focus of the first studies in this field. Freeman (1987, p. 1) defines NSI as ‘the network of institutions in the public and private sector whose activities and interactions initiate, import, and diffuse new technology’. The NSI concept drew attention, as especially the comparison of different systems delivered valuable input for policy makers. Therefore, the approach was also adopted by organizations like the OECD (1999b, 2002). In the following years, the approach was enriched by concepts like interactive learning and interaction between users and producers (Lundvall 1992). The systems of innovation research also developed other concepts for bordering a system of innovation. The concept of regional systems of innovation (RSI) uses a smaller unit of interest which is also relevant to industry cluster analysis (OECD 1999a). The sectoral system of innovation (SSI) approach defines a SI by a certain industry (Breschi and Malerba 1997). A third relevant subclass of SI research, called technological systems, uses a certain technology as the focal point for analysis (Carlsson and Stankiewicz 1995). Edquist (2005) tries to integrate different sub-approaches and proposes a general SI definition. For him, systems of innovation are the relevant determinants for innovation processes. Or in other words: ‘all important economic, social, political, organizational, institutional, and other factors that influence the development, and use of innovations’ (Edquist 2005, p. 182). A system of innovation consists of components and relations. The main components of a SI are organizations and institutions. While the
former are defined as ‘formal structures that are consciously created and have an explicit purpose’ (ibid.),
the latter are defined as ‘sets of common habits, norms, routines, established practices, rules, or laws that
regulate the relations and interactions between individuals, groups and organizations’ (ibid.). In this
definition, individuals and groups do only exist as a part of organizations, which are considered to be the
‘actors of the game’ (ibid.). The SSI approach of Breschi and Malerba (1997) adds individuals as another
kind of actor (without necessarily being a part of an organization). The main function of a system of
innovation is to develop, diffuse and use innovations (Edquist 2005). Applied to the context of
information technology (IT), we define an IT innovation as a (from the perspective of an actor) new
solution to a problem on the basis of IT. This definition uses a subjective viewpoint on innovations, which
is common in innovation research, especially in the diffusion of innovation research tradition (Rogers,
2003). Like systems of innovation, systems of IT innovation can be bounded by regional, sectoral,
national or technical criteria. In IS research, the SI concept has already been used in a few cases, for
example to analyze mobile telecommunications market innovation (Damsgaard and Gao 2004), the global
diffusion of the internet (Wolcott et al. 2001) or public programs (Vega et al. 2010). The SI research
tradition is, like important parts of innovation research in general, an interdisciplinary research field.
Disciplines like political science, economics, and sociology are involved. They use the basic concepts of SI
research for their individual studies and also contribute to the ongoing research in this field with the
results of their work. In his article, Edquist (2005) tries to summarize the commons, which research
activities in this field share. This leads to the very general definitions and concepts mentioned above. This
flat ontology aims at providing a common platform for several disciplines. Edquist argues for staying in
the status of ‘undertheorization’ and not to enrich the concept with additional sub-concepts, to keep a
common platform for sharing and discussing results from several disciplines. Though this is a valid
standpoint, for practically analyzing a system of IT innovation it is necessary to provide more theoretical
and methodological support. This should not hinder any discussions across disciplines’ boundaries.
Instead, as innovation is essential to sustaining and improving wealth and welfare, the research on SI may
be seen as a transdisciplinary research field. This kind of research leaves traditional disciplines aside to
focus on problems of society or organizations (Mittelstrass 2003). The relevance of transdisciplinarity and
its challenges for IS research are already being discussed in the field of IS theory (Wahoff, Porto de
Albuquerque, and Rolf 2012; Porto de Albuquerque, Simon, and Rolf 2008). Based on this viewpoint,
each discipline – like IS – should provide own concepts and methods to the discussion on systems of
innovation but it should also be open to adopt ideas from other disciplines or interdisciplinary fields
(Vega et al., 2010).

From analyzing systems of IT innovation to intervention

Studies in the field of SI research do often conclude with ‘policy recommendations’ after a thorough
analysis (e. g. Steinmueller 2004). This may be a result of the research tradition in the field’s dominating
disciplines like policy research. It may also be a result of the interests of studies’ sponsors, which are often
political actors or organizations like the OECD. These actors are interested in gaining information as an
input for their own or their member states’ political action. However, ending up with an analysis and
recommendation may not be enough in other disciplines, like IS research. One would – according to the
design science and action research approach – at least expect a suggestion for steps to implement these
recommendations, to analyze the implementation process or to evaluate its results. As systems of IT
innovation are very complex systems which may include thousands of organizations, political actors,
institutions, and their relations, changing or influencing these systems is an even more complex,
demanding and precarious task than changing organizations. Therefore, we suggest to use – following
general systems’ theory and Luhmann’s theory of social systems (Willke 1999) – the term of ‘intervention’
rather than ‘design’ when we go the step from analyzing systems of IT innovations to using the results for
a change project. Intervening into a system of IT innovation may be done by the researcher (leading to
action research) or by any other actor in the system (leading to different kinds of methods like case
studies or evaluation research).

Toward a theoretical framework

In the debate of under- vs. overtheorization of the SI concepts, Edquist (2005) argues for rather few
concepts as a general platform. Though this may be a helpful step for interdisciplinary research, we aim at
transferring these concepts into IS research and therefore need to address the special issues of this field. From the viewpoint of even broad IS research frameworks, Edquist’s framework can be characterized as undertheorized. Therefore, we used the ‘mikropolis model’ (Porto de Albuquerque, Simon, and Rolf 2008) to extend the conceptual basis of the SI tradition in a first step. This framework has been selected as it provides general categories for understanding IT innovations in organizations and society and as it has a transdisciplinary focus. Furthermore, we use additional concepts from interdisciplinary innovation research to enrich the theoretical basis. This selection until now has been done in a rather eclectic way and needs further rigorous investigation by an appropriate literature review. The resulting theoretical framework consists of two major parts (see Figure 1). The left side represents the structural aspects of systems of IT innovation. The right side represents the dynamic perspective with the concept of IT innovation projects. To explore the dynamics of a focal system, one first needs to identify and describe involved actors, the arenas they are acting in and the so called macro context. While the concept of actors is derived from the SI approach, the concepts of arenas (classes of actors) and macro context (including institutions of society like law and norms) are taken from the mikropolis model (Porto de Albuquerque, Simon, and Rolf 2008). As we focus on systems of IT innovation here, we also need to consider ‘the IT artifact’ (Orlikowski and Iacono 2001) and according specifications and standards. The major activities in a system of IT innovation are done in IT innovation projects, which address certain problems perceived by some actors and lead to certain results and outcomes (which may be – according to the definition – a solution to the problem). The IT innovation project itself is pushed forward by innovation activities like analyzing a context, developing IT, and change management. The socio-technical perspective of the mikropolis model supports the understanding of the complex tasks of decontextualization and recontextualization during IT development and adoption (Porto de Albuquerque, Simon, and Rolf 2008).

![Figure 1. Theoretical Framework for Systems of IT Innovation](image-url)

Both parts of the framework are linked by two concepts which support analyzing the relation between the static and the dynamic perspective. The first is called patterns of IT innovation. This concept was included as a result from the first study. An IT innovation pattern summarizes a number of similar IT innovation projects in a specific IT innovation system. It includes various project courses, which share essential characteristics (invariants). It also covers a number of different concrete forms (variants). The normative-critical perspective is an overarching concept which is used to identify shortcomings in the focal system of IT innovation. These shortcomings may be used as a starting point for an intervention project. This theoretical framework addresses the issue of ‘undertheorization’ in Edquist’s conceptualization by adding relevant existing concepts for better guiding the researcher to relevant aspects of systems of IT.
innovation. In the first step, it has been developed by integrating SI research with the mikropolis model and insights from interdisciplinary innovation research.

**Toward a methodological framework**

In the previous section we took the first step for supporting research on systems of IT innovation by presenting the theoretical framework. We now turn to the questions of how systems of IT innovation may be analyzed and how an intervention may be planned on the basis of the analytical results. For analyzing a system of IT innovation, the researcher needs to consider a lot of empirical material. Transcripts of expert interviews, observation protocols, journal articles, trade fairs, product brochures, and websites may all contribute relevant information. To analyze this material, we propose to use Grounded Theory in the tradition of Corbin and Strauss (1990, 2008). The first reason for this decision is the preliminary status of our theoretical framework. We cannot be sure that it will guide the analysis to all important aspects. Hence, we need more openness for concepts arising from the data. Unlike other methods which propose inductive coding and openness, Corbin and Straus' approach provides a number of general concepts for structuring the data and the codes. The third reason for selecting this method is, that the authors explicitly mention the relevance of using existing literature for increasing the theoretical sensitization during the process (unlike Glaser's variant of GT). Our methodological framework (see Figure 2) starts with the theoretical sensitization as the first step. The researcher needs to understand the concepts of the theoretical framework as described above. In the second step, the focal system of IT innovation needs to be defined and bordered. Depending on which system is chosen for analysis, the researcher needs to analyze existing literature covering important issues of IT innovation in the focal system. Previous studies may have addressed certain issues in the focal system or in a similar system (e.g. in another nation). Afterwards, the research approach for the empirical phase needs to be planned. In our initial study, we used the Grounded Theory method and different data sources, as mentioned above. Afterwards, the empirical data needs to be collected and evaluated. This first part of the research framework ends up with a description of the structures and dynamics of a focal system of IT innovation.

![Methodological Framework Diagram](image-url)
In the next part, we use the insights gained by the previous study to identify potentials for improvement and derive needs for action. This may result in a long list of problems, and each of them may need to be tackled in a separate interventional project. For the next steps, action research (Baskerville 1997, 1999; Baskerville and Wood-Harper 1996; Susman 1982) is considered to be a helpful guideline, if the researcher does the intervention herself / himself. However, some problems may require other actors to take the dominating role in the intervention project. In this case, other methods like observing the project in a case study may be adequate. The evaluation of the intervention project and the results of the previous analytical phase may then be used to reflect them vis-à-vis the literature on the focal system of innovation and the theoretical framework. Both may be pushed forward by the results of further studies and projects in an iterative way. With this methodological framework we present a first step toward an integrated approach for analyzing and intervening into systems of IT innovation. It is mainly based on grounded theory and action research for the first iteration, but it is open to the use of other appropriate methods in the future. The idea of combining grounded theory and action research it not new, it has already been discussed in sociology (e. g. Simmons and Gregory 2003) and IS research (e. g. Baskerville and Pries-Heje 1999). The combination of both methods aims at overcoming the shortcomings of only being analytic and not action oriented (grounded theory) and of not having a rigorous support for theory development (action research).

Using the framework for analyzing and intervening into the system of IT innovation for hospitals in Germany

So far, we used both frameworks in a study on the system of IT innovation for hospitals in Germany (Drews 2012a). The system of IT innovation under study is bounded by the focus on hospitals in Germany as a context for IT adoption. Within an iterative process of data acquisition and analysis, 16 transcribed expert interviews and 18 observation protocols from workshops, trade fairs, etc. were completely coded and analyzed. Furthermore, we analyzed 1700 documents like product brochures, journal articles, and web pages. The complexity of this context becomes visible in the result, a 140 pages Grounded Theory (ibid.). The results of the analytical phase were also used to identify 19 potentials for improvement and 9 recommendations for action. One of these recommendations was used as the starting point for an action research based project which improved the exchange of innovations between a software vendor and its customers (Drews 2012b). 7

Conclusion and next steps

In this paper, we have argued that systems of IT innovation are a relevant IS research topic. Analyzing and intervening into systems of IT innovation are complex research tasks. From the IS perspective, these tasks are even more demanding, as relevant concepts of this field were mainly developed by other disciplines. As innovation research and SI research are both interdisciplinary fields, IS researchers should consider existing approaches of those field as well as the additional effort for being involved in an interdisciplinary research area. For analyzing and intervening into systems of innovation, a research framework has been initially constructed. It includes a theoretical and a methodological part. In a first study, we applied both and used the results and reflections on the project’s course to improve the framework. Our theoretical framework, as we have argued, is in a preliminary stage. Further improvements of this framework may be based on the integration of additional (e. g. IS-specific) concepts. Another way for improvement is to analyze further systems of IT innovation in an iterative way. Insights gained from the analysis of additional systems of IT innovations are an important source of inspiration for identifying structures or shortcomings in other systems. Future research may also use different research methods as a part of the methodological framework. Qualitative case studies, for example, require a conceptual framework (Walsham 1993). A matured theoretical framework may be used as a guide for these case studies. This is desirable, as using the GT takes a great effort. Future research may consider the results of our study to further investigate relevant concepts for analyzing systems of IT innovation. Many traditional concepts from IS innovation research focus on the perspective on an individual or an
organization. By moving towards systems of IT innovation, the insights from this research is partly relevant, but it also has to be complemented by other concepts covering issues of interaction among diverse organizations in a surrounding macro context. While this 'helicopter perspective' in the first step may be relevant for researchers and policy makers, organizations and practice may profit from the results as they can use it as an input for designing their own IT innovation strategy and IT innovation management (Drews et al. 2013).

References


