Seidlmeier, Heinrich

**Working Paper**

# Theory of networks and processes: A first foundation of process networks

Rosenheim Papers in Applied Economics and Business Sciences, No. 7/2023

**Provided in Cooperation with:**
Rosenheim Technical University of Applied Sciences

Technische Hochschule Rosenheim

# Theory of Networks and Processes – A First Foundation of Process Networks

**Prof. Dr. Heinrich Seidlmeier**
Technische Hochschule Rosenheim
Fakultät für Betriebswirtschaft
Rosenheim Technical University of Applied Sciences
Heinrich.seidlmeier@th-rosenheim.de

**Rosenheim Papers in Applied Economics and Business Sciences**

**No. 7/2023**

**Abstract**

The impulse to think about process-induced social networks (in short: process networks) comes from the discipline of “Process Mining” (e.g. van der Aalst et al. 2005). The relevant literature refers to an "organizational view" or "organizational mining" in process mining.

In essence, process mining is about creating a time-logical chain of related tasks from automatically logged user activities on a computer. In this way, real processes can be mapped and analyzed as models. As a "by-product", task-related social networks are created between the process participants through the predecessor/successor relationships in the workflow.

However, it should be noted and criticized that process mining research neglects the potential of social network analysis. The extensive findings of classical network research are not taken up further. An organizational and social scientific deepening of the data-driven preliminary work is missing in this discipline. Process mining, which tends to be mathematical and technical, has not yet developed the ambition to ally itself with empirical organizational and social research.

This working paper tries to counteract this. It presents a first, social science-based approach to theoretically grounding process networks.

## Contents



## List of Figures

## 1 Social networks: Assumptions and mechanisms

The central assumption of network theory is that an actor's *"embeddedness"* (Granovetter 1985) in a social network strongly influences his or her behavior and behavioral outcomes. This means that the decision-making and actions of actors (of individuals, but also of multi-person units) may be shaped more by their relational embeddedness than by actor's characteristics or by the actor's environment. Being part of a network can thus be seen as an essential interpersonal condition that influences behavior (similar to the prevailing formal power relations).

The above-mentioned "embeddedness" is more precisely understood as three aspects in terms of explanatory, but also design dimensions (Ebers and Maurer 2019). First, the *types of relationships* between the actors play an essential role: For example, do network members interact with each other very often or rarely? Second, the overall *structure of the network* should be mentioned: For example, is it a very dense network with many exchange relationships or a rather loose structure with few relationships? Finally, the *structural position of an actor* is important: Does a person, a department or a company play a central, strong or weak role in a personal or business network?

Furthermore, network theory provides three *mechanisms* that explain how the embeddedness can influence behavior and behavioral outcomes (Ebers and Maurer 2019). First, embeddedness determines which *resources* in the network an actor can access. Second, relational embeddedness can be used to exert dominant *power* (influence control and monitoring control) over other actors. And third, embedding allows the sending of behavior-influencing, even manipulative, information or *signals* about an actor's reputation to other actors. Access to resources, exercise of power and signaling effects are the resulting effects of these mechanisms.

## 2 Process-induced networks as a starting point

The central idea of this paper can be explained very clearly in the form of an "Event-driven Process Chain" (EPC), a type of model for representing business processes. According to Scheer (1999), EPCs combine different views of processes. Only three descriptive views are relevant here.

The *organizational view* focuses on the formal elements of the organizational structure and in particular on the persons, positions, departments, etc. involved in the process. In the *functional view*, the operational functions or tasks to be performed are mapped in such detail that they can be used as process steps. In the *control view*, organizational elements and functions are combined in such a way that the functions are placed in a time-logical sequence and the executing organizational elements are assigned to them.

Reducing the view concept results in a simple, exemplary process model as shown in Fig. 1 on the left.

In the process shown in Fig. 1, five functions F1 to F5 (process steps) are processed purely sequentially. Each function is assigned a position (or job) responsible for its execution (position P1 to P4). For better clarity, the formally required "intermediate events" have been omitted from the process model. Only the process-triggering start event and the process-ending end event are shown.

If we now adopt the relational view of the network approach, another descriptive view emerges that complements the organizational view: the *network view*. In process chains based on the division of labor, there are direct relationships between predecessors and successors. The material or informational work output of the predecessor functions as work input for the successor. The result is a *process-based social network*. This means, e.g., in Fig. 1: The connection from position P1 to P2 is created by P1 performing function 1 (F1), the output of which serves as input for the subsequent function 2 (F2). A "working relationship" is established between P1 and P2.

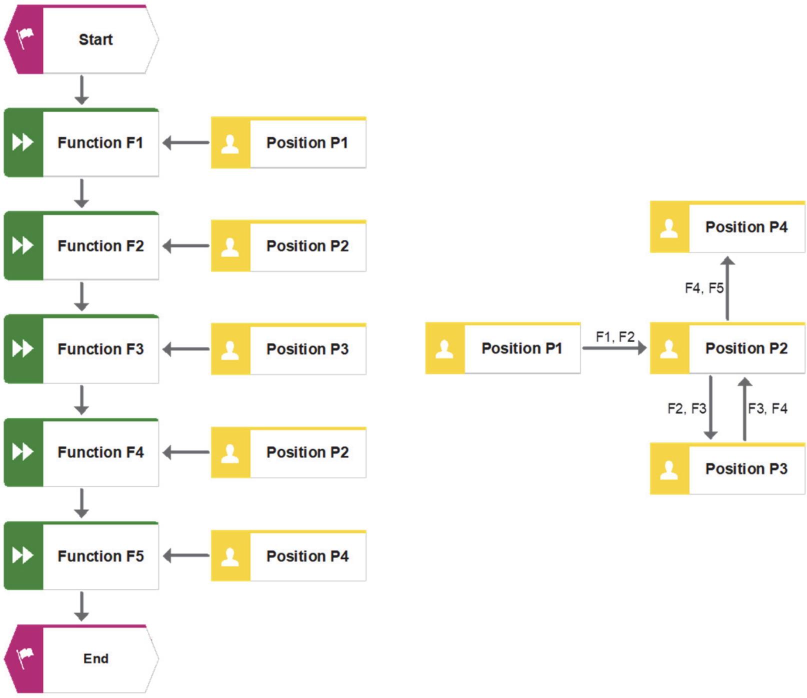


**Fig.1** Simple process model and derived network model

The reproduction of all formal, process-induced, performance-oriented relationships is shown in the network (in the form of a sociogram) on the right-hand side of Fig. 1. There is a directed relationship between position 1 and 2 due to the linked functions F1 and F2. Position P2 even has two relationships to P3 and P4 in the process flow. P2 obviously occupies a central position in the social network of the process example.

It is clear that the "transformation" of a process model into a network model does not change the data basis (for the analysis and design of processes). However, the network view of processes can reveal hidden connections in processes and generate new types of evaluation information. In addition, by extending the database, such *process-induced networks* (in short: *process networks*) can be compared with process- and task-independent social networks in the same research environment (at the company, division or department level). For example, if the professional cooperation in a process requires a high degree of trust between the process actors, the process network could be compared to a "trust network" (who trusts whom?). People with tasks in a process that can only be controlled with effort should have strong relationships in a trust network.

This basic idea is certainly accessible to people-intensive, "social" processes in particular (and not largely automated processes without human participants). Processes with special demands on the process participants, on the process environment (organization and technology) and on the process result also seem to be suitable. Here are some examples of process domains:

- Security (e.g., computer centers and military facilities)
- Health (e.g., hospitals and care facilities)
- Innovation (e.g., R&D departments)

## 3 Theory as explanation and design

The further procedure is based on the objectives of a *scientific understanding which is* recognized and widespread in applied business administration and also especially in organizational theory (Heinen 1985; Machlup 1978). The fundamental, *descriptive scientific objective* (describing and systematizing observed facts or events that have occurred) will not be considered further.

On the one hand, the article concentrates on the *theoretical goal of science* and thus on the verifiable explanation of empirical phenomena that have occurred (essentially events or effects) or of perceived reality by means of generally valid statements. Such explanatory statements or explanatory models express, for example, in the ideal form of causal law hypotheses, that under certain conditions (causes) certain consequences or phenomena (effects) are to be expected or predicted. A scientific, more precisely a deductive explanation *(explanans)* for the phenomenon of interest *(explanandum)* thus consists of causal initial conditions *(antecedent conditions)* and a regularity. This means for the problem of the article:

A process model created with empirical methods (e.g., surveys or process mining) should (simplified) contain all *antecedent conditions* and be transferred to the derived network model (e.g., "highly decentralized process network"). The *explanandum* is an observed process phenomenon (e.g., "many failures"). The core of a partial *explanatory model* is the theoretical regularities inherent in the process network (network model derived from the process model), which are based on the mechanisms already introduced: access to resources, exercise of power and signal effects. Alternatively, empirically determined regularities (e.g., "centralized/decentralized networks lead to few/many failures") come into play.

Neglecting conditions external to the model (e.g., the non-modelled expertise of the process participants), the ARIS methodology - as explained above - provides three descriptive views or explanatory approaches: the functional, the data and the organizational view. The new *network view*, as a view of the process-induced network, is to be seen as an insight-driving complement to the organizational view.

The central idea of network theory (see Section 1) is that the behavior of organizational members depends to a large extent on their network embeddedness, possibly even more than on personality traits and non-personal conditions (such as goal setting). Following this line of thinking reasoning, organizational elements (such as a job itself with its organizational equipment of competencies) of the organizational view, available data or more precise information of the data view and finally the specification of work steps of the functional view also play a subordinate role. How (e.g., with what care), when (e.g., after what waiting time) or even whether an assigned process step is carried out by a responsible agent at all can be influenced to a large extent by his direct relationship partners (predecessor or successor) and even by his indirect, more extensive relationships to others. Ultimately, the social network of a process has the highest explanatory power for the behavior of a process and thus for process performance. But certainly, networks alone cannot fully explain all observed phenomena.

On the other hand, this article attempts to develop *decision models* on the basis of explanatory models for the goal-oriented design of the area under investigation, i.e., of business processes, and for the solution of corresponding practical problems (*pragmatic goal of scientific*). Explanatory models are the basis of decision models for design. The conditions of an explanatory model can be used as decision variables (causes or means) to fulfill decision criteria (effects or goals). By changing the causal variables, desirable design effects can be determined with knowledge of the corresponding regularity. Possible courses of action as normative statements are the result.

## 4 Theory of networks and processes

In the following, the explanation of process phenomena from social networks will be deepened on the basis of the previous explanations. In Section 1, the *embedding of network actors* which controls the behavior and affects the results was presented - differentiated in the three dimensions: relationships between actors, overall network structure, structural position of an actor in the network. Embeddedness affects behavior and the resulting outcomes through three *explanatory mechanisms*: access to resources, exercise of power and signaling effects.

This embeddedness can be understood as a scientific regularity for explaining and predicting (as well as designing) process effects (process flows and process outcomes in terms of time, cost and quality). Via the mechanisms mentioned, the dimensions mentioned influence the process-executing actors and thus the processes. Regularities can be formulated as "generally valid conditional relations" in the form of if-then relations. If certain dimension characteristics are present as conditions (e.g., a very central position of a process owner), then certain behaviors (e.g., pronounced controls) and process effects (e.g., few failures) are likely to occur. *"If-networks"* can thus be understood as independent, explanatory causes ("if") for dependent *"then-process effects"* (process flows and process results) in a "quasi-causal" regularity. Following Borgatti et al. (2018) and Henning et al. (2012), we can speak of a *"network theory of processes"*. This "theory" is new to the fields of process organization and process management.

Only conditions and law together result in the explanans of the deductive explanation. In the context of this article, business processes or their modeled representations determine the antecedent conditions. It is important how the transformation of the conditional process model elements of an EPC (functions, events, logic, data and organizational elements, etc.) into the dependent *embedding dimensions* can take place. The derivation of a social network model from a process model was shown in principle in Section 2. The formation of a dependent network from an independent process can be called *"process theory of networks"* with further reference to the authors mentioned in the previous paragraph. Processes or process models determine the structure and properties of networks as independent conditions. This idea of process-induced social networks appears new and enriching for network research. Fig. 2 summarizes the considerations.

*The two sub-theories of a "(process) theory of networks" and a "(network) theory of processes" are collectively referred to as the "Theory of Networks and Processes".*

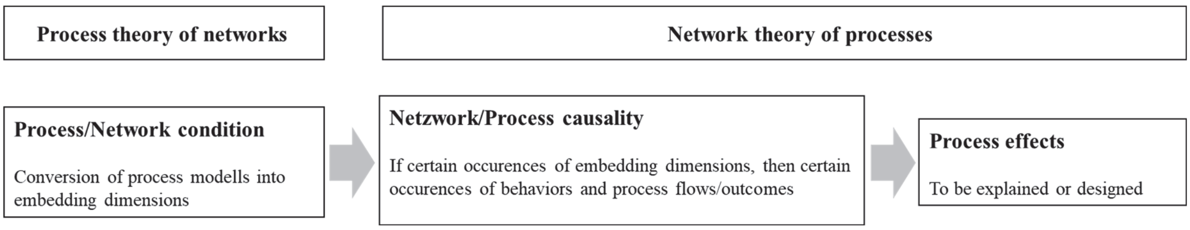


**Fig. 2** Theory of networks and processes

As mentioned in Section 2, there is a close connection between explaining the phenomena of a domain and designing the objects of that domain. Understanding the relations between independent process elements (e.g., number of participants) and dependent process effects (e.g., cycle time) with the help of the laws of process networks (e.g.: If actors are closely networked, then processes are accelerated), allows goal-oriented *design decisions* to be made. The independent process elements can be understood as *decision variables* and the dependent process effects as *decision criteria of* a decision model for design support. A final exemplary will illustrate this:

The person responsible for the process in a company is thinking about gaining specialization advantages in the form of reduced processing times of the process steps (decision criterion) by increasing the division of labor in a process. At the same time, he fears that an increase in the number of process actors will increase the transport, idle and setup times between the process steps. If it is known that very dense social process networks keep these non-value-adding times low (regularity), the person in charge can choose the design option "increase the division of labor" without having to fear (significant) temporal "side effects". When designing the process, however, he must make sure that the allocation of steps to processors creates as close a network of relationships as possible (decision variable). If, in an extreme case, a different agent were to be assigned to each step, a network in the form of a "chain" (string of actors) with minimal density would be created.

From the perspective of network-oriented process management, social networks function as "mediating variables". Networks can be derived from process models (for a first empirical application see Seidlmeier 2021). These in turn can be used to explain observed process phenomena or to design desired process effects.

**References**

Borgatti SP et al. (2018) Analyzing social networks. 2nd edn. SAGE, London

Ebers M, Maurer I (2019) Netzwerktheorie. In: Kieser A, Ebers M (eds) Organisationstheorien, 8th edn. Kohlhammer, Stuttgart, pp 391-412

Granovetter M (1985) Economic action and social structure: The problem of embeddedness. American Journal of Sociology 91:481-510

Heinen E (1985) Einführung in die Betriebswirtschaftslehre. 9th edn. Gabler, Wiesbaden

Henning M et al. (2012) Studying Social Networks - A Guide to Empirical Research. Campus, Frankfurt and New York

Machlup F (1978) Methodology of economics and other social sciences. Academic Press, New York

Scheer AW (1999) ARIS - Business Process Modeling. 2nd edn. Springer, Berlin and Heidelberg

Seidlmeier, H., Experimentelle Untersuchung der sozialen Beziehungen in einem Prozessnetzwerk - Vorgehen, Ergebnisse, Erkenntnisse (Rosenheim Papers in Applied Economics and Business Sciences No. 1/2021), online veröffentlicht (27.09.2021): https://opus4.kobv.de/opus4-rosenheim/frontdoor/index/index/docId/1758 (URN: urn:nbn:de:bvb:861-opus4-17585)

van der Aalst, W. et al. (2005). Discovering Social Networks from Event Logs. Computer Supported Cooperative work 14:549–593