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Preface

The Conference on Advanced Information Systems Engineering (CAiSE) has traditionally focused on aspects that intersect our field – technological and human, theoretical and applied, organizational and societal. The theme for CAiSE 2016 of "Information Systems for Connecting People" emphasized the wish to satisfy the needs and requirements of people, both as individuals and as parts of organizations, which are socio-technical systems. To further the research on these areas, it is important also to provide arenas where researchers can discuss new ideas in a supportive and exciting environment.

The CAiSE Radar is an experimental format, established for CAiSE 2016, to make CAiSE workshops livelier, exciting, stimulate discussions, and attract additional active participants by establishing an environment where not only well established and validated research is reported but research in infancy, new ideas, and potentially interesting research projects can be presented and discussed. So similarly to a radar, the idea is to enable researchers to look into the future of the field and identify upcoming trends early. The aim of such effort is on one hand to contribute to the building of research communities and promote the integration of young researchers into the community, and on the other hand to provide opportunities to discuss ideas early and to receive additional opinions on planned research.

In total, 7 papers were accepted as Radar papers and will be presented and discussed in the following workshops: ASDENCA, BUMDISE, COGNISE, and EMMSAD. As workshop chairs of CAiSE 2016, we would like to express our gratitude to all the workshop organizers and authors for supporting this new idea and for eliciting some very exciting papers.

May 2016

John Krogstie
Haralambos Mouratidis
Jianwen Su

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On the Need for More Requirements Towards Visual Notation Design of BPMN Extensions

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Abstract. We present an initial exploration of how BPMN extensions modify or add to the visual notation, and to what degree further clarification on the requirements for the design of these extensions would be warranted. We identify a number of concerns can that impact readability and understandability of models using these modified visual notations. We argue that these findings demonstrate a need for a more precise set of requirements to be satisfied by modifications to the visual notation in the BPMN standard.

Keywords: BPMN extension, visual notation, cognitive effectiveness

1 Introduction

Business Process Model and Notation (BPMN) is a *de facto* standard for process modeling. It is extensively used for different domains, as evidenced by the amount of extensions available for it. Besides adding to the abstract syntax, these extensions often also make changes or additions to the visual notation of BPMN itself. In the current BPMN 2.0 standard [5] there is little *explicit* requirements posed towards such changes, primarily ensuring that extensions do not modify the design of the BPMN core's visual elements. Although it stresses that a visual notation is desired that "all process modelers will recognize and understand", other potentially important requirements are left open, such as ensuring graphic design or color use is cognitively effective or remains coherent between extensions.

Using a literature review we investigated what additions and modifications BPMN extensions have made to the core visual notation, and what understandability and readability concerns with their design can be identified, possibly stemming from a lack of explicit requirements towards that design. As a starting point we use a recently published general review on BPMN extensions [1], further complemented with an additional literature search. We used similar search strings to [1], searching for "`BPMN +extension`", "`BPMN +domain`", and "`BPMN +domain-specific`" in Google Scholar and Web of Science. However, our selection criteria were designed to only include those extensions which reported or gave examples of changes made to the visual notation by the extension. This resulted in a list of 27 papers for our analysis.

2 Classification

A number of rules are given in [5, p. 8] to be followed when the visual notation is extended, essentially stating that new visual markers can be added to other elements, new shapes and line styles can be added if they do not conflict with other existing elements, coloring can be used with specific semantics, and that existing elements are not allowed to be changed. According to these criteria, we classified the extensions discussed above according to the changes they made to the concrete syntax (see Tab. 1). The addition of new markers to existing elements is by far the most popular addition to the concrete syntax, followed on almost equal footing by introducing new shapes and coloring. One would thus expect readability concerns to be primarily related to these kinds of changes.

Table 1: Classification of changes to BPMN's concrete syntax by investigated extensions according to the BPMN standard's criteria [5, sec. 2.1.3.]. For each kind of change the total amount and percentage of papers doing so are listed in the final row.

Ref.	New Marker / Indicator	New Shape	Coloring	Line style Change
Altuhhov et al. (2013)	☑	☐	☑	☐
Brambilla et al. (2011)	☑	☐	☐	☐
Braun et al. (2014)	☑	☑	☑	☐
Braun & Esswein (2014)	☑	☑	☐	☐
Braun & Esswein (2015)	☑	☐	☑	☐
Brucker et al. (2012)	☑	☐	☐	☐
Charfi et al. (2010)	☐	☑	☑	☐
Friedenstab (2012)	☐	☑	☐	☑
Gagne & Trudel (2009)	☑	☐	☐	☑
Kopp et al. (2012)	☐	☑	☑	☐
Labda et al. (2014)	☑	☐	☐	☐
Lodhi et al. (2011)	☐	☑	☑	☐
Lohmann & Nyolt (2011)	☑	☐	☑	☐
Magnani & Montesi (2011)	☑	☐	☐	☐
Magnani & Montesi (2009)	☐	☑	☐	☑
Marcinkowski & Kuciapski (2012)	☑	☐	☐	☐
Martinho et al. (2015)	☑	☐	☑	☐
Rodriguez et al. (2007)	☑	☐	☐	☐
Roder et al. (2015)	☑	☑	☐	☐
Saeedi et al. (2010)	☑	☐	☑	☐
Saleem et al. (2012)	☑	☐	☐	☐
Salnitri et al. (2015)	☐	☑	☑	☑
Schultz & Radloff (2014)	☑	☐	☐	☐
Sungur et al. (2013)	☑	☐	☐	☐
Supulniece et al. (2010)	☑	☐	☐	☐
Yahya et al. (2015)	☑	☐	☐	☐
Zor et al. (2011)	☑	☑	☐	☐
Amount:	21 (77%)	10 (37%)	9 (33%)	5 (19%)

3 Concerns Noted in BPMN Extensions

1. Suboptimal use of color. Extensions that use color often choose colors based on their intuitive connotations. For example, green and red are often used as the positive and negative sides to a bipolar aspect, in particular for security or access related topics, whereas orange is often used for intermediate positions. This poses a problem from a cognitive point of view if the notation is to be generally usable by the wider public, as such design considerations do not take into account color blindness. Furthermore, some extensions use color schemes that are hard to distinguish when they lose their actual color in a conversion to greyscale or even pure black and white, which is an expectable situation when models are printed or written by hand. A final concern is that of readability with for example color combinations like blue text on an orange background, which make it difficult to distinguish and read all elements in a model.
2. Use of overly complicated symbols as markers. The use of markers or indicators in models is important, as they are used to highlight specific attributes or show that a particular element is a specific subtype. Thus, it is important that such markers can be immediately read and understood. The extensions we analyzed give rise to two challenges: (1) Markers are not semantically transparent (i.e., have intuitive meaning) (2) Markers consist of too complicated graphics, especially when scaled down. In a best case scenario, this leads to people needing more time to read and understand a model, which slows down communication in the modeling process. In a worse case they will misinterpret the meaning of markers and interpret the model in an unintended way.
3. Homonymous use of symbols as markers. In some cases we identified the same or strongly similar symbols being used for different meanings in different extensions (e.g., a lightning symbol used by three extensions [4, 3, 6] all with a distinct meaning, lock symbols being used by many security related extensions). While in isolation this does not have to lead to concerns, it makes it more difficult to interchange models. Furthermore, it can lead to a situation where a particular extension becomes dominant and its use of the symbol becomes the *de facto* interpretation, requiring others to follow suit.
4. Increased graphical complexity. Some extensions introduce significant amounts of new symbols. While these symbols on their own are easily distinguishable, the sheer amount of different graphical elements present in a model will pose a threat to such factors as reading speed and the ability of people to easily distinguish between semantically different elements. This problem is opposite to the problem of symbol deficit of BPMN, that is, its lack of visual elements for all semantic constructs [2, p. 383].

4 Towards Design Guidelines for BPMN Extensions?

The concerns we have discussed here could become the starting point of a set of 'anti-patterns' that can guide how BPMN extensions approach the design of their concrete syntax, by showing what to avoid, instead of attempting to prescribe an exhaustive method that would theoretically lead to a good notation. Doing so will require additional work on determining appropriate requirements, and involvement of the BPMN community – both of researcher and practitioner.

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Due to space constraints the references of the papers selected in the literature review can be found in an online appendix at `www.dirkvanderlinden.eu/data`

Towards precise modeling of time constraints for processes with loops

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Abstract. Business processes may contain activities that must be executed in compliance with specified time constraints, e.g. activity B must be completed at most 2 days after activity A. If such activities appear in a loop, there is a lack of time constraints modeling that is able to define precise appearance(s) of activities executed in a loop. In this paper, we want to offer an extended time constraint definition that allows precise modeling of time constraints on activities that appear in loops.

1 Introduction

Compliance with deadlines and other time constraints is crucial in business processes, therefore (proactive) process time management is a very important and deeply investigated topic. An overview of this field is given in [3].

The aim of proactive time management is to predict and avoid violations of time constraints. First step towards this goal is the extension of the process definition with activity durations and other time constraints. An overview of time constraint types deliver Lanz et al. in [6]. In our work, we focus on two types of time constraints: the upper-bound (UBC) and the lower-bound constraint (LBC). They define the longest (respectively, shortest) time interval between the starting or ending points of two activities [2]. After this step, further time information is calculated and constantly monitored.

Time management becomes challenging if processes contain loops. In the literature, loops are a) not handled at all [7], b) handled as a complex activity [8], c) rolled out into a sequence [9] or rolled out into conditional blocks [5].

Representation of time constraints in processes with loops is, as well as the loop handling itself, mostly left out of scope. Currently, there are no adequate representations of time constraints, which allow to specify which of the appearances of an activity are constrained. In [6], the proposed pattern solution for iteratively performed processes introduces a special time constraint between two process elements where the second one lies in the succeeding iteration. Combi et al. [1] propose TNest, a new workflow modeling language for time constraints definition, that can be used to express time constraints between two activities in different cycles of a loop, however the notation has a limited scope.

In this paper we want to extend the expressiveness of time constraints. We propose an extended time constraints definition for precise modeling of time constraints in processes with loops.

2 Time Constraints

A time constraint is a temporal relation between source and destination nodes in a process graph $P = (N_P, E_P)$, where N_P are process nodes and E_P process edges. If a time constraint is specified on a node that appears in a loop in process P, the source and/or destination specification are more complex and until now not possible to express, since it is not clear which node appearance is meant by the node itself.

This problem is illustrated in a simple software development process shown in figure 1. It contains 2 loops, denoted with LS (loop split) and LJ (loop join), that may iterate arbitrarily often. There are 3 time constraints for this process, defined by the customer and/or project manager:

TC1: (1, UBC, 180, A, D) Customer and the company agreed on customer release 180 days after requirements elicitation.
TC2: (2, UBC, 90, B, D) The customer wants to see the first prototype at least 90 days before customer release.
TC3: (3, UBC, 5, B, C) Project manager requires that after each software development cycle the last test is completed within 5 days.

Since each activity that is placed in a loop might appear many times at runtime, it is not clear which appearance of activities B and C must comply to time constraints TC2 and TC3.

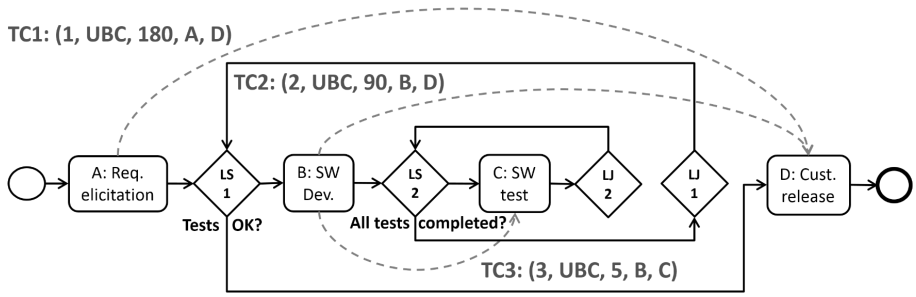

Fig. 1. Simple software development process

We introduce an extended time constraint definition based on time constraint definition from [2], such that source and destination are not only a single activity node but an expression that defines a set of source and destination nodes. With such expressions we are able to define the exact appearance of an activity placed in a loop. Extended time constraints, as defined below, can express all time constraints from the example precisely according to their intended meaning:

TC1: (1, UBC, 180, A, D)
TC2: (2, UBC, 90, FIRST B, D)
TC3: (3, UBC, 5, EACH B, LAST RELATIVE C WITHIN LS2 SAME_ITERATION LS1)

Definition 1. ***(Time Constraint)*** *A time constraint* (ID, *type*, δ, *source*, *destination*) $\in TC_P$ *is a temporal relation between a source node set* $S \subseteq N_P$ *and a destination node set* $D \subseteq N_P$ *from a process graph* P*, where* ID *is the ID of the time constraint, type declares whether the time constraint is an* LBC *or an* UBC*,* δ *is the required min. or max. time span between source and destination, and source and destination are specifications of the source node set* S *and destination node set* D*, respectively.*

The source specification is defined as $(quantifier, node\_label, loop\_reference)$ *and destination specification as* $(quantifier, relation, node\_label, loop\_reference, iteration\_reference)$

In the syntax of source/destination specification defined below, a *quantifier* specifies the topological node position, the *relation* whether a destination node must follow the source node (relative) or not (absolute), *loop_reference* binds the quantifier to a particular loop and the *iteration_reference* binds the destination to the same or next *iteration* as the source node, regarding a particular loop.

source := [<quantifier>] *node_label* [<loop_reference>]

destination := [<quantifier> [<relation>]] *node_label* [<loop_reference> [<iteration_reference>]]

<quantifier> ::= FIRST | LAST | EACH

<relation> ::= RELATIVE | ABSOLUTE

<loop_reference> ::= WITHIN *loop_label*

<iteration_reference> ::= <iteration> *loop_label*

<iteration> ::= SAME_ITERATION | NEXT_ITERATION

A time constraint induces a set of time constraints with only one node as source and one node as destination that apply to a particular appearance of a source and/or destination node in a loop. The induction rule for such time constraints is defined by the semantic of source and destination expressions and the function $atomize(tc)$ that creates source-destination node pairs from the source and destination node sets.

We define the semantic of source and destination expressions with help of *instance types* [4]. An instance type is a subgraph of a process graph P with an arbitrary number of loop iterations where each XOR-split (condition) and each LOOP-split have only one successor node. We define the function ξ that takes any possible source or destination expression ($specification$) of a time constraint tc as the input and returns a set of source or destination nodes $n \in N_{I_P}$ from the instance type I_P of the process graph P as output:

$$\xi(specification, tc, I_P) : specification, tc, I_P \mapsto R \subseteq N_{I_P}$$

For one possible source or destination expression $FIRST\,X$ the function ξ is defined as $\xi((FIRST\ X), tc, I_P) := \{n \in N_{I_P} | n.Label = X \wedge \nexists m(m \in N_{I_P} \wedge m.Label = X \wedge m < n)\}$

3 Conclusion

So far, there is no possibility to model time constraints on activities that appear in loops. In this paper we introduced an extension of time constraints definition that enables modeling of time constraints on processes with loops. We proposed a set of expressions for precise specifying of source/destination activity appearances in a process with loops and showed the principle for defining the semantics of such expressions.

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Challenges for Assessing and Designing Business Continuity Processes

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Abstract. Currently organizations face greater resilience challenges due to unpredictable and constant threat scenarios. Now these scenarios include, not only Severe Business Disruptions (SBD), but also the loss of human lives, critical to maintain daily operations. The consciousness of the need to address any weaknesses related to the resilience of organizations is now a topic of higher importance. From now on, organizations need to be able to deal with unpredictable changes within the IT and the business ecosystems, and for that, need to have a consistent and well-structured Business Continuity Plan (BCP). In line with this demand, the challenge to capture all business processes and document them, sometimes from insufficient, fragmented and inconsistent information, persists. The need to reduce the complexity of business processes with data collection and restoration of a holistic picture of Business Continuity Process is mandatory and the Business Impact Analysis (BIA), must be well addressed and support all business continuity activities in order to build good recovery strategies.
Keywords: Business continuity, DEMO, business impact analysis

1 INTRODUCTION

What is Business Continuity? As a concept, business continuity (BC) was introduced in the sixties as IT "disaster recovery" and was incorporated in the business environment with the motivation to ensure the high investments made in computer systems. A BCP grounds the strategies, procedures and critical actions needed to comply with and manage a crisis situation [10] and expresses in what state an organization is to deal with unexpected situations (disasters, forced outages, reorganizations and sudden changes in the business paradigm) [5].

The British Continuity Institute [4] points that the objective of BC is to provide a documented framework of processes in order to allow the organization to resume all of its business processes within its recovery time objective (RTO) and recovery point objectives (RPO) after a Disruptive Incident (DI). This allows organizations to create resilience to manage unpredictable changes within the IT and business ecosystems.

Recent disruptive events showed the vulnerability that the actual business environment faces and all companies that are technology dependent, with higher relevance for those in the finance, bank & insurance and telecommunications industry have. Due to this leverage risk, this theme gained higher importance for the global corporate landscape as BC preparedness can mean the difference between a company being able to recover from a DI and continue to operate or disappear.

Moreover, it is important to have one or more methodologies that allows an organization to change / adapt their processes, allowing the operation to continue working with the resources available if a SBD befall. Happening, an organization quickly needs to adapt its business to new realities and for that it needs to redesign and re-engineering their processes.

The aim of this research should not only be to draw attention to the constant need to work in business continuity processes, but also provide insight into the development of the BC function and its processes, finding links to other methodologies to leverage it.

Discuss around BC being part of the Governance, Risk & Compliance (GRC) [8] or be a separate and independent discipline exists. The fact is that as a result of a natural evolution along with the need to integrate similar disciplines to provide new solutions [2] [3] is now a demand. BC needs new arguments to face the unexpected and some buzz now about BC shift or adopt new paradigms is emerging [1].

There are examples from several other disciplines that have shifted their paradigms or adopted new methodologies, with major improvements and efficiency: Enterprise Engineering with DEMO [6]; Project Management with Lean and Agile; Enterprise Architecture with TOGAF [9], Quality control with Six Sigma and so on. Some other hybrid methodologies were also found during this research: Lean Six Sigma or Enterprise Operational Analysis Using DEMO and the Enterprise Operating System [7], are also important examples.

1.1 Problem

Nowadays, the majority of companies rely on technology to support its business and started to deal with more complex business processes that cross multiple departments and disciplines. The challenge to create and maintain a BC Plan by identifying, classifying and correctly document all the processes that compose the business structure, is becoming a very demanding and complex task.

A business continuity plan relies and depends on the correct assessment of all business processes to determine the cost impact of a sudden loss of key business functions. Such analysis is done along with a Business Impact Analysis to help evaluating which organization processes are most important and determining the best recovery strategies.

The problem is that these processes are often modelled using transformational techniques and don't define mechanisms to assess the consistency and completeness of a business process. On the other hand, the documentation used is often insufficient, fragmented and inconsistent, leading to an incorrect assessment and to misinterpretations. Many process models are hard to understand by other people and to keep up-to-date, mainly because don't have guidelines or pre-defined naming conventions. This can lead to wrong ideas of the elements of the adopted notation. Furthermore, when the natural evolution of the process takes place, these models often become inconsistent and difficult to maintain.

Moreover, it is necessary to provide to management a comprehensive view of the entire company and at the same time be deep enough, simplifying the representation of complex processes.

1.2 Approach

The BIA process description (found on ISO 22301, point 8.2.2) was used and analysed from the point of view of DEMO, in order to find contact points.

A business process involving different departments and external providers was used for the case study. All business flows, dependencies and activities among departments were captured and documented using DEMO.

The business process and the existent documentation (based on RTF), was analysed with all key stakeholders involved and a conversation based technique (DEMO) was used to assess, complete and validate the process, where applicable.

1.3 Integrating knowledge: DEMO & Business Impact Analysis

Design & Engineering Methodology for Organizations is a conversation-based technique for the design, engineering, and implementation of organizations and it is grounded in a theory named as Ψ-theory (PSI), where the standard pattern of a transaction includes two distinct actor roles: the Initiator and the Executor. The objective of the research on DEMO along with BCP is to empower the BIA to reflect a more accurate calculation of the impact of a DI at a business by giving emphasis to all critical aspect of the business process. Figure 1 points where DEMO can be used during the BIA process to identify which business units/departments and processes are essential to the survival of an organization.

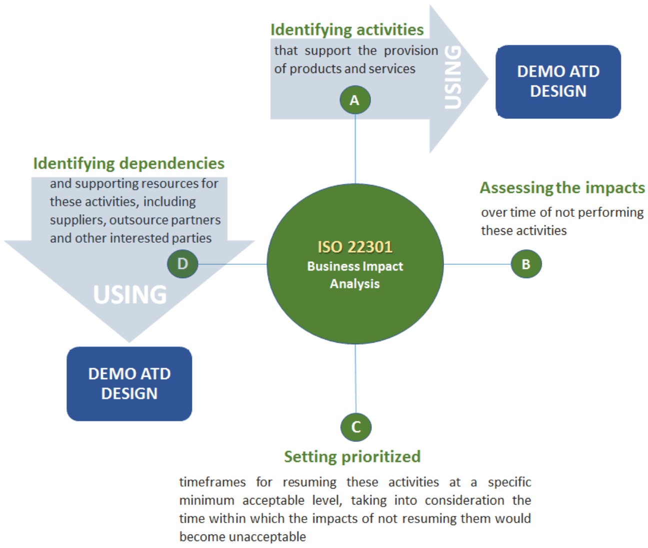

Fig. 1. BIA steps adapted from ISO 22301:2012 to show where DEMO is relevant

Observing the figure, step (A) of the BIA process, where is required to identify all activities that support the provision of products and services, DEMO is applicable. This is well explained and visible using an ATD model and a transaction result table.

Moreover, in step (D) the identification of dependencies that support the resources for these activities for all interested parties, is one of the best attributes that DEMO has by providing a complete and unified view of the process.

To make a BIA, all accountable aspects, possible interactions and dependencies are necessary to correctly calculate the impact of a DI on a business. DEMO uses business processes as their main focus, this characteristic become an essential tool to leverage the BIA.

1.4 Conclusions

The DEMO model used permitted to represent more realistically all accountable aspects of a business process and empowered the BIA to build a more accurate calculation of the impact of a SBD at the business. A BIA is prone to having flaws that need to be mitigated in advance (misinterpretations, sometimes unable to clearly identify business processes and by not having a clear and wide view of them), areas where DEMO can be used to mitigate these issues. DEMO models also can serve as a chance to discuss design issues and optimization opportunities with the stakeholders for the processes that are being assessed.

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Identifying and Addressing Adaptability and Information System Requirements for Tactical Management

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Abstract. Making tactical decisions is a daily reality for many people in different kinds of organizations. Tactics denotes dynamically choosing between alternative pathways, requiring continuous adaptation while realizing the organizational strategy within the current context. We are pointing out that tactical management is a dynamic capability with inherent adaptability that should be supported by a properly designed information system. Based on expert interviews and literature study, we identified adaptability needs for tactical management and derived the specific requirements for a tactical management information system. Through an Action Design Research involving four different companies in two countries, and by theoretically grounding the solution in Haeckel's Sense-and-Respond Framework for adaptability, we designed a method that uses Social Network Analysis techniques and tools and is aimed to support the person responsible for tactical management in the design and continuous revision of a personalized information system.

Keywords: Tactical Management, Information Systems, Sense-and-Respond, Adaptability, Capability, Complex Adaptive Systems, Social Network Analysis

1 Introduction

Tactical management is a managerial function aiming to achieve given goals, with given resources, in given circumstances, with respect to given rules, preconditions and strategic guidelines in a dynamic environment. We perceive tactical management as a capability that needs proper (1) common definition and (2) support with IS. There is a prerequisite for this function to be *adaptable* to dynamic changes in each of the 'givens' (strategy, goals and KPIs, processes, resources) – As a consequence, the tactical manager needs to continuously probe the *context* and get the *necessary and complete information* for successful facilitation and steering of the socio-technical system towards given goals. The ability to deliver a certain business value continuously, while the circumstances are dynamically changing is denoted by the concept of business capability [28]. A *dynamic capability* is defined as the ability to integrate, build and reconfigure internal and external competences to address the changes in the environment [29]. Tactical management facilitates continuous adaptation of an open system of interrelated entities achieve a goal through dynamically changing expectations, resources, circumstances – by maneuvering with what is given. To clarify tactical management challenges in adaptability, we are adding the notion of complex adaptive systems. The company, the team [19] the system of stakeholders directed towards a purpose that tactical manager needs to steer towards given goals can be characterized as a *complex adaptive system* (CAS). It is an open system with autonomous agents networked together, complex and non-determined processing of inputs into outputs and emergent behavior [10]. Managing a CAS, along with the numerous 'givens' discussed in the beginning, enhances the need for tactical management to be adaptable.

The current information system models and solutions are addressing tactical management in a rudimentary form – mostly because they are not considering its specificity and needs. The information system supporting tactical management should provide continuous context capture, broad scope of information entities and diverse type of information attributes. At the same time, it needs to support system view and handle the mismatch of the incoming data with expected outcomes. By addressing tactical management as static, rigid, mid-term planning oriented and process-prescribed managerial function that is similar to strategic or to operational management, the information systems are not supporting in an effective manner this uncovered source of competitive advantage [18].

Our work follows the direction of the dynamic alignment modeling discourse of [6] who provide a framework to offer systematic methods and tools for capturing, representing, and reasoning about enterprise and IT capabilities when co-designing organizational and IT architectures; the runtime adjustments of [33]; along with the dynamic capability modeling for strategic management [29]. Our work is complementing these approaches with the goal for shaping and addressing the dynamic capability of tactical management, its adaptability and information systems. Our specificity is in the way *how* to achieve it by placing a focus on the person – the manager. We are situating the research in the domains of Management and Information Systems. In order to emphasize the adaptability of this capability, we provided a managerial method that endorses strategic adaptability (based on the Sense-and-Respond framework [8]) and developed and applied it for tactics. To map its information requirements we incorporated components in the method which enable information system continuous self-design and revision. We are arguing that by enabling design of a personalized information system by the manager we are contributing an important component in realization of the adaptability of the dynamic capability of tactical management towards effective business-IT alignment.

One of the most vital questions we pursued in the research is how to model and visualize a CAS and its behavior for the purpose of mutual understanding and orchestrated action of all involved parties? Will this model and visualization help the manager convey the adaptability of his/her system and map his/her information needs? CAS can be modeled with fractals, differential equations, agent based models, cellular automata and networks. Graphs and matrices of the *Social Network Analysis* (SNA) [30] [13], even though with very high potential, have been used in organizations very little. SNA metrics have been used in: construction [21] and in supply chain management [23]. We will draw attention to the applicability and the benefits of the SNA visualizations and metrics for managerial purposes of adaptability – as well as for information system requirements elicitation.

The research has followed Design Science Methodology [9] respecting the guidelines of the organizational design and information systems design. The relevance of the research has originated in 30 expert interviews for positioning of the problem, followed by literature study of current contributions and knowledge gaps. The knowledge base has been repeatedly consulted for foundations, methodologies and tools on how to design the artifact. This resulted with selection of the Sense-and-Respond framework, along with the concepts of dynamic capabilities, Complex Adaptive Systems and the techniques of Social Network Analysis used in the research. An Action Design Research (ADR) [25] has been conducted with practitioners in 4 international companies in two countries – Belgium and Macedonia. Our research effort resulted with design of an artifact – a method for tactical management adaptability and information systems self-design. The research has been communicated through conferences and publications.

We proceed as follows: The next section provides a background for tactical management, its managerial and information system support. Next, we describe the research methodology employed in the research. We then discuss the delivery of the artifact; by elaborating our theoretical starting point, the findings of the ADR and our idea on addressing them. The final section concludes the implications, limitations and contributions of the research.

2 Problem investigation

We are investigating two interdependent problems – the tactical management's need for modern definition and recognition; and the tactical management's information systems design. It is necessary to derive the second from the first, while emphasizing the emergence of the adaptability as a most significant feature of the tactical management capability.

Strategy is determining the goals of the organization along with the set of coherent choices concerning the allocation of resources, activities and approaches to realize those goals. The main concerns of strategic management are effectiveness and organizational alignment. Strategic management involves strategy formulation, implementation, and measurement of strategic benefits realization. Support for these activities is available in the form of a rich and diverse set of conceptual tools and management instruments (e.g., Balanced Scorecard, Strategy Maps, VMOST analysis, SWOT analysis, the Value Chain concept, 5 Forces Analysis, the Performance Prism). Business Informatics research has integrated such techniques in the design of several modeling techniques providing understanding, analysis and design support for strategic management (e.g., the Business Motivation Model [3], the Business Intelligence Model [14], the Business Model Canvas [16], the Component Business Model [5]). Furthermore, strategic management information in the form of scorecards and dashboards with KGIs and KPIs is offered by different types of enterprise information system [15].

The key element in the contemporary view on *operations* is the process (e.g., production process, service process, or business process in general). The main concern of operations management is process efficiency in terms of cost, time and quality. Appropriate managerial methods and techniques include Six Sigma, Theory of Constraints (TOC), Total Quality Management (TQM), (Lean) Six Sigma, Statistical Process Control (SPC), Agile and others. Operations are nowadays characterized as a “high frequency – low latency environment” [12].

Compared to operational and strategic management, relatively few managerial methods and techniques relate to *tactics*. The managerial function most closely practicing tactical management is project management – addressed with PMBOK, Prince2, Scrum, MS Project. However, project is “a temporary endeavor undertaken to create a unique product, service, or result” [20] and “must be completed by a specific time, within budget, and according to specification” [31] – tactical management continues for an undetermined period of time and requires a ‘systems’ approach and capability for adaptability rather than a ‘projects’ approach and predictability. Tactics is a concept that is much harder to characterize than strategy and operations. Abstracting from its originally military context, we can describe it loosely as employing available means to accomplish an end. More specifically, tactics refers to the residual choices open to a firm by virtue of the business model that it employs [4]. As working definition for our research we define tactical management as the managerial function that addresses the following question: ***How*** *to achieve what is* ***expected*** *by* ***utilizing*** *what is* ***given*** *and following certain* ***governing principles*** *in the* ***current context*** *of the* ***organization and environment?*** [17]

The IS requirements elicitation and analysis, and to certain extent specification and validation [32] have been achieved through the following strategies. We explored the literature, for the generic IS requirements for all managerial functions; we supported and complemented it with the initial and the secondary set of interviews; after which the notion was completed with analysis of the behavior of end-user 1 and end-user 11 when they were using our artifact. In the latter, the enhanced adaptability enabled genuine authentication of the tactical management IS needs.

In [18] based on an in-depth review of the literature we observed that when examining the support of information systems for different management levels, there is significantly less coverage of tactical management in general, while operational management is in hive of solutions, followed by strategic management. There have been attempts at interconnecting business intelligence and performance management in a closed-loop approach [11]. For instance, the Business Activity Monitoring (BAM) approach integrates strategic and operational management levels through closed loops, providing for tactical management informational input for an event-driven complement of traditional monitoring [26]. The diffusion of BI into operational and tactical management layers has been coined Operational BI [11]. Another example is the Corporate Performance Management (CPM) Integration Grid [22] attempts to provide a multidimensional approach where the tactical management level is cohered to the strategic level. In general, we concluded that there is a significant ‘ingestion’ of tactics by operations or strategy resulting in a scarcity of information systems and business informatics modeling and analysis tools that support the specificities of tactical management. These specificities relate mainly to taking systems view of the organization (rather than processes or projects view) and the need for right-time information on contextual changes (rather than real-time information). More than anything else, tactical management information systems should help realizing tactical management’s essential feature of adaptability, as much as it was associated with mid-range planning, in the past.

The main threads of answers with regards to how appropriate the IS in the company is for the manager dealing with tactical issues – have been that strategic dashboards don’t capture the current context, while the operational real-time data is too overwhelming and not needed for tactical management (with some exceptions). The interviewees had all different interfaces (paper, electronic, combined) for organizing the wide variety of obligations deriving from their tactical management function. In terms of reporting for tactical management needs – the users addressed a struggle between daily, detailed operational reports and periodical (monthly, quarterly, annually) reports, usually being too late for something to be effectively improved. The interviews shed light on the notion that numerous entities (stakeholder, other department, external collaborator) or events (developments) are not captured in the information flows for tactical management. With regards to the managerial methods, the users practiced Agile, Scrum, Microsoft SureStep, Waterfall models or any method or tool implicitly incorporated in the IS. The finding of unaddressed mismatch of incoming data and expected KPIs has been consensual for all.

The offer for systematic methods and tools for capturing, representing, and reasoning about the enterprise, its subsystems and the IT capabilities when co-designing organizational and IT architectures is scarce. Danesh et al. recognize the need to "(i) represent and monitor the environment in which the enterprise is situated, (ii) represent and analyze the strategic objectives and positioning of the enterprise [29], (iii) design flexible and reconfigurable enterprises that enable transformation (Combs, 2011), and (iv) specify and build adaptable services that can adhere to changes in their context and deliver value to consumers [33]" [6]. Complementary to these needs, we are investigating whether for tactical management there can be person- not organization-oriented support for IS design; handling the mismatch of incoming data and expected goals; incorporating risk management; using visualizations for communication and orchestration purposes; supporting systems design.

3 Research Methodology

As the goal of our research is a method (i.e., a designed artifact) to be used by tactical managers for designing and continuously revising (i.e., contextual awareness and adaptability) personalized information systems that support their tactical decision making, Design Science Research (DSR) [9] provides an overall guiding framework for our research [17].

The *identification of Tactical Management adaptability needs and information systems requirements* was performed to further characterize the adaptability needs of tactical management and derive from these requirements for tactical management information systems. We performed thirty semi-structured expert interviews with senior, middle, operational and project managers as well as SME owners, in national and international companies in the authors' countries Belgium and Macedonia, to assess their perception of the role of tactical management in organizations and how this role is currently supported by information system artifacts, with a special emphasis on the need for adaptability based on context capture and approaches tailored to individual needs. A parallel effort has been placed in literature review on current managerial methods and information systems support for operational, tactical, strategic and project management, focusing on the identification of specific needs of tactical management for adaptability to changes and information systems support.

A separate *search* has been performed to find appropriate *theoretical foundation for the envisioned method*. To provide rigor to our research, we wished to ground the design of the envisioned method in existing theoretical frameworks and concepts that we deemed appropriate for addressing the tactical management adaptability needs and information system requirements identified in the first stage of the research. We therefore looked at various contributions in different fields like Strategic and Operational Management, Leadership, Information Systems, Knowledge Management, Complexity Theory, Behavioral science, Systems Theory, Network Theory, Social Network Analysis, and Social Systems Design.

To strengthen the relevance of the research, and to develop, build, justify and evaluate an artifact that has been immediately proven to work in at least one real environment, we performed *Action Design Research* (ADR) [27]. The Building-Intervention-Evaluation cycles (BIE) of the ADR took place in 4 companies in Belgium and Macedonia – 2 small and 2 big ones (Company 1, 2, 3, 4) with 11 managers as end-users. In Company 2 and 3 we have investigated tactical management issues of optimizing staff utilization across projects and shifting the customer perception of the company – and proposed S&R framework-based solution for the management to follow. We consider this to be the Alpha-version in the artifact design. In Company 1 we have investigated the tactical management issues of enabling customer's management to spend least time possible on remote communication with geographically scattered staff members. In Company 4 the issue was to provide earliest possible information status and discrepancies to management in a new factory and equipment alignment project. The solution design for the last two companies is the Beta-version in the artifact design. The research encompassed group sessions and individual conversations.

4 Design and Development

In the following section we will elaborate how the systems design concepts are used to design personalized tactical management information systems and how the SIDA loop is used to continuously reform the structure of the tactical management system towards its purpose and the personalized information system towards its runtime adjustment.

The *Sense-and-Respond (S&R) Framework* [8] has been selected as most appropriate for supporting tactical management adaptability [17]. The main tenets of the S&R Framework are outcome instead of output, accountability instead of traditional job description responsibilities, effectiveness before efficiency, and system design before process design. These ideas are fundamental to creating adaptability in environments where there is high unpredictability. The S&R Framework centers both on Systems Design (SD) – using concepts of purpose, governing principles, roles and accountabilities, conditions of satisfaction, negotiations – and on the Sense-Interpret-Decide-Act (SIDA) loop for the continuous discovery of early signals, reasoning upon them, and introducing changes and reconfiguring the system accordingly. With the S&R Framework, systems should be structured around a mutually agreed purpose, which is always defined from the outside-in, or customer-back, not firm-forward.

The *solution artifact is a method to be used by a tactical manager* that embodies principles, guidelines and prescriptions on how to achieve adaptability for the tactical management function by means of reasoning how to act and proper information system self-design. What we have conceptualized in the Alpha-version of the artifact has been implemented and evaluated in the four organizational contexts in Belgium and Macedonia, and with all end-users 1-11. We here present the Beta-version of the method, which incorporated improvements and was given for implementation and use, to the end-user 1 in Belgium and end-user 11 in Macedonia:

1. Designing a *System*, according the S&R Framework principles
   - Starting from the *Purpose* (i.e., the end, the reason for being)
   - *Visualizing* the Role-and-Accountability Diagram
   - Specifying *Conditions of Satisfaction* for every negotiated outcome
2. Designing *Information Sensors* – what the tactical manager would need to have as information (regardless of the current supply with reports) in order to have overview of his system
3. Designing the *Information Emitters* – what the tactical manager would like to have been told by the other roles in order to be aware on time for possible issues disturbing the agreed outcomes
4. Designing the *Risk Management*
   - *Visualizing* the Information Sensors, Information Emitters, and Risks per role, around the role of the system designer
   - Stating the necessary *attributes* and their *indicators*
5. *Continuous Revision* of the System, Accountabilities, Roles, Information Sensors, Information Emitters and Risks by performing the Sense-Interpret-Decide-Act (SIDA) loop and deciding on next steps

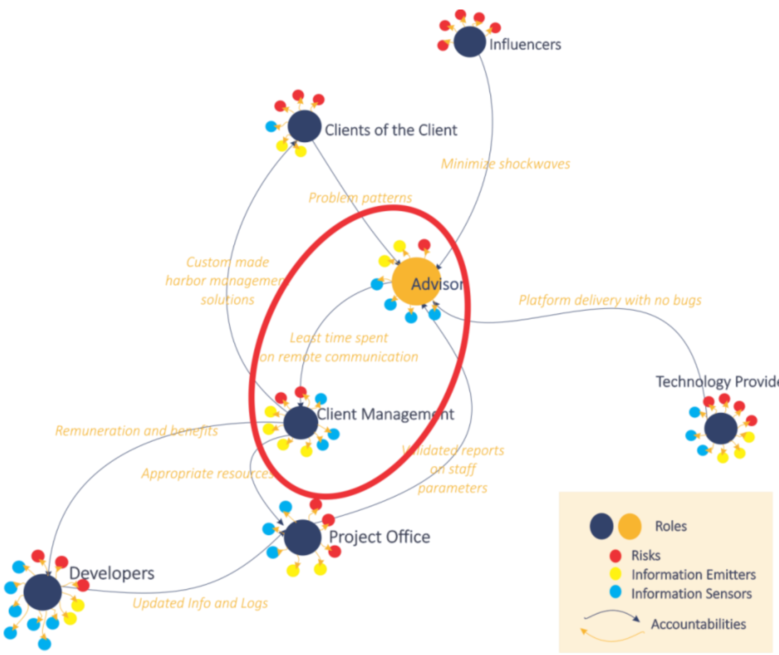

Fig. 1. Snapshot 1 with Bi-Partite directed graph using Social Network Analysis for showing a Role-and-Accountability Diagram, for the 'role' of 'Advisor'

To support the application of the method we have developed an Excel Workbook with 4 separate sheets for points 1 – 4, while the changes initiated by the SIDA revisions (i.e., point 5) are registered as monthly changes of the information system elements, their attributes and indicators. The end-users had the responsibility to manage their system upon instructions and revise the content of the worksheets according to everyday business activities. They had to note needs, changes, addressed and un-addressed issues of adaptability and information needs, and neatly record any change to the system during the research.

For visualizing the result of the design and revision of the tactical management information system, we use Social Network Analysis (SNA) and the software tools Gephi and NodeXL. Fig. 1 presents an example snapshot of the artifact-in-use of end-user 1 (Company 1). This SNA visualization shows the Role-and-Accountability diagram onto which the tactical information needs for the role of the 'Advisor' are mapped (i.e., information sensors, information emitters and risks).

The primary outcome '*least time spent on remote communications'*, highlighted on the figure with the red oval shape, is the primary purpose of the system around which the initial system of roles and accountabilities is designed. The roles are nodes represented with big filled circles colored blue and orange (for the role fulfilled by the tactical manager of interest). The blue edges represent accountabilities between roles. They are directed lines with an arrow from the provider role – the role that is accountable for an outcome (in orange text) – towards the client role – the role that is receiving the effect of the specific interaction. The orange edges denote how each role is connected with information system entities (i.e., information sensors, information emitters and risks). The information sensors, emitters and risks are visualized with blue, yellow and red circles respectively.

After the initial design of the tactical information system by the ADR researcher and practitioner (as in Fig. 1), the end-user used this SNA visualization during the SIDA loop – the perpetual engine for scanning of the context and providing adaptability to the system of roles and accountabilities – along with the Excel workbook with the four sheets of details (attributes and indicators) for the role-and-accountability diagram, the information sensors, information emitters and risks. A view of the Role-and-Accountabilities diagram (Fig. 2) when, after changes in the context of work, there was a need to introduce a new node – a 'role' – *absence coverage* – due to a high level of staff turnover in the developers role. The new role has accountability relationships with three existing roles. Such new roles/accountabilities get introduced or get extinguished as part of the SIDA loop mechanism for adaptability to the changing context. Also, some of the information sensors, information emitters and risks have been marked with red, black or blue squares (colored to denote at least three types of changes in attribute measurements) – to visualize changes in the content of the attributes for the respective information flows. The need for a complete re-designed system of roles and accountabilities occurs after a change of the primary purpose of the system. This situation occurred with end-user 1 after 10 months of use and revision of the initial system.

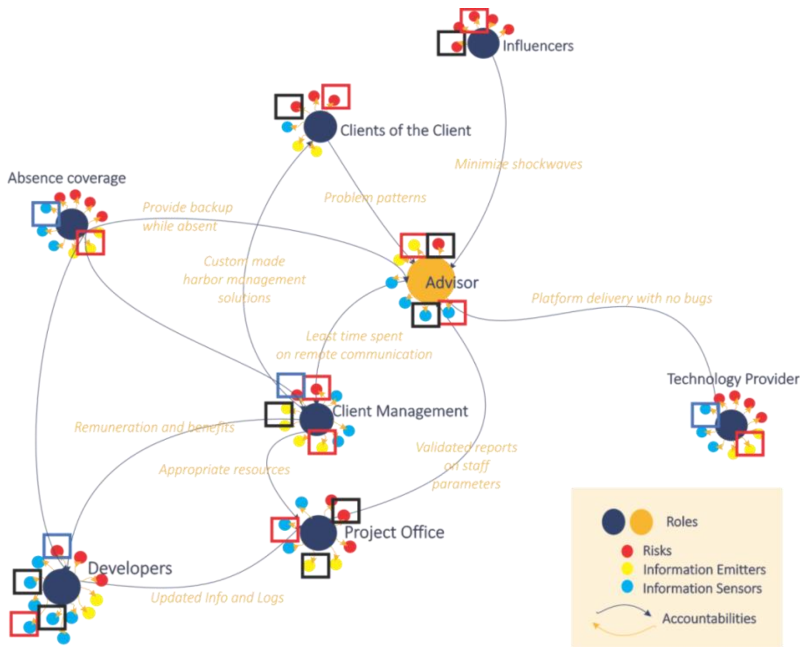

Fig. 2. Snapshot 2 – Revised R&A Diagram with changes in nodes, edges and IS attributes

5 Discussion

We have supported the manager performing the tactical management function with an artifact for providing adaptability (Sense-and-Respond framework implemented and enhanced for tactical management) and visualized the behavior of the system being managed (with Social Network Analysis), through a period of two years. The artifact is a managerial method that is consisted of components how to manage a Complex Adaptive System and components how to self-design own information system, continuously, responding to changes while aiming to reach the given goals.

The discussion of the experiences and outcomes can go in several directions – first of which is the need for *shifting the mindset* of the business collaborators in the ADR, as well as of the general audience in this research – from command-and-control to sense-and-respond way of thinking and acting; from output to outcome; from resource planning in terms of people towards roles and accountabilities; from process to system thinking. When establishing the manager's system it was necessary for his/her hierarchy level to have a helicopter view and proper authority over the system.

The end-user 1 experience has been of biggest importance, for several reasons. One was the answer to the question how did *planning and adaptability* get along in the tactical management challenge? Important learning from this interaction was the user's addition of a Plan-Do-Check-Act (PDCA) loop for each of the attributes in the four sheets. While our research focused on providing an adaptability capability for handling uncertainty by means of the SIDA loop, the end-user felt the need of better support of planning. In fact, for each of the information sensors, emitters and risks, the user had idea how something in the specific roles or accountabilities can be improved – and followed it up until actual implementation. This behavior finds support in the single- and double-loop organizational learning theory[1] The single-loop denotes operationalization of given or chosen goals, values, plans and rules. But, double-loop learning occurs the moment when there is critical questioning of the given mechanisms and altering the 'givens' or deploying different tactics, or different strategies to reach the goals. This SIDA + PDCA loop is included in the method.

The S&R framework offers components for *adaptability* such as: (1) negotiations between roles concerning the conditions of satisfaction, (2) population and re-population of roles with different employees/departments according to changes in context, (3) introduction or re-introduction of roles and/or accountabilities in order to respond to the changing context while aiming for the same primary purpose. But once it is changed, then there is punctuation of the equilibrium [24] and new system needs to be designed – which actually happened with end-user 1, denoting continuous dynamic reconfiguration of roles and capabilities, and flexibility and re-configurability in general for the purpose of continuously providing value to the customers. The information flows paralleled the adaptability of the system – the indicators showed that attributes record continuously changing values. This behavior corresponds with the needs of tactical managers to know and dynamically self-design their own personal information flows. For example, out of all the information sensors, emitters and risk issues, 48% changed their attribute *frequency* (daily, weekly, bi-weekly, monthly, quarterly), more specifically 26% increased and 22% decreased their frequency. There was a shift of 13% in the attribute *manner of obtaining*, from an on-demand to daily or weekly, which denotes an important change in the manner of how the tactical manager wished to obtain the information. Overall, 61% of incoming information is on-demand *unstructured* information, which means that only 39% of the information is provided through *event-driven* reports. It is further noteworthy that 87% of all sensors and emitters contained *qualitative* information. The system sustained by our method, lasts until there is no change in the primary purpose. In the 10th month, this development occurred with end-user 1, so a completely new design was needed – and completely new information content. The *scope of entities* translated into information entities represented on the R&A diagram is widest possible – the employees of the Advisor are populating only two other roles, while the roles of clients, clients of clients, technology provider, developers (Fig. 1) are populated by persons/departments/companies out of the Company 1.

The Social Network Analysis *(SNA) visualizations and metrics* have proven to be the motivating force of distinguishable importance for the end-users, in visualizing their system, needs, changes, and communicating it with the management, stakeholders, clients. When presented on a timeline, the SNA visualization gives precious insight on the adaptability of the system (with roles (nodes) popping-up or being removed, accountabilities re-negotiated, or complete system re-design). The same occurs with the Information Sensors, Emitters, Risks changing every of their attributes (frequency, scope). The method provided *the managers* insight in their own responsibilities but also of the people they were in contact with, by combining several points of view into a 360° overview of the workspace they were functioning in.

6 Conclusion

We used the Sense-and-Respond framework [8] as a generic managerial method for adaptability and introduced it for tactical management. This enabled the exposure of the real essence of the adaptability as authentic behavior of the manager and his/her Complex Adaptive System. Our method has integral feature of information system self-design and its continuous revision – which resulted with mapping the information system distinctive requirements for tactical management. By matching the characteristics of Complex Adaptive System, Sense and Respond framework and how they can be visualized and measured by the Social Network Analysis – we have been able to design a method for tactical management to be used by the person, supporting adaptability and continuously designing own information system requirements.

In this study we contribute to management and its information systems by emphasizing the notion that for the tactical management capability – adaptability is essential. Likewise, the manager should be positioning his/her information sensors and emitters according to his/her own context, and review them continuously. Our study provides theoretical and empirical evidence that adaptability to changes, especially for a function 'in the middle' such as tactical management, with many 'givens' needs to be addressed with managerial support of thinking and acting, and appropriate information system support. Along with capturing of the multi-faceted aspects of context, we are introducing the risk awareness and management to be conscious in the reasons that may disable a role from fulfilling it accountability. Last but not least, we focused on the person, as a source of adaptability and alignment.

In order to practice the method, the manager has to comprehend and apply the principles of S&R framework and the method for tactical management. Also, the tool support for Social Network Analysis has been in beta-versions, putting the practitioners in a position to depend on researcher's input of the visualizations and metrics – suppressing greater creativity and independence of the current users. There is an issue of getting every stakeholder on board in the system of Role and Accountabilities, with the same (different) way of thinking and acting – which is not always possible nor is the case – resulting with resistance and hardship in this sense.

Tactical management is dynamic, complex, very person-dependent function that is hard to describe as well as support in terms of management and management information systems. Very few artifacts try to address the person, not the organization. Even fewer support the visualization of the system being managed. Our artifact is generic enough to be applied for any business type, category, managerial level or profile, environment, business or life in general. Hopefully, in near future, this dynamic capability will become focused source of competitive advantage.

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Enabling Corporate Innovation through the Middle

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Abstract. Recent research on innovation in large corporations has been polarized to two extremes: top management decision on new initiatives or innovations emerging from the bottom of the organization. The focus on these extremes may partially blunt the crucial role of middle management for the successful implementation of new innovation initiatives. Building on illustrative cases of three innovation initiatives, we explore the distinctive organizational capabilities that need to be developed in order to embed corporate innovation programs into the organization's middle layer, where middle managers drive, adapt and implement these programs.

Keywords: middle management, corporate innovation, organizational capabilities

1 Principal topic

Established firms need to continuously invest into innovation in order to stay on top against upcoming transformations and disruptions in the market [1], [2], [3]. Traditionally, firms' internal R&D capability, such as corporate R&D labs and centers have served to fulfill this need. However, the model is reaching its limits as it has proven not sufficient for capturing developments and trends taking place outside the boundaries of the firm—or even beyond the industry or market. In this regard, established corporations are increasingly finding themselves in the search for new and unconventional sources of innovation potential to tap into [4], [5]. As a result, top management decides to set-up new innovation programs to meet the challenges and maintain competitiveness. While top managers give generic directives and initial mandate for such novel programs—e.g., with the primary goal to open up a new market or improve quality—, an efficient middle management is needed to design systems, carry them out and re-direct the staff's activities accordingly.

Recently, the literature on middle managers' role and importance for strategy formation and firm performance has regained attention [6]. Existing literature describes middle managers' role in areas of strategy [7], innovation [8] or corporate entrepreneurship [9]. Several studies have described middle managers as the source of novel innovation [10], key actors for implementing, driving and communicating novel programs [11] and mediators between top management and the rest of the organizations [12], [13]. However, only recently the literature looks at the mechanisms, which are used by middle managers, to achieve their goals. For example, a recent study by Van de Oever and Martin [14] investigated the micro-processes middle managers use to initiate and drive business model changes in large organizations. While these findings are relevant to deepen our understanding on how middle managers drive innovation (e.g. through business model change), we still lack more fine-grained insights on the organizational capabilities needed to form a stimulating environment—i.e. an enabling context—for middle managers to act in. Indeed, existing literature points out that we need to better understand "how they [the middle managers] fit these ideas into the broader strategic context, and the overall effect of these behaviors on the firm's innovative capacity" [15].

Against this background, we build on the illustrative cases of three innovation initiatives in large organizations with the aim of exploring the distinctive organizational capabilities firms need to develop in order to be able embed corporate innovation programs into the organization's middle layer, where middle managers drive, adapt and implement these programs. Our findings suggest that, established firms are able to innovate through the middle by enabling four distinct organizational capabilities i.e., *stakeholder commitment, experience continuity, mission longevity,* and *openness to change*.

2 Methodology & research setting

Unified by a shared disbelief of a corporate future where R&D labs take the same center stage as they have done in the past, we brought together a group of senior industry leaders with the mission to develop a new vision for corporate innovation. The core team consisted of experienced middle managers from major European industry corporates, Alpha, Beta and Gamma. This set of companies represents a highly interesting and relevant sample out of several reasons. First, all of the three companies represent—in one way or another—traditional European R&D-centric industry firms, with significant track records in their respective industries (and industrial histories), as well as with significant sizes. Second, all of the companies shared the common concern about the limits of the current R&D-based approach to innovation, and agreed on the upcoming challenges related to novel sources of innovation, whatever these may be. Third, the companies were all traditionally strongly relying on technology. While the underlying differences in technological legacies may seem obvious, the companies where at different stages in evolution in terms of freeing themselves up from their dependence on technology per se. Lastly, as the companies at the time of the study where not active in mutually competing businesses, this setting allowed an open and free-minded exchange of experiences, concerns and ideas.

On the basis of this unique access to senior-level middle managers, we were not only able to develop and document three distinct case studies, but moreover all firms joined a 2-year series of regular workshop roundtables to discuss challenges related to the future of corporate innovation, where the participating companies sent senior executives and had placed this topic on a senior agenda.

As an outcome of these two elements of data collection and generation of insights, this study presents the shared collective knowledge from a joint learning journey. In particular, data was collected through interviews, observations, workshops, informal meetings, archival data and other, publicly-available documentation at various points of time during an observation period of 36 months. We used structured approaches and formal coding schemes [16], [17] to derive insights and concepts. Emerging findings and constructs were iterated within our research team, but also with key informants, revisiting the cases through additional interviews, allowing continuous iteration between theory and observations [18].

Against the background of a plethora of insights generated around best practices, methods and tools, the purpose of this article is not to jump into reporting on company-specific details on how such where implemented and applied. Instead, the abstraction, comparison and iteration across the three cases yielded a set of generalizable findings with respect to the organizational capabilities these three corporation developed in order to be able to inject innovation programs through their middle management. In the following we will first give some insights on the distinct companies and their innovation programs (see Table 1 for an overview).

Table 1. Researched firms and innovation programs

Company	Industry	Innovation program
Alpha	Manufacturing and energy distribution	Corporate venture capital unit
Beta	Special chemistry	New business development unit
Gamma	Manufacturing and engineering	Advanced services unit

The case of Alpha

Alpha is international firm with a focus in manufacturing and energy distribution. To complement its long-standing technological expertise and renowned R&D centers around the world, Alpha sought after additional means to reach the next frontier or corporate innovation. In this context, the group's top management decided to established corporate venture capital (CVC) unit in 2009. The CVC unit invests in early and growth stage entrepreneurial ventures with technologies or business models of strategic interest to Alpha. It was established specifically to execute upon the investment opportunities, which would both complement the R&D and M&A activities. Specifically, corporate venturing entails the origination, financing, and development of entrepreneurial ventures that are introducing to the market new technologies and solutions that increase performance, open up new business models or commercial opportunities.

While every venture investment that the CVC unit enters into passes typical venture capital thresholds for financial returns, it must additionally meet the strategic objectives of Alpha and help accelerate a business line or a potential area of business interest. To ensure and maximize the strategic value from the venturing activities the CVC unit is strategically aligned to the corporate parent, for example, with linkages with Alpha's business units and R&D/technical resources. Moreover, a thorough understanding of the strategic interests of Alpha's business units and R&D priorities allows the CVC unit to work closely with them so that the venture investments are carefully coordinated and corporate's knowledge and assets can be leveraged both early in the evaluation process and later in the post-investment activities.

The case of Beta

Beta is one of the world leading companies within the specialty chemicals industry. Beta's products provide innovative and sustainable solution for various industries. Analysts describe Beta as a financial healthy and lean organization, which successfully manage a turnaround.

Traditionally, companies within the specialty chemistry industry have been growing mainly organically from inside or through acquisitions and mergers with competitors. Though, in 2010, driven by tensions within the industry, Beta decided to launch a new corporate innovation initiative to foster new business creation by establishing a distinct corporate unit for new business development (NBD). In particular, the aim of this corporate innovation initiative is to complement the traditional forms of R&D and business development by looking into alternative sources of innovation and value creation. The focus is to look at opportunities or business models completely new to the organization -which differ from Beta's core technologies and markets- with a high growth potential.

From the perspective of organizational structure and embeddedness, the NBD unit forms an autonomous, corporate unit within the organization with no significant own budget to fund projects. It reports directly to Beta's CTO, but direct links to the executive committee are ensured as well. Decisions about projects to be executed and opportunities to be pursued are taken by a steering committee, which is formed by members of the executive committee, the CTO and other relevant company-internal stakeholders. Furthermore, the unit collaborates for specific projects closely with operating units and the traditional R&D centers, so it is well embedded and connect within and to the entire organization.

The case of Gamma

Gamma is a globally operating, leading industrial engineering & manufacturing firm. Gamma offers a wide range of innovative products and sustainable solutions in rotating equipment and follows the typical business model of a manufacturing firm: it sells products and life cycle services oriented around maintenance and repair.

Over the last decade, Gamma's top management has put major effort to develop its service business and in 2013, Gamma went through a major re-structuring to set-up separate product and service divisions. Today services contribute to more than 40% of Gamma's revenues. Distinctively, besides traditional services such as repairs or maintenances, Gamma has also placed emphasis on advanced services, which is based on professional skills and expertise, to create opportunities for exploiting the existing service and product business through further leveraging customer relationships; on the basis of existing technological capabilities. This top management emphasis on services in general has turned a business under the radar –i.e. advanced services– into a strategic one. Advanced services may not seem financially attractive at first sight; however, the middle management realized and eventually championed the strategic dimension of such services in gaining organizational recognition. For example, the technology and knowledge intensity of advanced services enables Gamma to spot latent customer needs and to create spillover business through sales of new equipment and related lifecycle services. Moreover, as a company dedicated to keep its strong product identity, advanced services help Gamma in optimizing the product vs. services sales and managing the complementarities between the separate businesses through mitigating value conflicts inherent to two distinct businesses.

3 Results and implications

A closer examination of the three diverse and illustrative cases reveals four organizational capabilities—*stakeholder commitment, experience continuity, mission longevity, and openness to change*—that enable middle managers' action for corporate innovation. In the following we will briefly explain the identified capabilities and their importance.

Stakeholder commitment. As boundary spanners, middle managers perform a coordinating role through mediating, negotiating and interpreting connections between the different internal and external stakeholders of an organization [19]. Middle managers interface role with multiple stakeholders enables access to diverse knowledge and creates a greater potential for knowledge creation. For example in the case of Alpha, the established CVC unit perceived great commitment from the top management, but also from other parts of the organization. This stakeholder commitment enables the CVC unit's middle managers to established important relationships with the external VC environment as well as the start-up ecosystem, which are crucial for the success of Alpha's innovation program.

Experience continuity. While literature focuses on the role of middle managers in organizational change [6], it has neglected the importance of middle manager experience and political capital within the organization. Our study revealed the capability of experience continuity to be necessary for the successful implementation of a corporate innovation program as the developed and accumulated political capital facilitates issue selling in ensuing change. For example, in the case of Beta two third of members of the NBD unit had a long employment history in Beta, while the remaining third started their employment with this innovation program. This was a deliberate choice as personal development of employees and succession planning is deeply anchored in Beta's overall strategy. This combination of seniority with Beta among the middle managers not only allowed a transfer of deep technical knowledge and political experience, but also supported the successful execution of the innovation program.

Mission longevity. Corporate innovation programs have a long-term orientation rather than fulfilling short-term operational objectives. As in any innovation activity, although program success is expected be lucrative, the process bears unpredictable contingencies and involve high probability of failure [20]. For example in the case of Gamma, although advanced services as an independent business is not financially attractive at first sight, its synergistic effects with core businesses have turned it into a strategic unit, as it uncovers latent customer needs and opens the door for spillover product and service sales. The effect was not immediately prominent to top management but rather emerged in the long run through the observation of middle management and operational levels. Hence, organizations willing to uncover hidden middle management potential require a more failure-tolerant behavior regarding its innovation initiatives. This is also in line with a recent study by Tian & Wang in 2014 [21], which find positive relationship between failure tolerance and innovation productivity.

Openness to change. Recent literature suggests that middle managers play a crucial role in organizational change [14]. While our insights confirm these findings, they also suggest that the organization needs to have certain openness to change in order to allow middle managers to implement the innovation programs. For example in the case of Beta, the R&D centers realized that the NBD unit implemented an efficient process by using a specifically designed database and decided to adapt this process also for their activities. The Beta's openness to change organizational processes stimulated the middle managers to further refine and communicate their process leading to a better implementation of the corporate innovation program.

In summary, our preliminary findings suggest that large firms need to develop certain organizational capabilities in order to inject novel corporate innovation programs into the middle layer. We contribute to the growing literature on middle management perspective [6] by identifying distinct organization capabilities as important elements for successful middle managers' action. This has relevant implication for academics and practitioners alike. Further studies, should examine how an organization can deliberately develop such capabilities and how they influence middle managers' micro-processes [14]. From a practitioner's perspective, our findings should redirect managers' attention from the ideation of the corporate innovation program to the important elements of its implementation. Senior executives should be aware of the organizations need to develop distinct capabilities in order to harness middle management efficacy and allow them to achieve their full potential to drive corporate innovation programs.

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A Cognitive Study of Business Process and Business Rule Integration

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Abstract. The conceptual and pragmatic overlap between business process models and business rules indicates a need to model the two related aspects together, at least under some specific conditions. While a considerable amount of research has focused on the development of integration methods for process and business rule modeling, whether such integration improves (or diminishes) the understanding of business processes has not been investigated. Following our prior work in which we proposed a cognitive process model to explore theoretical foundations that underpin the understanding of process models, in this paper, we propose a design of an eye tracking study to explore integrated and separated modeling of processes and rules on the backdrop of the cognitive process.

Keywords: Business Process Modeling, Integrated Modeling, Cognition Theory, Eye-Tracking, Human Information Processing

1 Introduction

Conceptual models are widely used in organizations by information systems analysts and designers to represent, understand and analyze complex business domains [1]. A good understanding of a domain is a prerequisite to effective communication and design. Thus, how conceptual models improve human cognition of the domain represented is a very important research question. Such questions have also been explored in the context of business process models.

Business process models mainly focus on the modeling of business activities of an organization. In practice, business rules, which are extracted from laws, policies and procedures, play an indispensable role in the design, specification and implementation of process models. Business rules can be represented in a separated or an integrated manner, and often by a mix of the two. By 'separated manner', we mean the rules constraining process activities are documented in separate documents or rule engines, and the relations and connections of business process models and the rules are not explicitly represented in the process models. By 'integrated manner', we mean graphically in a process model. In such integrated models, business rules can be represented either as text annotations, as graphical links to external rules, or diagrammatically using a combination of sequence flows, activities and gateways.

Despite arguments for integration and despite a variety of integration methods being available, whether such integration improves user understanding of the process models has not been investigated. In particular, while researchers have argued that integrated modeling can improve the understanding of business processes, this proposition has neither been theoretically analyzed, nor empirically evaluated. Yet, such understanding is crucial for the advancement of process modeling methods. To bridge this gap, in our prior work [2], we proposed a four-stage cognitive process model to explore the theoretical foundations that underpin the understanding of process models and different integration methods, i.e. rule linking, annotation, and diagrammatical integration. Following this contribution, three important questions remain to be answered: (1) what are the differences in cognitive activities when rules are modeled in a separated manner and in an integrated manner, (2) what are the cognitive differences of different integration methods, and (3) what is the best integration method for different types of rules in terms of model understanding. In this paper, we focus on the first question. We use rule linking as a representative integration method to compare with rules modeled in a separated method, with an innovative design to evaluate those arguments in our prior work [2] which can be measured using an eye-tracking device.

2 Cognitive Process Model

In our prior work [2], we used cognitive load theory [3], information representation theory [4], and information integration theory [6] to reason about the cognitive process of a user using a process model with related business rules. We argue that to fully understand a business process, three components need to be studied: the process model, the business rules, and the impact or implications the rules have on process activities. Thus, our paper [2] proposed a four-stage model based on a human information searching and processing cognitive model [7]. The four cognitive stages involve rule awareness (being aware of the existence of rules that the business activities are required to be in compliance with), rule locating (finding the relevant rules), rule comprehension (development of understanding of an individual information element), and information integration (combining knowledge of the process and how the business rules constrain it together).

In the next section, we will introduce our experimental design based on the cognitive process to explore the effect of business rule integration.

3 Experiment Design

Our aim of the experimental design is to identify differences in cognitive activities when rules are modeled in a separated manner and in a linked manner, thus a between-groups design will be used. We aim to have 40 - 100 students participate in the study, all of whom have a background in conceptual modeling (although not process modeling). All student participants will have knowledge of Entity-Relation diagram modeling and analysis. To facilitate the data collection in the eye-tracking stage, the process model, rules, and the questions are presented on the screen at the same time. The layout is illustrated in Fig. 1. In the following, we will use area Q, P, R to refer to the question area, process model area, and rules area respectively. Each participant will be presented one of the treatment randomly. In treatment A, a process model and rules will be displayed separately, and all the rules will be presented in area R. While in treatment B, the same process and rules will be linked together, i.e. when a rule icon in area P is clicked, only the corresponding rule will be displayed in area R. The order of questions and rules will be random to control for learning effects.

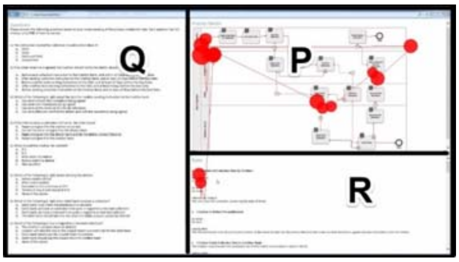

Fig. 1. Screen layout illustration

Participants will first be briefly introduced to business processes, business process models and BPMN, as well as business rules. Then in the experiment, a participant will be asked to answer eight comprehension questions based on the process model and related business rules. Finally, perception questions about the difficulty of the model and rules will be asked, as well as the difficulty of the questions, and the confidence of answers given.

Efficiency and effectiveness are two typical objective measurements in classical conceptual model understanding experiments [8] . In this study, we are firstly motivated to explore whether integrated process and rule representations have better efficiency and effectiveness in model understanding. Thus, we use the time to complete model comprehension questions as the measure of efficiency, and the correct number of answers as the measure of effectiveness. In the following section, we will use micro-level cognitive behavior data to evaluate our arguments.

4 Measuring Cognitive Activities

Using eye-tracking devices, we will be able to record micro-level cognitive behavior data, which we would not be able to easily capture without such equipment. We will rely on [9] to reuse common eye tracking metrics. We use Tobii X2-30 as the eye tracking hardware and Tobii Studio as the data collecting and analyzing software. We will analyze the difference of eye fixation durations, fixation counts, the sequence of fixations, and visit counts between the control and the treatment. Fig. 2 illustrates the sequence of fixations, fixation heat map, and statistics of visit count and fixation durations from a test of the equipment on control group experimental materials.

a b c

Fig. 2. Data capture illustration

Although the earlier outlined four cognitive activities are different, they cannot be easily separated using eye tracking devices. Moreover, as the sequences of these cognitive activities can be interlaced, the identification of each stage becomes even more difficult. Thus, we may need to measure some stages together, which is a limitation of this research. In the following discussion, we introduce our arguments and possible measurements, which are still being refined.

Rule awareness. We argue that "awareness of business rules can be improved by integrating the rules into relevant process model diagrams through any of the already existing integration approaches" [2].

Measurement 1: Rule awareness can be captured by the time from start of reading of a related question to the time the participant starts to look for a relevant rule. In Fig. 1, this would refer to the first time the participant's eyes leave area P and enter area R.

Measurement 2: Lack of rule awareness occurs when, after reading a question, the participant starts to answer the question only after focusing on the process model but not reading the rules, i.e. the eyes only focus in area Q and P but not area R. The number of times this happens can be a measurement of rule awareness.

Rule locating. We argue that "by integrating business rules into business process models the cognitive effort in searching for relevant rules can be reduced" [2]. Three measurements can be used, depending on different scenarios:

Measurement 1: If a participant finds the right business rule at the first opportunity and remains fixed on that rule, then rule locating can be the sum of time the eyes stay in area R, from the point of reading the question until the initial time the target rule is found.

Measurement 2: If a participant finds the target rule but continues to explore other rules, this situation indicates that participant does not realize they have located the right rule. The number of times this scenario happens is the measurement.

Measurement 3: If a participant starts to answer the question without reading any rule, this is an indication of rule ignorance.

Rule comprehension and information integration. Although rule comprehension and information integration are two different cognitive behaviors, it is hard to separate the two using the eye-tracking device. I.e. when eyes are fixed on an activity or a rule, we cannot tell if the participant is comprehending the information, or integrating the information with other information. Accordingly, we will measure these two together. Given that we argue that if information elements are not integrated physically then one has to mentally integrate them, which involves dividing attention between the multiple sources of information, cross-referencing each source [2], our measurements are planned as follows:

Measurement 1: Number of visits in area P and R respectively. A visit is defined as the entering of eye fixations to an area from outside. A visit means an attention switching to this area from another area.

Measurement 2: Number of eye-fixations and fixation durations on the target activity and the target business rule, which are indications of cognitive function [8].

5 Discussion

In this paper, we proposed our experiment to evaluate the differences of cognitive activities between rules modeled in a separated manner and rules modeled in a linked manner, based on our prior proposal of a cognitive process model. We expect that modeling business process in an integrated manner can achieve better efficiency and effectiveness than in a separated manner, and we proposed three arguments and several possible cognitive activity measurements that can indicate such difference. The result of this study will evaluate our arguments and provide a variety of detailed cognitive behavior data that will provide insight on how users understand business process models.

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The State of Research on Visualization in Information Systems Engineering

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Abstract. The relevance of information visualization and visual communication is continuously growing on a large socio-economical scale. This implies an increasing variety of applications and research questions related to visualizations that are used as part of information systems, and for the design thereof. Several overview publications have pointed out the relevance of scientific reflection on the use and the effects of visualizations in information systems engineering. This paper aims at taking stock of recent developments in the field and systematizing some recent contributions dealing with cognitive, formal and empirical challenges.

Keywords: information visualization, data visualization, modeling, diagrams, information systems, systems engineering, cognitive factors

1 Visualization in Information Systems Engineering

There is a growing need for systematic and scientific underpinnings of visualizations, as the visualizations incorporated in today's system engineering methods will be implemented in tomorrow's infrastructures and system environments, and thus will shape the way humans interoperate with and benefit from a technologically engineered infrastructure in the future. Information systems engineering is concerned with the processing and usage of information of diverse kinds. To understand and communicate the settings in which systems operate, to interact with them, as well as to conceptualize requirements and design specifications, visualizations have become an important cultural technique for designing and operating systems.

Not despite, but because of its cross-cutting relationships to diverse fields of systems engineering and its fundamental role as an ubiquitous cultural technique, the use of visualizations has not yet systematically been put into the focus of research activities in the engineering discipline. This seems to be caused by the fact that from the individual perspective of a specialized engineering discipline, the use of visualizations is naturally perceived as merely imported from other disciplines such as graphic design, visual communication, and semiotics. Even in closely related fields of a single discipline such as information systems, there are groups working in, e. g., business process modelling, enterprise modelling, software engineering, and requirements engineering that would share similar, if not outright the same, underlying fundamental challenges, yet do reinvent the wheel by spending time on fundamentals that could be investigated in joint efforts.

The Visualization in Information Systems Engineering Network (VISE-Network) is a recently launched pan-European international collaboration between academic and industrial partners located in Germany, Israel, Luxembourg, the Netherlands, and Turkey. Researchers involved in VISE have all come across different visualization challenges at some point, and realized the use of stronger collaboration to learn from each other's work in dealing with such challenges.

This paper is meant to give a summarizing look on recent advances that VISE members have made in visualization research with respect to information systems engineering. These reflect the research interests of the different members and institutes, as well as already ongoing collaborative efforts for particular visualization challenges. We further hope to stimulate more discourse on these topics, as well as involvement of others interested in visualization research.

2 What have we achieved so far?

The challenges investigated by different VISE members address various concerns, but so far in particular center around those of a cognitive, formal or empiric and methodical nature. The below sections give a brief overview of current ongoing work we address.

2.1 Cognitive viewpoints on visualizations

One of the main purposes of using visualizations in information systems engineering is to communicate knowledge between different stakeholders with conceptual models. The work of the VISE network has shown that the model factors, the characteristics about how the model is structured using its notational elements, have an important effect on the understandability of the models [17]. Even when the model factors are the same, presentation of the models in different modular structures may affect the understandability [16]. Moreover, we have shown that the concrete syntax; the design of symbols, colors and position of nodes; and the design of labels and icons on model elements have an important impact on model comprehension [18, 19, 16]. The guidelines on structuring the specific types of models we have developed became a well-accepted practice [11].

In our studies, the comprehension of models is found to be dependent on personal factors such as background, experience, motivation and learning style

[20, 14]. Improving such personal factors for the specific case where a conceptual model is used even without changing the visual aspects of the conceptual model may help enhance comprehension and communication between stakeholders. Overall, we were able to categorize the factors affecting the comprehension of models based on user characteristics, context and notational properties [24].

We have also focused on utilizing advanced highlighting and animation techniques to enhance the model reading experience [2, 15, 1]. With respect to different modes of perception and their influence on cognitive processing of information, [5] discusses fundamentals on how the use of audio as part of concrete syntax elements of modeling languages can look like.

2.2 Formalizations of visual languages and visual artifacts

Next to ensuring that visualizations are appropriate for their users and their cognitive make-up, ensuring that they can be systematically designed and used is of significant importance. Work of the VISE Network has focused on several aspects here, ranging from introducing meta-models and DSMLs to appropriately use visualizations, to more fundamental work comparing modeling languages using foundational ontologies and investigating the very feasibility itself of formalizing the requirements we have for the design of good visualizations.

The state-of-the-art view on formal visualization modeling assumes that visualizations can sufficiently be described by a one-to-one mapping between conceptual elements and visual representations [8]. To overcome these limitations, [6] suggests a meta-model that introduces additional concepts specific to the domain of visualizations which enrich the semantics of formalized visualization descriptions beyond simple type-to-symbol mappings.

Work on incorporating existing philosophical models into the discourse on visual modeling languages is presented in [13], which examines the Business Process Modeling Notation (BPMN) language on the background of concepts provided in the Bunde Wand Weber (BWW) ontology. Using philosophical work in a responsible way to enrich the discourse in the Information Systems discipline is one of the directions the VISE Network is picking up in ongoing research.

Formalization is used as a way to operationalize aspects of conceptual modeling languages, that is, to ensure their application is systematic and leads to replicable results. The call for formalization has led to efforts to formally verify whether visual notations are cognitively effective or not, by operationalizing (parts of) a widely used theory: the Physics of Notations (PoN) [12]. However, in recent work we examined whether all parts of the PoN theory are equally, or at all, suitable for formalization. We found [23] that not all principles of the PoN can be represented in a formal manner (e. g. using set theory), because they require additional external information which in itself might be difficult to formalize, or in the most difficult cases require direct user involvement.

2.3 Empirical user studies

Empirical work, in particular work involving users of visualization artifacts, is of vital importance to evaluating its benefit in practice. Research done by VISE members ranges from experiments comparing what kind of diagrams contribute most to comprehension of a domain (e. g., [9]) to studies evaluating the degree to which visualization design involves users in the first place, to the design of platforms fostering collaboration between users of visualizations themselves.

Our network has focused on empirically evaluating model comprehension using different techniques. Retention and transfer tasks have been used heavily to compare the model comprehension under different personal and notational factors [15, 19, 16, 10]. By means of these experiments, we have understood the effect of cognitive viewpoints as discussed in Subsection 2.1 on model comprehension better. The survey studies also support us to understand the viewpoint of model readers [17, 18]. Based on the findings, we deduct that to enhance cognitive aspects in modeling domain, new visualization studies shall consider notational semantics, concrete syntax and personal factors equally to provide better understanding for the users.

While the importance of user involvement in the design and development of visual artifacts is widely accepted, many efforts do not manage to reach significant levels of user involvement. In a recent work [22, 21] we explored to what degree applications of the PoN involved users. We found that a significant amount of applications did not involve users at all, whether for the critical analysis of existing visual notations, or the design and implementation of new ones. This means that little requirements elicitation for the visual notation is actually done with the very people using it.

In an ongoing project we are designing a platform, or perhaps, *marketplace*, for the collaborative design and evaluation of visual elements. Initially this is targeted at elements of visual notations for modeling languages, but it can be used for other visualization efforts as well. This could lead to a kind of 'certification' for visual elements: that particular core elements are known to be interpreted correctly and efficiently by users, in which contexts it is so, and for what purposes it is already used.

2.4 Applications of visualizations

Besides knowing how to create good visualizations, it is important to know how to put them to good use. This ranges from being able to select the appropriate kind of visualization and its parameters, to setting up interaction strategies. VISE members are working on topics like the animation of process models and other kinds of annotations, as well as on methods for applying visual models in software development processes.

We have used highlighting of process model constructs to focus the readers to the relevant parts of the model [15]. To include the readers better in the process of reading, animation support based on different scenarios, textual and audio annotations, and active involvement of users via controls are essential [2]. Currently we are developing process model animation techniques to guide the focus of the users as they read the models and enhance comprehension [1].

Utilizing visual models as construction tools in model-driven software development processes requires to embed them into a tool chain where their formal content is further analyzed and transformed by code generation and interpretation techniques. While traditional approaches mainly focus on general purpose modeling languages with few semantic expressiveness, [4, 3] put semantically rich domain-specific visual enterprise modeling languages into focus for this.

An approach for automatically suggesting visualizations for data analyses in specific domains is introduced in [7]. It is based on domain-specific semantic characteristics of the underlying data, which allows to narrow down the range of useful analytic views compared to merely syntactic approaches.

3 Future outlook

In this paper we have given an overview of recent work by VISE members on different visualization challenges in information systems engineering, from dealing with the cognitive point of view to formalization and empirical work. We hope to stimulate more researchers interested in visualization to collaborate on these and other challenges and exchange their insights on research strategies to best deal with these and other emerging challenges in the field of visualization in Information Systems.

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