

# Application of Knowledge Problem Patterns in Process Oriented Organizations

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**Abstract.** This contribution introduces a method for the identification of knowledge problems in process-oriented organizations. On an operative level, knowledge problems occur when the generation, storage, transfer or application of knowledge is not in accordance with an organization's business goals. The introduced method represents an instrument for pointing organizations to such shortcomings and thereby opens up solution spaces for overcoming them. This contribution introduces a set of knowledge problem patterns and an accompanying process of applying them in organizations - both supported by empirical data generated in three conducted case studies. In doing that, this contribution provides new stimuli and insights for current research in the domain of business process oriented knowledge modeling and -audits.

## 1 Motivation

Modern knowledge-based organizations increasingly face an urgent need to consciously deal with and effectively manage their most critical resource knowledge. On an operational level, many efforts focus on the management of knowledge activities in organizations such as the generation, storage, transfer or application of knowledge [1]. To ensure that KM initiatives focus on *relevant* areas of organizational knowledge work, often a process-oriented approach is pursued [2, 3]. By analyzing business processes from a knowledge perspective, *relevant* knowledge activities in organizations can be identified through e.g. the concept of knowledge processes [4]. With knowledge processes, organizational knowledge work within and across distributed business processes can be visualized [5]. Based on such knowledge processes, problems and barriers in organizational knowledge work can be detected. Many factors are known that represent problems for the effective execution of knowledge processes such as a lack of technological resources, transparency or trust [6]. Yet, these factors implicitly assume the suitability of existing knowledge processes and do not question the design or execution of them. Therefore, the contribution at hand introduces a set of hypothetical knowledge problem patterns on a generic level together with empirical experiences that aim to 1) point organizations to wrongly defined or sub-optimally executed knowledge processes and 2) sketch up solution spaces in order to enable organizations "to do the right things" (vs. "to do things right") when it comes to

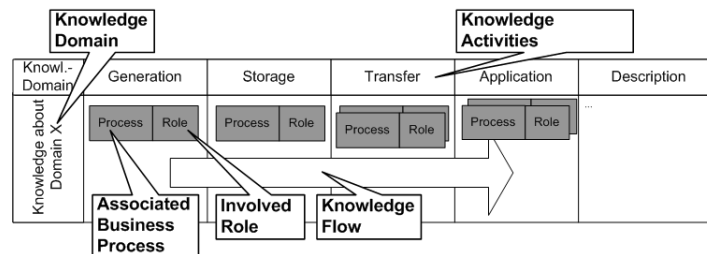
managing their most critical resource. Successfully addressing these challenges would enable organizations to increase their level of maturity concerning the management of knowledge processes [7, 8].

## 2 Approach

Knowledge problem patterns build on the existing concepts of knowledge processes [4, 5] and patterns [9]. *Knowledge processes* represent an approach of visualizing organizational knowledge work based on business processes and thereby are considered to *represent the generation, storage, transfer and application of certain knowledge domains across or within business processes* [4] while *patterns* represent a *relation between a certain context, a problem, and a solution* [9].

### 2.1 Knowledge Processes

Figure 1 depicts the main elements of knowledge processes. The concept of knowledge processes intends to depict knowledge activities that themselves are considered to run within and/or orthogonally to business processes [10, 11, 7]. In addition to the elements depicted in figure 1, extensions to these elements illustrate how knowledge is e.g. stored and transferred within certain knowledge domains. Today, organizational knowledge processes can be identified, modeled and visualized with available frameworks and software tools (such as [5]).



**Fig. 1.** Knowledge Processes Visualize Distributed Organizational Knowledge Work

Observations of reoccurring knowledge work patterns (e.g. [12]) and the supposition that patterns of certain knowledge process constellations are able to indicate relevant knowledge problems give reason for the following definition of the term *knowledge problem pattern*:

*Knowledge problem patterns are generic constellations of knowledge processes that indicate potential knowledge problems and -deficits in organizations.*

By having such knowledge problem patterns available, organizations would be able to algorithmically investigate their knowledge process models and identify potential knowledge problems and -deficits. In this contribution, we present a set of hypothetical knowledge problem patterns and report on practical experiences made from applying them in 3 case studies. Therefore, we introduce a set of 10 *knowledge problem patterns* in section 2.2 and an accompanying *process of applying them* in section 2.4 for the identification of potential knowledge problems in process-oriented organizations.

## 2.2 Knowledge Problem Patterns

Based on an inductive (empirically driven<sup>1</sup>) and deductive (hypothesis driven) approach, a set of 10 knowledge problem patterns emerged. The set consists of the following patterns:

1. Implicit Knowledge
2. Undefined Responsibility
3. Mythos
4. Knowledge Detour
5. Knowledge Outage
6. Long Term Indirect Communication
7. Chaos
8. Broadcasting
9. Culmination
10. External Dependency

Each of them will briefly be explained in the following: 1) Implicit Knowledge points to situations where knowledge of a certain knowledge domain is only available in implicit form. 2) Undefined Responsibility indicates situations where knowledge work is implicitly carried out, with no official responsibilities defined by the organization. 3) Mythos points to knowledge management instruments including storage- or transfer mechanisms (such as databases, intranets, e-mail lists) that were established within organizations, but are not actively used or do not contribute to key value-generating activities. 4) Knowledge Detour identifies situations where knowledge is transferred between two actors through a series of mediators, potentially causing misunderstandings or loss of information. 5) Knowledge Outage refers to situations where knowledge needs of knowledge workers respectively business processes are not fulfilled. 6) Long Term Indirect Communication takes place whenever the generation of knowledge occurs in business process activities only *after* the knowledge is applied. While this seems to be contradictory at first, it makes sense when taking multiple process instantiations into account. An example for such a case would be a process activity

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<sup>1</sup> Empirical data from 3 conducted case studies represented the basis for the empirically-driven identification of patterns. The case studies were performed with partners from automotive, software and consulting industry. Each case study focussed on the identification of and support for knowledge processes based on [4]

'project requirements definition' that needs to consider experiences gained from past project activities 'project realization'. While on a business process level the activity 'project realization' takes place after the 'requirements definition' activity, across multiple instances it might as well be the other way around. 7) Chaos points to situations where a broad range of transfer mechanisms is applied within a single knowledge process. While this might identify creative activities in organizations, it might as well be desirable to reduce variety of these instruments for the sake of traceability or standardization. 8) Broadcasting identifies situations where a single actor transfers knowledge to a series of other actors. Various knowledge management instruments, such as push technologies, exist to support such activities. 9) Culmination points to situations where a single actor needs to acquire knowledge from several other actors. Knowledge management instruments such as portals could integrate different sources and thereby support such situations. 10) External Dependency identifies situations where knowledge that is needed to perform well in business processes is generated outside of the organization. This may indicate critical dependencies from external knowledge suppliers.

It is important to note that all of these patterns are supposed to be applied on a generic level and do not take specifics of certain process instantiations into account. The benefit that can be reaped from such a restriction is that the patterns are potentially applicable across business process instances and organizations as well. Also, although patterns in the sense of [9] include the elements 1. problem 2. context and 3. solution, the knowledge problem patterns at hand predominately focus on the elements *problems* and *context* and only sketch out *solution spaces*. Experiences gained in the three case studies indicated that the development of concrete solutions strongly depends on organizational environments and conditions and therefore is strongly context dependent (in contrast to the *generic* knowledge problem descriptions).

### 2.3 Details on Two Selected Knowledge Problem Patterns

In order to enhance understanding about these patterns, two of them are introduced in greater detail:

Knowl.-Domain	Generation	Storage	Transfer	Application	Description
Knowledge about Domain X	Process   Role	?	Process   Role	Process   Role	...

**Fig. 2.** Knowledge Problem Pattern 1: Implicit Knowledge

*Pattern 1 "Implicit Knowledge"*, schematically depicted in figure 2, refers to constellations of knowledge processes that do not include any kind of knowledge

storage respectively explication, inferring that the only knowledge available in such situations is considered to be implicit. Organizations suffering from high employee turnover rates might increase the degree of explication concerning the affected knowledge domains in order to overcome this knowledge problem.

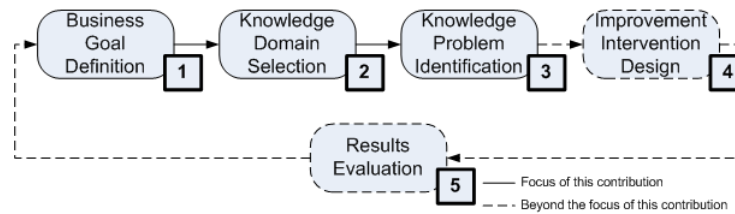
Knowl.- Domain	Generation	Storage	Transfer	Application	Description
Knowledge about Domain X	?	Process Role	?	Process Role	...

**Fig. 3.** Knowledge Problem Pattern 5: Knowledge Outage

*Pattern 5 "Knowledge Outage"*, depicted in figure 3, refers to situations in which either the generation or the transfer of knowledge is not appropriately anchored within a business process. A critical business processes BP depending on knowledge domains where the generation and/or transfer of knowledge is not sufficiently managed may suffer from this unreliable "knowledge supply chain". Organizations aiming to tackle this problem might emphasize on the stronger integration of these knowledge activities in their respective business processes and thereby increase organizational knowledge support for business process BP.

Since all introduced knowledge problem patterns build on *formal* descriptions of knowledge processes (as introduced in greater detail in [5]), they easily can be applied by performing automated analysis on top of identified knowledge processes.

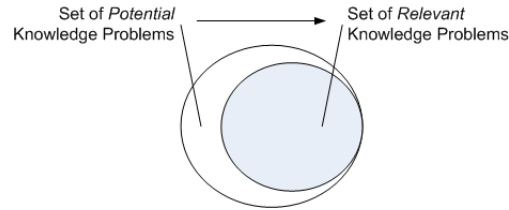
#### 2.4 Pattern-based Identification of Knowledge Problems



**Fig. 4.** The Process of Knowledge Problem Identification

Knowledge problems *do not exist per se*. They represent current conditions that prevent organizations from effectively achieving their business goals. Therefore, in order to identify knowledge problems in organizations, first a set of business goals need to be recognized and/or defined (Step 1 - depicted in figure 4).

Based on business goals, organizational knowledge domains and according identified knowledge processes can be selected (Step 2) that are considered to be of utmost importance for achieving these goals. Subsequently, knowledge problem patterns are applied to the selected knowledge processes in order to identify *potential* knowledge problems (Step 3).



**Fig. 5.** Potential and Relevant Knowledge Problems

In this step, the identified *potential* knowledge problems need to be evaluated, discussed and reduced to a set of *relevant* knowledge problems, as depicted in figure 5. This is done by e.g. involving experts and investigating if the potential knowledge problems represent real problems for organizations. A detailed investigation of *relevant* knowledge problems yields the design of improvement interventions (Step 4) that themselves need to be evaluated (Step 5) regarding their contribution to the addressed business goals (Step 1). The next section introduces two cases in which the method of this contribution is applied to identify relevant knowledge problems in organizations.

### 3 Application of Knowledge Problem Patterns

#### 3.1 Knowledge about Customers

Improvement of customer satisfaction is among the top prioritized business goals of organization O. Acknowledging that knowledge about customers plays a key role in achieving higher customer satisfaction, the organization follows a knowledge-oriented approach to address this challenge. Figure 1 depicts the knowledge process "Knowledge about Customers" that was identified and considered to be important by organization O. In this knowledge process, researchers (Resear.) of organization O need to apply knowledge about customers in their respective product development (Product Dev.) business process (see situation 'A' in figure 1). They receive that kind of knowledge through informal meetings (see situation 'B') with sales agents (see situation 'C') that generate that knowledge through customer interaction.

After applying knowledge problem patterns to the knowledge process constellation of figure 6, the following can be concluded for organization O: 1. No knowledge is being explicated in that knowledge process (Pattern 1 "Implicit

Knowl.-Domain	Generation	Storage	Transfer	Application	Description
Knowledge about Customers	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <span style="border: 1px solid black; padding: 2px;">?</span> Sales         </div> <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 5px auto;">C</div> <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 5px auto;">Pattern 5</div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <span style="border: 1px solid black; padding: 2px;">?</span> </div> <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 5px auto;">Pattern 1</div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <span style="border: 1px solid black; padding: 2px;">?</span> Sales Resear.         </div> <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 5px auto;">B</div> <i>informal meetings</i>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">           Product Dev. Resear.         </div> <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 5px auto;">A</div>	Sales staff generates knowledge about customers. Sales transfers this knowledge through informal meetings to Resear. staff that needs to apply that knowledge in its respective Product Development Process.

**Fig. 6.** Pattern-based Knowledge Problem Identification

Knowledge” in figure 6) and 2. The generation as well as the transfer of knowledge about customers is not covered respectively organizationally supported in any business process (Pattern 5 ”Knowledge Outage” in figure 6). Findings like these might pose severe problems for organization O’s goal to improve satisfaction among its customers. Based on these insights, the organization might focus on increased explication of knowledge (e.g. introduction of meeting minutes) or on the detailed modeling and implementation of sales processes that take knowledge aspects into account to overcome the identified knowledge problems and thereby meet their respective business goals. In doing that, organizations are enabled to implement *necessary* knowledge management interventions that *visibly contribute* to organizational business processes.

### 3.2 Knowledge about Part Lists

In the second case, the effective design and ongoing improvement of its supply chain is a critical business goal for organization P. When manufacturing automobiles, knowledge about automotive components (part lists) is important to both organizations and their suppliers. Figure 7 depicts the knowledge process related to knowledge about part lists within organization P. In this knowledge process, engineers (Engin.) generate this knowledge within planning processes and store it in engineering data systems. Logisticians (Logist.) and controllers (Contr.) need to apply that knowledge in their respective administrative business processes while suppliers need it in their product delivery processes.

Knowl.-Domain	Generation	Storage	Transfer	Application	Description
Knowledge about Part Lists	<div style="border: 1px solid black; padding: 5px; display: inline-block;">           Planning Engin.         </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">           Planning Engin.         </div> <i>Engineering Data System</i>	<div style="border: 1px solid black; padding: 5px; display: inline-block; text-align: center;"> <span style="border: 1px solid black; padding: 2px;">?</span> </div> <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 5px auto;">Pattern 5</div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">           Adminis- tration Logist. Contr.         </div> <div style="border: 1px solid black; padding: 5px; display: inline-block;">           Product Delivery Suppl.         </div>	Engineers generate knowledge about part lists in their corresponding planning business process. This knowledge is stored in an engineering data system. Roles who need to apply that knowledge include logisticians, controlling and suppliers. The transfer of knowledge is not supported by the organization.

**Fig. 7.** Pattern-based Knowledge Problem Identification

After applying knowledge problem patterns to this knowledge process, pattern 5 indicates a potential knowledge problem by highlighting a lack of knowl-

edge transfer. After investigating this potential knowledge problem in greater detail with representatives of organization P, a relevant knowledge problem could be identified: The reason for the lack of transfer in this knowledge process was the technical separation between the engineering data system, used by engineers to store knowledge about part lists, and the logistics software, used by logisticians, controllers and suppliers. This issue led to duplication of data and subsequently to inefficient process cycles. Therefore, the improvement suggestion developed in this case was the technical integration of the two currently separated technological software systems. By doing that, organization P leverages explicit knowledge already available within its software systems for further reuse, to increase efficiency of their supply chain.

## 4 Experiences

Interesting experiences could be gained from applying the knowledge problem patterns in real world situations. First of all, *relevant* knowledge problems could be identified by following the outlined approach. In discussions with representatives of the case study partners, we received positive feedback concerning the severeness of the identified problems. Second, some patterns were found to be *more stable* than others. Among others, especially the patterns 1 and 5 that were introduced in greater detail led to the identification of *relevant* knowledge problem problems. Furthermore, we experienced that the availability of knowledge problem patterns aids in focus setting. Since we have identified between 20 and 50 knowledge processes in each of our case studies so far, instruments that aid in focus setting are crucial. Knowledge problem patterns help in focussing on relevant areas for improvement.

On the downside, pattern application at the moment is labor intensive and needs interpretation. While the patterns can be applied algorithmically by a computer program, during the time of conducting this research we had to apply them manually because of our explorative research approach. Furthermore, each potential knowledge problem needed to be investigated, verified and discussed with representatives of the organization in detail. This again turned out to be a labor-intensive, yet effective, approach. As indicated in their name, the suggested knowledge problem patterns are more *problem-oriented* rather than solution oriented. They aid in identifying problems and deficits and hardly aid in selecting/developing appropriate solutions. To summarize, the utilization of knowledge problem patterns in the process of analyzing knowledge processes represents a feasible approach for the identification of knowledge problems and -deficits in organizations that, however, needs further elaboration.

## 5 Future Work

Based on our experiences made with knowledge problem patterns, we suggest two main directions for future work: 1) A software tool that applies knowledge problem patterns to the identified knowledge processes in an automated way



would allow for easily testing further empirical data and would significantly speed up the process of experimenting. 2) Quality metrics for the assessment of different knowledge problem patterns need to be introduced. In analogy to retrieval metrics, we suggest to use the notion of precision/recall as indicators for the quality of knowledge problem patterns. While high precision would increase the ratio between identified *relevant* and *potential* knowledge problems, a high recall would increase the set of *relevant* knowledge problems that can be identified with a knowledge problem pattern approach at all.

## 6 Conclusions

Knowledge problem patterns point organizations to conditions that potentially prevent them from effectively achieving their business goals. In this contribution, a set of knowledge problem patterns and an according process of applying them was introduced. Thereby it is important to keep in mind that the introduced knowledge problem patterns represent indicators for *potential knowledge problems* and no bullet-proof triggers for improvement actions. They thereby represent "objects-to-think-with" for analysts who aim to improve knowledge work in organizations. By identifying knowledge problems in organizations, knowledge problem patterns bear the potential to significantly accelerate analysis efforts and aid in the design of improvement interventions in *critical* business areas. Thereby, organizations are enabled to exploit previously unknown improvement potentials from a knowledge management perspective for successfully addressing their business challenges.

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