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Information Systems Change and Social Interaction: A Research Agenda

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INFORMATION SYSTEMS CHANGE AND SOCIAL INTERACTION: A RESEARCH AGENDA

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Abstract

As the investments in IT are still growing and organizations are more dependent on IT than ever before practitioners as well as researchers are still lacking theories or models that help and explain if and when IT has to be adapted, partly exchanged or entirely implemented. In this paper we claim that one major reason for IS change lies in the interaction of human agents while using IT to solve tasks. Human agents cooperate within and simultaneously build a social network that is partly self-organizing, dynamic and uncontrollable from the outside. This dynamic can cause unintended pressure on the use and the usability of IT and therefore may force organizations to change the IS. This article discusses the Structurational Model of IT and concepts of the Social Network Analysis and draws several implications of examining the impact of social interaction on IS change.

Keywords: IS Change, Structurational Model of IT, Structuration Theory, Social Network Analysis.

1 INTRODUCTION

Since the end of the 1950s the analysis of the effects of technology on productivity stands in focus of both academic literature and in practice (e. g., Leavitt and Whisler 1958, Leavitt 1965). The continuous pressures of competitiveness and costs as well as the need to increase productivity are among the main drivers of permanent investment in technology. If a company invests in new technology, it expects the creation of added value and an increase in productivity respectively. The widespread impacts of information technology (IT) on business processes are increasingly acknowledged to be fundamentally strategic, as new IT continues to progressively penetrate core business processes (Davenport and Short 1990, Hammer 1990). Many contributions argue that IT enables us to redesign and reengineer business processes and to make them better, faster, leaner and so forth (Davenport 1993, Hammer and Champy 1993). As a result, organizations and their IT are growing mostly inextricable, and all large organizations are fully committed to their IT as infrastructure (Courtney et al. 2008, p. 43). Today, expenses in IT are comparable to expenses in research and development, ranging typically from 1% to 3% of revenue and extending up to 5% to 10% in some industries (Gomolski et al. 2001). Global spending on IT continues to grow and is expected to reach 1.66 trillion US Dollars in 2009 (Bartels 2009). Empirical analysis of survey data shows that the highest IT spending priorities are in the areas of administration, production and distribution (Cha et al. 2009). But other studies suggest that investments in IT do not necessarily lead to an increase in profit or productivity (Dempsey et al. 1998). This apparent problem has been prominently coined the "IT Productivity Paradox" or "IT Black Hole" (Brynjolfsson 1993). IT investments as well as increases in productivity form a complex relation; they are not inevitably connected with each other (Brynjolfsson 2003). The interaction between IT and organization is very complex and influenced by many mediating factors, including the organization's structure, standard operating procedures, politics, culture, environment, and management decisions (Laudon and Laudon 2005, p. 77).

The importance of IT in today's business world is undeniable. However, the impact of IT on the organization and vice versa is not entirely revealed and needs further clarification. IS change in general is ambiguous and dynamic as the nature and means of IT vary over time. The starting point for our research project is on human agents and their cooperation in order to accomplish tasks by using IT. Our main interest is to investigate to what extent social interaction of individuals shapes and determines the use and the evolution of IT and therefore puts pressure onto the necessity to adapt or completely change the IT. The question is: *How is IT being adapted in the course of complex indeterminate interactions between technology and human actors in organizations and how do complex changes in the environment affect this interaction?*

In contrast to static variance models (e. g., Davis 1989), we intend to emphasize *social interactions* as one of the main drivers of IS change. We argue that this will hopefully provide new insights into the development and pattern of IT use and change. We propose the application of the structurational model of IT (e. g., Orlikowski 1992) for explaining the interaction of human agents and the use of IT as well as the construction of social constructs. However, the model is constrained in its consideration of organizational influence since the operation, role and influence of human agency is rarely scrutinized (Jones et al. 2004). That is why we suggest using social network analysis (SNA) as a research methodology to collect data that digs deeper in the process of social construction and to apply the concepts of self-organization and emergence to describe different stages of IS change. The findings might provide researchers as well as practitioners with in-depth knowledge about the processes underlying IS change and might help to explain and control IS change.

The remainder of the paper is structured as follows. In the next section, we discuss the causes of IS change and explain the structurational model of IT. Afterwards, we present our research objectives. Following this we explain our research methodology and the current state of the project in section 4 and conclude in section 5 with our research agenda.

2 IS CHANGE AND THE STRUCTURATIONAL MODEL OF TECHNOLOGY

2.1 Causes of IS Change

An information system (IS) in general does not only comprise the IT that is being developed and applied in practice, rather an IS embraces the organizational context and the users of IT who interact within the context (Ives et al. 1980, Lyytinen 1987). Therefore IS are *socio-technical systems* in a specific organizational context, which includes both technical and organizational sub-systems. Whereas a more technical view on IS was prevalent during the early days of IT due to the relative costs of the technical components, today the social dimension is more likely to cause problems since overall, the technology is reliable and well tried (Avison and Fitzgerald 1995, p. 6). Therefore, rather than thinking of an IS solely as a technical artifact, it seems more appropriate to think of it as a social system: IT is only able to play a limited role in an organization by capturing, storing, forwarding, and processing data signals; organized human behaviour depends on a far richer form of communication than any machinery can account for (Stamper et al. 2000, p. 15).

Similarly, *IS change* is concerned with generating a deliberate and intended change to an organization's technical and organizational sub-systems that deal with information (Swanson 1994). It comprises the "generation, implementation, and adoption of new elements in an organization's social and technical subsystems that store, transfer, manipulate, process and utilize information" (Lyytinen and Newman 2008, p. 590). However, with respect to the social sub-system, not all changes have to be inevitably planned by managers or designers – organizational actors can change or conserve business processes in ways not intended, planned or whished for (Tsoukas and Chia 2002, p. 569).Therefore we argue that IS change does not have to be necessarily intended, and that is worth paying attention to *unintended IS change*. This is contrary to viewing IS change as akin to a consciously planned and systematic design of organizational strategy, structures, processes and IT by designers and managers (Chan et al. 1997, Teo and King 1997). This belief in the "rational design" of IS is potentially dangerous because there is only a vague understanding of the complex interactions, dynamics and multi-causal relationships in the involved social interaction and co-evolutionary processes (Allen and Varga 2006). There is little doubt that decision-making of organizational actors is multifaceted, emotive, and only partially cognitive; regardless of one's viewpoint on how individuals *should* make decisions, the processes they *actually* rely on are far from the rational ideal (Keen 1981). Consequently, we regard IS as deliberately changing and unintended evolving systems, therefore changes in IS refer to *differences over time* – a process view (Markus and Robey 1988). Because different human individuals in different organizations make individual choices in the adoption or implementation of new IT, one organization might interpret this process and experience IT changes differently from another organization.

Technological innovations are not the only reasons organizations and IS are adapted or changed (for an overview see Krell et al. 2008). One can distinguish factors of influence that are exogenous and affect the organization and the IS from the outside or factors that are endogenous and impinge on the organization and the IS from the inside (Table 1). These causes for IS change may in return lead to several effects, for example, the decision to outsource complete business processes or parts of the IT infrastructure of an organization (e. g., Mani et al. 2006). Consequently, the managers of an organization have to develop strategies that grasp the reasons for changes in order to ensure that the IS – the system which is composed of IT that is used by human agents to capture, store and process data within an organizational context – will "survive" and support core business processes after an intended or unintended change has occurred.

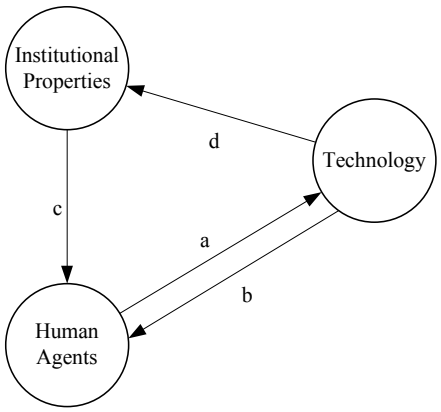
FACTOR OF INFLUENCE	EXAMPLE / DESCRITPION
Exogenous factors	
Industrial Norms and Standards	For instance, the Sarbanes-Oxley Act forced many companies to change their accounting systems
Emerging IT	IT can become obsolete when new versions of applications enter the market and organizations may choose to replace their legacy systems or to expand them with new functionalities.
Mimicry of Competitors	Competitors that show success on the market may impose standards on other organizations and force competing organizations to mimic their IT
Endogenous factors	
Business change	As business processes rapidly change, the technological infrastructure has to be constantly adapted in order to support core processes (Hammer 1990).
Organizational change	Company mergers can obviously create pressure to replace, adapt or merge IS.
Human agents	One of the most important factors of influence that induces changes in the IS relies in the human agents who are interconnected as organizational actors in a social network, and who co-evolve with the IT (Allen and Varga 2006).

Table 1. Factors Influencing Organization and IS

2.2 Structurational Model of Technology

Social and technical processes are always embedded in practice so that all kinds of IT components are considered to be a part of a more complex socio-technical ensemble. Consequently, socio-theoretical frameworks have often been used for the investigation of IT in organizations (e. g., Mumford 2003, Lyytinen and Newman 2008). In order to account for the change of IS we refer to the so-called *structurational model of technology* because a structurational perspective is inherently dynamic and based on human interaction (Orlikowski 2000). Therefore it has the potential to explain change in technologies and use. Structuration theory (Giddens 1984) is according to Jones and Karsten (2008) one of the most widely cited social theories in IS research. It is a theory of social action, which claims that society should be understood in terms of action and structure; a duality rather than two separate entities (for overviews see Poole and DeSanctis 2003, Jones et al. 2004, Jones and Karsten 2008). Building on structuration theory, the structurational model of technology (Orlikowski 1992), and particularly the concept of duality of technology, explain that technology is physically constructed by actors in a given social context as well as socially constructed through the action of human agents.

The duality of technology refers to the recursive and dynamic interaction between social structures and IT and tries to elucidate the recursive dependency between technologies, organizations and social structure (Orlikowski and Robey 1991, Orlikowski 1992). Structures (rules and resources, organized as properties of systems) are not located in technology or organization but are enacted by interacting human agents. That is why the structurational perspective accounts for a fluid and flexible view of structure (Orlikowski 2000). In doing so the structurational model of technology implicitly comprises the change of IS, for example, by proposing the "interpretative flexibility" of technology (Orlikowski 1992). It proposes four key influences (Figure 1), that operate continuously in the interaction between human agents, technology and organizations (Orlikowski 1992). The central element is the human agent and her or his interaction with other human agents, creating social structure. This is why the structurational approach helps to highlight the nature and influence of human agency. However this approach so far is limited in its attention to organizational influences (Jones et al. 2004), in its disregard to vital elements of agency because collective actors and agents are rarely scrutinized (Vaughan 2001, p. 198), and in its dealing with the motivation why agents reproduce a social system or try to transform it, which requires a theory of interacting subjects (Alexander 1992, Bryant 1992, Vaughan 2001).



- *Technology as a Product of Human Action* (a). Technology is an outcome of such human action as design, development, appropriation, and modification.
- *Technology as a Medium of Human Action* (b). Technology facilitates and constrains human action through the provision of interpretive schemes, facilities, and norms.
- *Institutional Conditions of Interaction with Technology* (c). Institutional Properties influence humans in their interaction with technology, for example, intentions, professional norms, state of the art in materials and knowledge, design standards, and available resources (time, money, skills).
- *Institutional Consequences of Interaction with Technology* (d). Interaction with technology influences the institutional properties of an organization, through reinforcing or transforming structures of signification, domination, and legitimation.

Figure 1. Structurational Model of Technology according to Orlikowski (1992)

3 SOCIAL INTERACION AND IS CHANGE

Social structure is continuously being created through the flow of everyday social practice and comprises rules and resources, organized as properties of a social system (Jones et al. 2004, Jones and Karsten 2008). Small, incremental adaptations in organizations and IS are generated by contextual variation (Weick 1998), that are initiated by exogenous or endogenous factors that have an impact on the organization (Figure 2). Whereas these factors act upon the organization as a whole, another change factor can occur when human agents adapt to environmental changes and begin to *self-organize* (Anderson 1999). During the process of using technology in a social context and in practice, the shared understanding, the interpretative flexibility (Orlikowski 1992) or the structural properties (Orlikowski 2000) of IT can change. Adding to all of this, the social network of interacting agents using IT in an organizational setting changes, too (Barley 1990). This is why IS change in general is ambiguous and dynamic in that the nature and means of IT vary over time while context changes, or while human agents evolve unpredictably. The development and evolution of a social system is incremental and ongoing (Tsoukas and Chia 2002), and the need for a change is obvious only if, for example, a certain extent of complaints from the agents is being gathered or the IT does not support the business process in an adequate way.

Referring to the causes for IS change, we argue that human agents do not only act upon organization but also constitute to a large part the IS by using technology. Human agents do not only deliberately or inadvertently shape structure: in the course of social interaction and by being part of a socio-technical system, the social network of human agents adjusts its way of behavior relative to changing internal or external conditions. The IS as a socio-technical system is *self-organizing* in the sense that its members adapt autonomously and dynamically to changing conditions, acquiring and maintaining structure without external control (Ashby 1962, Kauffman 1995, Anderson 1999, De Wolf and Holvoet 2005). Self-organization emphasizes the adaptive behavior of individuals in a system and the creation and maintenance of an increased order. A concept similar but different to self-organization is that of emergence. *Emergence* refers to the fact that global properties of a whole system dynamically arise from the interactions between the parts of this system (De Wolf and Holvoet 2005). Simply put, emergence in this context means that a system shows properties and behavior that are not located in its parts and components but in their *interaction* – "the whole is greater than the sum of its parts" (Kauffman 1995, p. 24). Such properties cannot be reduced to the properties of the sub-systems and are relative to self-organization more rigid and stable across time. Then self-organization is the emergence of order through the interaction of the components of the system – human agents in IS.

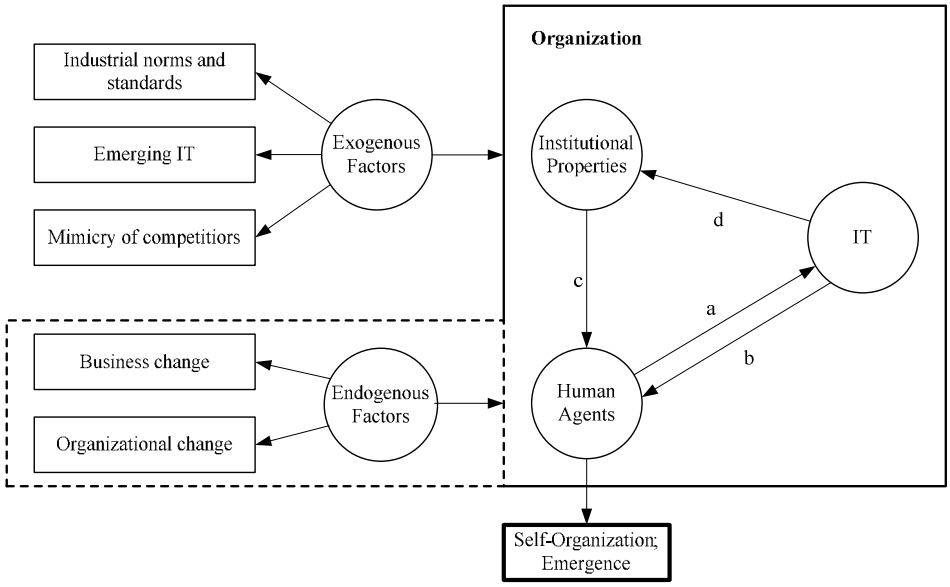


Figure 2. Structurational Model of IT and IS Change Factors

To the best of our knowledge, these two concepts have until now only rarely been applied to the structurational model of technology or IS change. Traditionally, research on IS change as well has focused only on how IT influences organizational structure (e.g. variance models Davis 1989, DeLone and McLean 2002) and the interaction of individuals (Barley 1990, Burkhardt and Brass 1990). We intend to change the line of vision by investigating to what extent the social interaction of individuals shapes and determines the use and the evolution of IT, and thus how evolving IS affects the use of IT. As IT is a passive element in the process of self-organization and emergence, passive in the sense that IT (the material artefact) cannot change itself independently according to variations in the environment, be it the human agents or the external environment, the evolution of IS and the point of time when IT has to be actively adapted have to be made clear in order to guarantee sustainable IT use and business support. In other words and paraphrasing structurational IS research theory: rather than starting with the technology and examining how actors appropriate its embodied structures, we start with human action and examine how it enacts emergent structures through recurrent interaction with the technology at hand (Jones et al. 2004). The following three proposals lie at the core of our approach:

(1) *Social structure – the enactment of structures in practice – manifests itself in specific network structures of self-organizing human agents who cooperate, communicate and work together using technology*. Related perspectives have been often employed by previous research and amply demonstrated to be fruitful (e. g., Braha and Bar-Yam 2007, Kleinbaum and Tushman 2007). In adopting a network view, we abstract to a degree from the individual knowledgeable and reflexive human being and claim that every interaction with other individuals and IT will lead to observable network structures in the long run. These network structures can be understood as a visualized map of social structure.

(2) *Specific properties of networks will emerge through the interaction of human agents that can be measured by using well-known concepts from social network analysis (e. g., Wasserman and Faust 1994, Scott 2000).* Among these are concepts such as cohesion and centralization.

(3) *The concepts of self-organization and emergence can provide useful insight to seize and comprehend the dynamics of IS change in more detail.* Interacting and communicating human agents affect evolving network structures on the one hand. On the other hand the behaviour of human agents and the ability to connect and communicate with each other is constrained by well-established and existing network structures (Barley 1990).

The combination of social network analysis with the structurational model of IT will not only make a theoretical contribution to the field. In addition to that, dependencies of human agents, IT and institutional properties can be unveiled and explained in more detail as well.

4 METHODOLOGY AND CURRENT STATE OF PROJECT

4.1 Social Network Analysis

We suggest employing SNA as a methodology for examining our proposals. SNA is an approach used to study the exchange of information among individuals. Several studies have shown that network analysis is of great use in capturing the business or workplace performance of organizations or teams (Balkundi and Harrison 2006, Kleinbaum and Tushman 2007). In contrast to the classical hierarchical view of an enterprise, a "network view" suggests that all people are interconnected in a complex web of connections. In this context, social networks can be understood as interpersonal, non-hierarchical links between individuals, business units and organizations along which information flows (Laumann et al. 1978, McKeen and Smith 2007). These connections, links or ties are a fundamental part of how work gets accomplished within an organization (Brown and Duguid 2001). SNA has been extensively used to analyze organizations, teams as well as groups (e. g., Braha and Bar-Yam 2007, Kleinbaum and Tushman 2007) and has recently received more attention from IS research (Wu et al. 2008). For example, Burkhardt and Brass (1990) used SNA to examine whether the implementation of new IT has an impact on the organizational structure. Amongst other results, they observed changes in the network structure as a result of using new technology. At the same time, Barley (1990) showed that the effects of a new technology are profoundly social: on the one hand, the existing network structure may constrain use of a new technology; on the other hand, it may alter the social structure. Similarly, Wu et al. (2008) demonstrate how SNA can be employed to understand what types of social structures are most conducive to transferring knowledge and improving work performance in face-to-face communication networks of IT professionals.

To summarize, SNA is a methodological framework for understanding phenomena, offering a range of substantial and useful concepts and methodological tools to ISR. Traditionally, SNA has been less theoretically and more empirically driven; it is rooted in the empirical observation that patterns of interaction of many actors can be looked at as networks (Cook and Whitmeyer 1992). SNA on its own is more alike to a lens for "viewing and explaining the world" (Gregor 2006, p. 613), not a theory for "explaining and predicting" (Gregor 2006, p. 620). However, adopting this lens will allow us to examine our proposals empirically in detail. Therefore we argue that until now (1) we are still missing a model or theory that links SNA concepts to theories for explaining and predicting IS change, and (2) we do not have an understanding of which SNA concepts are most appropriate or useful in order to unveil the extent of network organization and IT involvement. We suggest that the analysis of micro-social dynamics of interacting human agents, examined on an aggregate network level, can potentially help us to identify patterns that support the gathering of information about the actual use and usefulness of IT, and consequently to provide information about the *status of* or the *need for* IS change. In contrast to static variance models (e. g., TAM), a SNA-based approach will allow us to observe and analyze the actual *processes* of IS change.

4.2 Social Analysis Concepts and IS Change

Known factors that affect the distribution of information within a social network can be subsumed under *relational and structural characteristics*. Relational factors refer to the nature of links, for example, the strength and quality of the relation between two objects whereas the structural characteristics of social networks, for instance, the network density, clustering, the existence of special nodes and so forth, refer to structural factors (Tichy et al. 1979, Haythornthwaite 1996). Apart from that network analyst have developed a number of useful definitions and algorithms that identify how

larger groups are compounded from smaller ones, such as cliques, n-cliques and k-plexes (Wasserman and Faust 1994). For an overview of relevant concepts see Table 2. These characteristics account for network characteristics and if applied over a period of time will hopefully be suitable for the disclosure of organizational self-organization and emergence.

CONCEPTS	DESCRIPTION
Structural factors	
Density	The number of actual links in the network as a ratio of the number of possible links (Tichy et al. 1979).
Inter-unity density	The number of existing ties from individuals in unit A to individuals in unit B as a proportion of the total number of potential ties (Kleinbaum 2006).
Structural hole	Location of so called "network entrepreneurs" to fill the gap between two separated groups (Burt 1992).
Cliques	A clique in general is a sub-set of a network in which the actors are more closely and intensely connected than they are to other members of the network (Wasserman and Faust 1994).
Relational factors	
Centralization	The degree to which a set of individuals are organized around a central point (Haythornthwaite 1996, Scott 2000).
Degree centrality	The number of ties a certain node has (Wasserman and Faust 1994).
Closeness centrality	The total distance of a node to all other nodes (Wasserman and Faust 1994).
Betweenness centrality	The number of times a node needs a given node to reach another node (Wasserman and Faust 1994).
Cohesion	Attributes of the whole network, indicating the presence of strong socializing relationships among network members, and also the likelihood of having access to the same information (Haythornthwaite 1996).
Structural cohesion	The minimum number of nodes, if removed from a network, would disconnect parts of the network (Moody and White 2003).
Structural equivalence	Two nodes that have identical ties to and from all other nodes in the network (Burt 1992).
Strong/weak ties	Strong/weak personal relations between individuals (Granovetter 1973, Burt 1992).

Table 2. Social Network Analysis Concepts

Whereas the concept of self-organization refers to the dynamic interaction of human agents and IT, the concept of emergence accounts for the emerging network structure properties that are more rigid and stable across time and only vary seldom. With respect to the proposals in section 3 we expect correlation between concepts of SNA and self-organization respectively emergence. Table 3 gives some possible examples of this. It is our hope that these concepts and their relationship to self-organization and emergence can help to reveal the dynamic process of IT use and IS change in the long run.

	SELF-ORGANIZATION	EMERGENCE
Time dependence	Time-variant; continuous evolving and changing network structure?	Rigid network structure; stable over time; when change occurs it is radical and rigorous?
Relational SNA-factors	Varying cohesion and density within sub-groups?	Average network cohesion and density are stable?
Structural SNA-factors	Varying degree of degree centrality, closeness centrality and betweenness centrality; Low structural cohesion and structural equivalence?	High degree of degree centrality, closeness centrality and betweeness centrality of certain nodes; High structural cohesion and structural equivalence?

Table 3. SNA and the Concepts of Self-Organization/Emergence

5 RESEARCH AGENDA

5.1 Proposed Data Collection & Further Course of Project

The focus of our research is the self-organization of social systems as well as the emergence of social structure and the resulting implications that force IS to change. Our research is driven by our three proposals stated in section 3. In order to investigate these proposals we are planning to conduct a qualitative as well as a quantitative longitudinal case study within one organization as a first step. Special focus must be put on the choice of the research instruments in order to account for the different communication channels and cooperation. A subject may use face-to-face communication or computer-mediated communication to accomplish tasks. Within the social network communities there exist multiple methodologies to obtain network data such as surveys, questionnaires, and self-reports. However data collection based on self-reporting are often biased toward the inclusion of strong links whereas data from surveys and questionnaires tend to produce better quality for close and strong ties than for distant and weak ties. Another problem arises when subjects fail to describe details such as discussion topics or the timing of interactions (Marsden 1990). Another approach to collect network data is the analysis of e-mail communication. The main advantage is that researchers here have the opportunity to collect real-time communication data, since e-mail archives record detailed communication logs (Aral and Van Alstyne 2007). Although nowadays e-mail communication is an vital communication tool face-to-face conversations remain an important and in many cases predominant mode of communication. Therefore we plan to also employ new data collection methods, for example, utilizing sociometric badges for recording real-time patterns of face-to-face interactions between employees in real-world work settings across time (Waber et al. 2007). Since we are interested in the evolution of IS we have to pay special attention to the interaction with and the use of IT. IT as a means to support direct communication refers to links between human agents whereas IT artefacts such as ERP systems refers to nodes. A case study is ideally suited for the application and the investigation of the structurational model of IT within an organization. With the help of observations and structured interviews we hope to gather enough information about the institutional properties and the use of IT by human agents in addition to the quantitative data from the SNA. By using the concepts of SNA we hope to gather information about the organizing behaviour of human agents when using IT. Further we will investigate whether the concepts of self-organization and emergence are suitable for the explanation and prediction of IS change. The combination of case study results and qualitative SNA results will provide useful new insights in the evolution of social networks within the structurational model of IT that serves in turn as a framework for explanation.

5.2 Future Research & Conclusion

The collected qualitative and quantitative data will have to be merged and preprocessed in order to be suitable for the analysis with established SNA tools like *Pajek* or *UCINET* (Huisman and Van Duijn 2005). The development of the social network will be examined from a longitudinal perspective using several time points of measurement. Thus the implications of changing social network structures for the use of IT should be revealed. So far this research paper builds the theoretical basis for our research project. The application of SNA in combination with the structurational model of IT as an explanatory framework will contribute to the comprehension of IS change and enable researchers as well as practitioners to make sense of the processes underlying IS change. This work will have implications for theory as it will hopefully contribute to the understanding of IT use and social action in a multiuser setting and provide insight into the complex interaction of IT and human agents. We hope to unveil to what degree self-organizational behaviour is positively correlated to IT use and when interacting agents start to bypass the IT in use by developing new SNA constructs. The concept of emergence will hopefully help to elicit social structures as posited in the structurational model of IT. Practitioners must be aware not only of the user-system and interpersonal interactions but have to pay attention in

particular to the status quo of interpersonal networks. Our research will hopefully show to what extent managerial interventions are necessary especially when emergent network structures change in an unintended way. Above this desired and undesired self-organization will be disclosed. However this research project is highly dependent on the organizational support to conduct the social network analysis. Only if data can be collected over a longer period the effects of social interaction on IS change can be properly and rigorously examined.

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