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Brian Donnellan, Rob Gleasure, Markus Helfert, Jim Kenneally, Marcus Rothenberger, Monica Chiarini Tremblay, Debra VanderMeer, Robert Winter (Eds.)

At the Vanguard of Design Science: First Impressions and Early Findings from Ongoing Research

Research-in-Progress Papers and Poster Presentations from the 10th International Conference,
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Preface

This volume contains selected research-in-progress papers and poster presentations from DESRIST 2015 - the 10th International Conference on Design Science Research in Information Systems and Technology held during 20-22 May 2015 at Clontarf Castle, Dublin, Ireland.

DESRIST acts as an outlet and discussion forum for researchers and practitioners engaged in all aspects of Design Science research. The 10th DESRIST built on the foundation of nine prior highly successful international conferences held in Claremont, Pasadena, Atlanta, Philadelphia, St. Gallen, Milwaukee, Las Vegas, Helsinki and Miami. This year's conference places a special emphasis on broadening the research agenda and nurturing the symbiotic relationship between Design Science researchers and practitioners. To this end, individuals from academia and industry came together to discuss and share new ideas and innovative solutions across a range of domains.

The growth of design science means that a significant proportion of the work being done falls under the heading of research-in-progress. The title of this volume "At the Vanguard of Design Science: First Impressions and Early Findings from Ongoing Research", reflects its focus on communicating early findings from such research. This provides authors a platform to engage with the community and share nascent findings from studies at the leading edge of the discipline. Completed research from DESRIST 2015 is presented in a separate volume entitled 'New Horizons in Design Science: Broadening the Research Agenda', which is published by Springer International Publishing, Switzerland.

Overall we received 37 research-in-progress papers, of which 16 were presented at DESRIST 2015, together with 6 poster presentations for separate studies. Each research-in-progress paper and each poster presentation was reviewed by a minimum of two referees. The final set of accepted papers in this volume reflects those presented at DESRIST 2015.

We would like to thank the authors who submitted their research-in-progress papers and poster presentations to DESRIST 2015, the referees who took the time to construct detailed and constructive reviews, and the Program Committee who made the event possible. Furthermore we thank the sponsoring organisations, in particular Science Foundation Ireland,

Irish Design 2015, Intel, Maynooth University and Dublin City University for their support.

We believe the research described in this volume addresses some of the most topical and interesting design challenges facing the field of information systems. We hope that readers find the insights provided by authors as valuable and thought-provoking as we have, and that the discussion of such early findings can help to maximise their impact.

May 2015
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Exploring an Agent as an Economic Insider Threat Solution

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Abstract. The insider threat is a security problem that is well-known and has a long history, yet it still remains an invisible enemy. Insiders know the security processes and have accesses that allow them to easily cover their tracks. In recent years the idea of monitoring separately for these threats has come into its own. However, the tools currently in use have disadvantages and one of the most effective techniques of human review is costly. This paper explores the development of an intelligent agent that uses already in-place computing material for inference as an inexpensive monitoring tool for insider threats. Design Science Research (DSR) is a methodology used to explore and develop an IT artifact, such as for this intelligent agent research. This methodology allows for a structure that can guide a deep search method for problems that may not be possible to solve or could add to a phenomenological instantiation.

Keywords: Insider Threat · Linear Genetic Programming · inference, software agent · learning.

1 Introduction

The insider threat continues to be a problem, but not due to a growth in occurrences. Ponemon Institute (2013) reports that the frequency of security breaches have had either "no change or decreased at 47%", but the severity has "increased by 52%". It is estimated that organizations typically experience a security breach yearly where more than half of them are caused by an employ for non-compliance [26]. The insider is internal to an organization behind the firewall as a trusted user [29]. Blackwell (2009) suggests that "The attacker uses a tool to perform an action that exploits a vulnerability on a target causing an unauthorized result that meets its objectives". Since insiders need a physical means to commit insider crime and logical security policies are technical settings that can be configured, then it is system monitoring that is the effective technique to determined non-compliant behavior [8].

The need is for a tool that learns on its own, as well as one that can promote cost friendly insider threat detection programs for organizations. This paper explores the intelligent agent as an effective and inexpensive tool for the detection of insider threats. First the issue of current tools available is discussed (Section 2). Next is a discussion on software agents (Section 3). Fourth is the presentation of the proposed intelligent agent (Section 4). Next is the research methodology to design and build the intelligent agent (Section 5). Lastly is the conclusion that includes future research intended (Section 6).

2 Issues with Hardware Tools

The hardware tools available that may be used for insider threat monitoring are costly to implement and manage both in funding and man hours. Typically different tools would have to be combined for complete effective monitoring for insider threats. There are other possible hardware solutions other than the examples in this section. However, the idea is that an effective insider tool has the ability to stand on its own and be specifically for internal threats so two examples of possibilities is used.

2.1 Intrusion Detection System (IDS)

The intrusion detection system (IDS) is to detect intrusion to a network or computer. The anomaly signature-based IDS is the traditional configuration, but requires constant updates with new signatures and these are increasing at a fast pace, for example, five years ago SNORT reported an increase from 1500 to 2800 over a two-year period [3, 5]. According to Axelsson (2000) high false-alarm rates plague the IDS. Configuring the audit policy within the IDS is complicated and would be especially so for insider threats [15]. This device may be able to be used for insider threat detection, but the performance continues to be an issue [11].

2.2 Expert Systems

Expert systems are considered the knowledgeable device and experts in problem solving. They make decisions based on the information it is given and inferences referred to as modus ponens, "given (p) q) and p we deduce q" [12]. Expert systems are not able to learn more than the knowledge base they are provided. The device is not configured for game-base programming or decision-theory computation [16]. Heuristics is available, however, this capability is useless unless it was programmed for such where the decision is based on the knowledge and rules it is given [2, 13].

3 A Software Approach

Software agents have the capability to be created and configured to learn, evolve, adapt, and have self-reliance in any environment. They are able to abide by themselves where constant intervention is not required [6, 22]. This is an important characteristic with so many users within an organization. Agents have the ability to understand their environ-

ment by learning as they complete their tasks. They are commonly known as micro software systems that interact in an environment to achieve a goal [28]. There are many types of software agents available that could be insider monitoring tools.

3.1 Agent Types

The adaptive agent is one that creates an explicit control plan for events that occur in dynamic and difficult computing infrastructure, it adapts to its environment on its own [10]. The intelligent agent has three attributes for its intelligence where they can perceive the changes in their environment, react and impact the conditions of the environment, and possess reasoning in order to infer, interpret, determine, and take action [10]. This type of agent has the capability to modify its own code since its code is part of the environment [20]. The artificial intelligent (AI) agent is where humanistic abilities are applied and at a high-level of cognition [19, 31]. With these different qualities available, the software agent is capable of insider threat detection.

4 Proposed Artifact

The Intelligent Agent Monitoring Inference Engine (IAMIE) is a one-tool solution to detect and respond to insider threats while making use of already in-place operating system (OS) components, in this research it is Windows. The software agent produces cognitive units of programming object classes (considered cognitive units hereafter) that monitor the actions and objects of an insider threat. These are translated from audit logs and user actions then assimilated into an instance of context within the context engine. Here the units are arranged with the logical elements of inferential mechanics to identify what has occurred. They are then sent to the inference engine without their knowledge factors to infer possible responses using Linear genetic programming (LGP). The LGP allows the intelligent agent to respond to actions within the context engine. It is a method that uses the I/O (inherent to the OS) to read and write ad hoc protocols into the agent's source file with the C# code. This provides the ability to execute all possible inferred responses for context input and output.

The inference engine processes input through predicate and fuzzy logic to associate knowledge to the input. The process of predicate logic is the loop where the starts and stops are coded into the loop, such as true and false. The loop checks for conditions over and over. The fuzzy logic is used to check for conditions based on reasoning from approximation and possess partial evidence of true where logic is between the range of 0 and 1, not completely true and false [17]. These processes of logic allow the structure for the agent to take into account Scruffy and NeuroEvolution of Augmenting Topologies (NEAT) computation. The Scruffy performs ad hoc inference processing, meaning math is not used; while, the NEAT option of inference does perform discrete measurements [14]. Code tells the inference platform how to process the structure.

The cognitive units are then sent to the cognitive engine to obtain their knowledge once the first phase of inference . The cognitive units obtain their knowledge from the cognitive engine through the engine's memory retrieval from Extensible Markup Lan-

guage (XML). Once the new knowledge is obtained they will go back through the inference engine to manipulate the assessed knowledge into the cognitive units.

Finally the context engine converts the inferred, processed, and assimilated knowledge into new instances of the cognitive units for each implication made in the previous context. A response is displayed and an action is taken by the cognitive units. If it is determined that the action is a possible insider threat a simple alert message is sent to the PC of the user and the monitoring PC of the agent. Figure 1, Artifact Diagram, provides an overview of how the intelligent agent works.

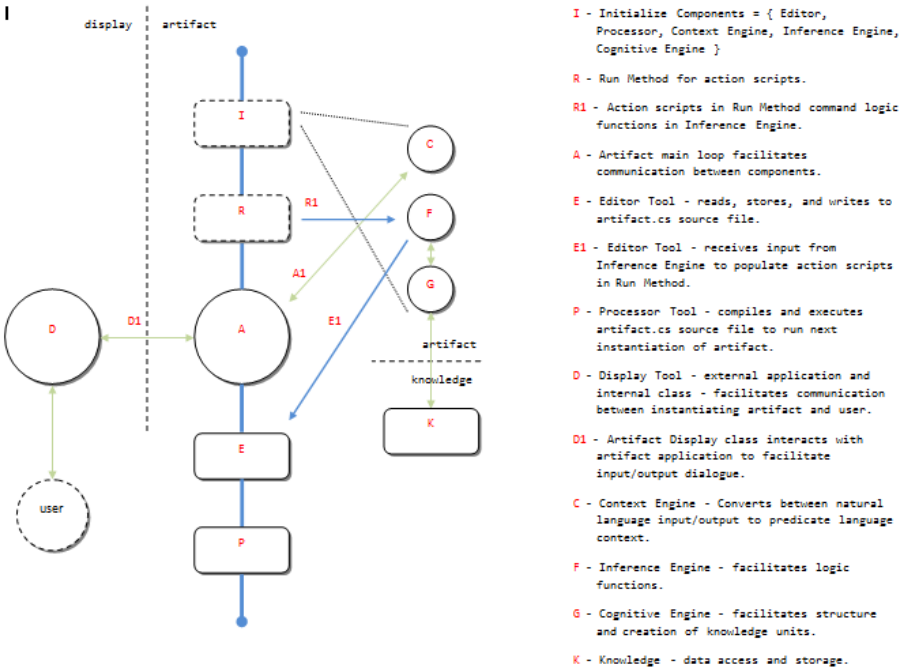


Fig. 1. Artifact Diagram

4.1 Artifact Example

The intelligent agent takes input that comes in the form of actual command line prompt inputs of natural language, it reads event log entries, or it watches for specific actions to occur that are established as rules in its programs. For example, the organization may have a specific folder that is restricted to only specific personnel since it contains the designs that gives a product its competitive advantages. The folder lists of users that have permission to access, read, write, and execute the folder contents. The agent is a software program that resides on the computing device where the folder is located. The agent produces cognitive units that infer if accessing users are allowed to perform the actions they take with the folder. Flags set within the agent perform an alert message when certain activities in the folder are performed and if an unauthorized user is found it

will send out an alert message. The key to the intelligent agent is that it watches the actions performed by trusted individuals.

5 Artifact Methodology

Design Science Research (DSR) is a method focused on the construction and improvement of an information Technology (IT) artifact or prototype and requires strong evaluation [21, 27]. Its use allows the whole of the research to add to the knowledge base [27]. For this agent research the DSR model chosen is the five-cycled General Design Cycle (GDC) model of awareness, problem, suggestion, development, and evaluation [25]. The frame used from DSR is the experiments and exploration to guide the research outcome to an operational prototype [24]. This research involves software development and the development life cycle (SDLC) chosen is an Agile approach of Rapid Application Development (RAD) using Iterative and Incremental phases (known as RADII within research documentation). Figure 2, Artifact Research Model, provides an overview of how DSR and a Software Development Life Cycle (SDLC) is used for developing the artifact.

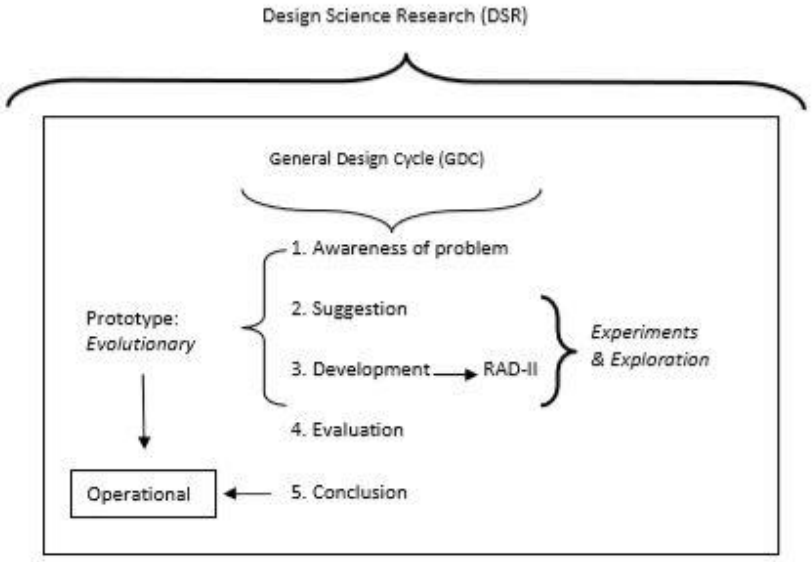


Fig. 2. Artifact Research Model

This intelligent agent research will include the dynamics of the suggested seven principles of DSR to address the rigor and processing, as follows: 1) Design as an Artifact; 2) Problem Relevance; 3) Design Evaluation; 4) Research Contributions; 5) Research Rigor; 6) Design as a Search Process; and, 7) Communication of the Research [26]. The same rigor to apply principles of the design of experimental research also must be applied to and by DSR [9].

5.1 Reason for DSR

DSR has the purpose of finding solutions to problems in technology that may not seem solvable or cannot be fixed with engineering alone [27]. The iterative and cycled approach of DSR is useful for practitioners and researchers who have some experience in using this approach [7]. The goal is to create a solution to a real-world problem and provide practical relevance. The key is the relevance of the problem to determine if research is needed beyond engineering. This is important since the activity of research is to contribute to the understanding of a phenomenon and add to the existing body of knowledge [1, 23]. The research goal is that the intelligent agent's cognitive engine can indeed write new instantiations of itself from LGP processed learning so it can better detect the invisibility of insider threats.

6 Conclusion

This research has defined the nature of the problem where the increase of insider threats is not the frequency of incidents, but the damage and its cost of one incident at one time. The the research is an intelligent software agent as an economical tool that effectively detects insider threats.

The DSR methodology is specifically to find solutions to problems within the field of technology. The ability for a research method that can go beyond engineering to answer to those problems that may not be solvable is invaluable. When a technology problem exists the first course of action is to decide if engineering can solve the issue or if DSR is applicable. Although DSR can go beyond creating a prototype or improvement by providing new knowledge, to force its use may not help the outcome.

In this specific agent research the use of DSR is valuable in order to take the IT artifact into operations. The intelligent agent processing information through the Context, Inference, and Cognitive engines makes possible emergent intelligent, where an agent's cognition grows as it performs its inferences [30]. When emergent intelligence is embraced in this specific research it exposes the availability of further implementation of the agent for different areas of technology. Research being performed in a parallel form is the knowledge that can be applied to the intelligent agent as an audit log reduction tool. The future research is the agent being structured for cloud application and open source processing.

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CloudNeg: An Autonomous Multi-Issue Negotiation System, with Preference Elicitation Component, for Trading Cloud Services

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Abstract. Cloud services provide its users with flexible resource provisioning. But in the current market, a user has to choose from a limited set of configurations at a fixed price. This paper presents an autonomous negotiation system termed CloudNeg for negotiating cloud services. CloudNeg provides buyers and sellers of cloud services with autonomous agents to negotiate on the specifications of a cloud instance, including price, on their behalf. These agents elicit their buyers' time preferences and use them in negotiations. Further, this paper presents two artifacts: a negotiation algorithm and a prototype which together form CloudNeg.

Keywords: cloud computing, time preference, autonomous negotiation, design science.

1 Introduction

Cloud computing is a computing paradigm in which users buy IT resources as a service. It offers several advantages to buyers like reduced operating costs, scalability and flexibility but at the same time poses challenges like data lock-in, confidentiality and service availability[1]. US National Institute of Standards and Technology (NIST) classifies cloud computing service models into Infrastructure as a Service (IaaS) e.g. Amazon EC2, Platform as a Service (PaaS) e.g. Microsoft Azure and Software as a Service (SaaS) e.g. Salesforce.com. These cloud services can be availed either directly through vendors or through e-marketplaces. We draw motivation for this research from the increasing focus on adoption of electronic negotiations (e-negotiations) for cloud computing services [2], [3].

A negotiation can be manual or automated. Research has shown that automated negotiations are faster and provide higher utilities and better agreement rates as compared to human negotiators [4]. Thus agent based automated negotiation is adopted. Furthermore, e-agents represent buyers and sellers and therefore, it becomes imperative for the negotiating agents to acquire their user's trade-off preferences to be able to negotiate better [5].

Some researchers have tried integrating preference elicitation with agent technology in the past [6]. While representing those preferences, it is assumed that preferences of issues (like price, bandwidth and time) are independent of each other. But, from the literature on behavioral sciences (intertemporal choice) [7], [8] one can infer that the pref-

erences among delivery time and other issues (such as bandwidth and storage speeds) are not independent.

Frederick et al. [7] define time preference as "preference for immediate utility over delayed utility". To capture this time preference, Samuelson [8] gave the discounted utility model which discounts the future payoffs exponentially. Though the model is simple and convenient it fails to explain various intertemporal anomalies, one of them being the common difference effect [9]. The common difference effect essentially means that preferences might switch when incremented by constant delay, a property known as non- stationarity. To explain this anomaly, Lowenstein and Prelec [9] proposed a generalized hyperbolic discounting. Extending this effect in the context of procuring cloud services, the trade-off between delivery time and other parameters can change with time. A person who might pay higher to get a delivery of a cloud instance in 5 hours over 10 hours may not pay a higher price for the delivery of a cloud instance in 30 hours over 35 hours. Even though the difference between the choices offered is same but the choices have been delayed by 25 hours [9]. Such kind of behavior can give real insights on how a buyer perceives different offers and can help negotiating agent get a deal which might maximize buyer's utility. Krishnaswamy & Sundarraj [10] have explored this by analyzing the effect of time discounting on offer concessions in e-negotiations. They have suggested incorporation of intertemporal preferences in e-negotiations. Pahuja et al. [11] have used Time Tradeoff (TTO) sequence to elicit time preference in the context of movie ticket negotiations but they have dealt with only price and time negotiations. Also they did not elaborate on the details of offer evaluation and generation during a negotiation. This research attempts to improve extant system by developing a multi-issue negotiation system (CloudNeg) incorporating time preferences using a design science approach. CloudNeg provides a platform for automated negotiations between buyers and sellers on the following cloud service specifications: price, time, bandwidth, storage read and write speeds. CloudNeg also provides a preference elicitation subsystem to gather buyer preferences. The system is elaborated on in subsequent sections.

2 Design Science Research Methodology

CloudNeg is developed using a design science research approach. Our research is aimed at developing artifacts which together constitute an e-negotiation system for cloud services. The research approach follows the set of guidelines prescribed by Peffers et al. [12] for the design and implementation of the artifacts.

Identify problem and motivation.

Even though there exist quite a few E-commerce negotiation platforms like the MAGNET and Genius, time preference elicitation has not been given due importance in the autonomous negotiation literature . Alsrheed et al. [3] present a cloud negotiation system, but their work primarily focusses on algorithms for automated negotiation and not on preference elicitation and its incorporation. Experiments conducted by Krishnaswamy & Sundarraj [10] established the need for efficient representation of time preferences in the context of cloud negotiations. Works of Son & Sim [2] do consider time slot negotiations but their algorithm relies on the preferential ordering of the time slot as

stated by the buyer. In their work, they have interpolated the utility of intermediate time slot which fall between the ordered time slot preferences. The streams on intertemporal choice and e-negotiations have been disjoint. We propose a different approach to time slot (delivery time) negotiations in an attempt to emulate user behavior. This is achieved by modelling the time discounting behavior of buyers and then using it to discount the utility of other issues with respect to delivery time of the offer.

Define objectives of a solution.

To this end, we define the objectives leading to the development of proposed negation system. The first objective is to design a system that is capable of modelling and user's devaluation of utility with time. This is achieved by implementing a time preference elicitation subsystem, using the concept of discounting function[1]. Discounting function governs the trade-offs between time and other issues (price, bandwidth, storage speeds). The second objective is to develop a modular negotiation system that exposes the APIs necessary for offer generation and evaluation, thus enabling an option to test different strategies.

Design and development.

At the design stage, we look into the literature on intertemporal choice to estimate the time discounting function from the time preference. We adapt a tool called as Time Trade-off Sequence proposed by Attema et al. [13]. TTO sequence is favoured because it does not assume linear utility and focusses on single outcome. The only drawback of this method is that it assumes that the discounting function doesn't change over time. The design of the system is based on negotiation systems proposed by Lin et al. [14]. The interaction of preferences with offer generation and evaluation is adopted from the mechanism proposed by Venkataraghavan & Sundarraj [10].

Demonstration.

Based on the objectives, we have developed two artifacts: an algorithm to approximate preferences and a prototype instantiation exhibiting modular design. The proof of concept, which dealt with price and time negotiations only, was demonstrated at GDN 2014 [11]. The artifact was extensively modified to accommodate multi-issue negotiation, since in real life negotiations include several issues other than price and time.

Evaluation.

We will use a case study approach, based on guidelines given by Yin [15], to evaluate CloudNeg. Case studies will primarily consist of semi-structured interviews with buyers of cloud services to understand their perceptions of such a system.

[1] A mathematical function to capture a person's impatience. E.g. Samuelson's Discounted Utility Model [8]

3 Research outputs:

3.1 Artifact 1 : An Algorithm to capture buyer's preferences and use them in negotiations

Given that an offer is received, the algorithm calculates the utility of the received offer, and then based on the utility for that round it either accepts the offer or proposes a counter. Accordingly, we divide the algorithm into three parts: the first part deals with calculation of utility of the received offer, the second part elaborates on round-on-round utility concessions and the third part describes the steps involved in proposing a counter offer.

Part 1: Calculating the utility of a received offer.

In this part of the algorithm, buyer's preferences about price, delivery time, bandwidth, storage read and write speeds are captured into a multi-attribute utility model, which is then discounted using buyer's time preference. This part can be further divided into three segments: the first segment deals with multi-attribute utility model, the second with time discounting of utility and the final with cumulative utility model.

Segment 1: Multi-attribute utility model.

1. The agent asks the buyers about maximum and minimum acceptable values of the issues other than delivery time (price, bandwidth and storage read and write speeds). It also asks about the weights of the issues, which signify their relative importance.
2. The utility of these issues is calculated using the multi-attribute utility model

$$U(X) = \sum_{1 \le j \le n} w_j \, U_j(x_j) \quad (1)$$

where $U_j(x_j)$ is the utility of issue j at value x_j, from the received offer. Further, buyers value a lower price and higher bandwidth, storage read and write speeds. Therefore utility function for price is

$$U_{price}(p) = \frac{p_{max} - p}{p_{max} - p_{min}} \quad (2)$$

where p is the price and p_{max} and p_{min} are maximum and minimum acceptable values of price.

Utility function for bandwidth, storage read and write speeds is

$$U_j(x_j) = \frac{x_j - x_{min}}{x_{max} - x_{min}} \quad (3)$$

where x_j is the value of the issue (bandwidth, storage read and write speeds) and x_{max} and x_{min} are maximum and minimum acceptable values of that issue.

Segment 2: Time discounting of utility.

1. To capture buyer's time preference, electronic agent then administers TTO sequence [13] to get the parameters of discounting function CRDI 2 [16]

$$\phi(t)=ke^{-a\ t^{1-\delta}} \quad (4)$$

where a > 0, δ < 1, k > 0

Given a delivery time t, equation 5 gives the corresponding discount factor

Segment 3: Cumulative utility function.

Incorporating time preference into the multi-attribute utility model, the proposed discounted utility model is

$$U(X,t)=U(X)\phi(t) \quad (5)$$

where $U(X)$ is the utility of all the issues except delivery time; ϕ(t) is the discount factor at delivery time t.

Part 2: Round-on Round Utility Concessions.

The negotiating agents employ tactics, a set of functions derived from buyer's preferences, to calculate utility for a particular time. Tactics can belong to one or more of the following types: time dependent, resource dependent and behavior dependent [17], [18]. In this research, agents use the time dependent tactic to vary the utility with negotiation round.

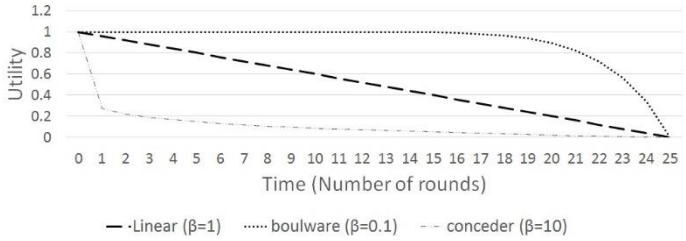
$$U_r=U_{min}+(1-\alpha^r)(U_{max}-U_{min}) \quad (6)$$

where $\alpha^r=\left(\frac{r}{r_{max}}\right)^{\frac{1}{\beta}}$; $U_r \in (0,1]$;

r is the current round and r_{max} is the maximum number of rounds

$U_{min}=0$ & $U_{max}=1$ are maximum and minimum utility

Based on the value β, time dependent tactic can be classified into two sets of families: boulware and conceder. If β < 1, the agent does not concede significantly on utility until the deadline almost expires, and then it makes large concession upto u_{min}. This type of behavior is termed as boulware. If β > 1, the agents concedes substantially in the initial rounds and not so much till the deadline is reached their behavior is termed as conceder.



(See figure 1).Based on their TDTs, agents decide on the utility for a particular round (u_r), which they use to accept an offer or propose a counter.

Fig. 3. Round on round utility concession using time dependent tactic

Part 3: Offer Generation.

1. The utility of the current round is calculated as per the second part of the algorithm.
2. An offer is accepted if the utility of that offer is more than or equal to expected current round utility, else multiple concurrent counteroffers are proposed by trading-off the distribution of utility between discount factor ϕ(t) and utility of issues other than time $U(X)$.
3. Delivery time is calculated using inverse of CRDI 2 function (equation 4) and values of other issues are calculated using the utility functions (equations 2 and 3) described in part 2.

3.2 Artifact 2 : System Instantiation

CloudNeg sports a modular design, which enables testing different negotiation strategies. There have been many negotiation systems proposed in the past, but, to the best of our knowledge, none of them focus on eliciting time preference and using them in multi-issue negotiations. Work of Luo et al. [6] is somewhat closer to our work. They employ a default-then-adjust method to elicit buyer's trade-off preferences. But neither do they consider non-linear preferences like time preference nor they provide a mechanism to use the trade-off preferences in negotiations.

It is assumed that buyers and sellers are negotiating on pre-agreed set of issues. The negotiation system is targeted at the post discovery phase. The negotiations are time bound and the negotiating agents are self-interested and utility maximizing. An alternating offers protocol is followed, where e-agents take turns to propose offers.

Logical Description.

CloudNeg can be logically divided into two main subsystems: preference elicitation and negotiation. Preference elicitation subsystem deals with eliciting buyer's preferences and converting them to actionable reasoning model which will be used during negotiation. The negotiation subsystem takes over once preference elicitation is done. It loads the seller preferences and buyer preferences into their respective automated negotiating agents and establishes a communication channel between them. Negotiations begin by buyer proposing an offer. Negotiation ends once an agreement is reached or the deadline is expires.

Technical Description.

CloudNeg follows a Model View Controller (MVC) architecture (see figure 2) by implementing Struts2 framework. The web application is hosted on Apache Tomcat Web server. GUI comprises of a set of JSPs, which are used to record buyer preferences and display negotiation outcome. Code for negotiation subsystem is linked to the controller. The negotiation subsystem communicates with database (MySQL) to retrieve seller profiles and system properties, and store the results of negotiation. Hibernate framework is used to map the model to MySQL tables.

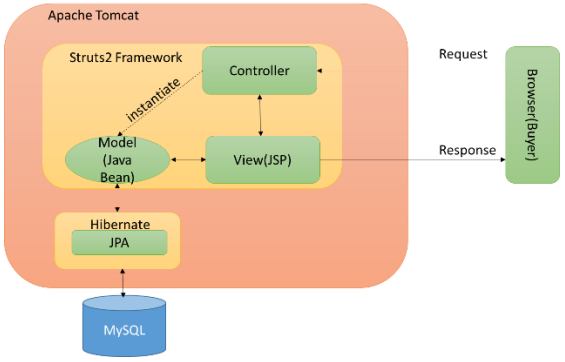


Fig. 4. Overview of technical implementation of CloudNeg

4 Conclusion, limitations and future work.

In this paper, CloudNeg is presented as an artifact for negotiating cloud services. It was developed using DSR approach. The system was described in general and a prototype was developed. The novelty of the system is in its approach to integrate time preferences with negotiation systems. There have been attempts to apply behavioral economics to understand the individual decision making process in the context of Information Systems and our work is a step forward towards understanding those decision making behaviors and making the system imitate part of it in a negotiation setting. We limited the time preference elicitation to TTO sequence [13] due to practicality issues. Other preference elicitation techniques need to be explored in order to adapt them to current context. Effects of loss aversion and reference dependence on negotiation behavior need to be studied and incorporated with the system. Current implementation of CloudNeg features only preference elicitation and negotiation subsystems. Other supporting subsystems such as service discovery and negotiation ontologies need to be implemented. We leave this for future work.

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Shipping Information Pipeline: Initial Design Principles

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Abstract. This paper presents a design science approach to solving persistent problems in the international shipping eco system by creating the missing common information infrastructures. Specifically, this paper reports on an ongoing dialogue between stakeholders in the shipping industry and information systems researchers engaged in the design and development of a prototype for an innovative IT-artifact called Shipping Information Pipeline which is a kind of "an internet" for shipping information. The instrumental aim is to enable information seamlessly to cross the organizational boundaries and national borders within international shipping which is a rather complex domain. The intellectual objective is to generate and evaluate the efficacy and effectiveness of design principles for inter-organizational information infrastructures in the international shipping domain that can have positive impacts on global trade and local economies.

1 Introduction

This research in progress paper seeks to contribute to Design Science Research (DSR) by identifying and evaluating initial design principles for IT-artifacts that help resolve existing problems, create operational efficiencies and increase competiveness in the supply chain of international trade. The paper reports on a research project that seeks to design and develop an innovative IT artifact named Shipping Information Pipeline. The domain of international trade has evolved over centuries. The utilization of standardized containers has enabled very efficient inter modal shift, for example between truck transport and sea transport. The international physical infrastructures have evolved technologically to become very efficient supply chains. Even so, the business eco system is rather complex and there are quite a few barriers in the supply chain for international trade, mainly administrative barriers which is a significant challenge for international trade. The actors in the supply chain are missing an efficient information infrastructure to facilitate the physical infrastructure [12]. The aim of the shipping information pipeline is to provide such an information infrastructure utilizing the internet as a foundation for the communication. It's estimated by World Economic Forum that lowering barriers for international trade by increasing collaboration will have a positive impact on economy. Some stakeholders have already realized that modern IT could be the means towards efficiencies but also that they can't be successful doing it on their own. Existing research shows that the domain for the shipping information pipeline is complex with more than twenty organizations involved in any given individual shipment and each of the organi-

zations utilize their proprietary IT solutions. From an industry perspective, the problems and issues in the domain of international trade are around the barriers since the physical infrastructure is already quite efficient. But the organizations can't lower the barriers by themselves since the solution has to involve multiple organizations along the supply chain of the international trade lane. None of the organizations involved are the obvious driver of such an IT solution. Therefore a key stakeholder has reached out to researchers for help to investigate and design a possible solution a shipping information pipeline. From an academic perspective, there is a research gap in the extant DSR knowledge regarding the design of a shipping information pipeline. To address this knowledge gap, we propose to employ the theory about inter-organizational systems and design theory for information infrastructures. Towards this end, we formulate the following research question: *What design principles can help inform the design, development and evaluation of a shipping information pipeline for international trade?*

2 Research design

This research-in-progress paper reports on approximately one year of research and development effort. The research reported here is drawn from a large four year research project which involves many different types of organizations in the European business eco system for international trade. The primary research field is Information Systems (IS) with other domains such as operations management, international trade economics and law informing the project. Given that the aim is to design an IT artefact that has both academic rigor and industry relevance, the method of Design Science is an obvious choice. Design science research is a particular perspective within IS research [4, 19] which focuses on the development of artifacts related to information and communications technology. Design science research includes an evaluation of the designed artifacts. Design science research places IS research in between the industry environment or practice and the academic realm of knowledge base. In the case of the shipping information pipeline, our criteria for relevance and rigor are guided by a set of "seven guidelines for Design Science in Information Systems" [10]. More than twenty five interventions are part of an ongoing dialogue between stakeholders in industry and researchers related to the large research project CORE (www.coreproject.eu). The interventions have involved both researchers and practitioners and range from dedicated workshops, meetings and conference calls to conferences arranged by others. The initiator and facilitator of the interventions vary: sometime it's the practitioner and at other times it's the researchers. Data collected from these interventions consists of audio-recordings and written material. The interventions have been documented by written material in the form of minutes of meetings and presentations which in the subsequent interventions have been taken up for discussion and comments.

3 Theory

The dominant IT artifact utilized for efficiency gains in the supply chain for international trade is Inter-Organizational Systems which are also characterized as one type of infor-

mation infrastructure. Inter-Organizational systems are defined as "information systems to span boundaries between countries, organizations and the relatively separate components of large, geographically dispersed corporations" [5]. IOS can bring "significant competitive advantages" [13] and serve an essential role to facilitate integration and develop unique processes across the supply chain [24]. Extant literature on the utilization of IT for collaboration across organizational boundaries and borders is primarily focused on IOS [14]. Further, current literature on IOS employs more than 25 theories [18] and no single theory stands out as predominant. The majority of research regarding IOS is focused on EDI [21], and a majority of the described IOS are successfully utilizing EDI [22]. For international trade, the benefits of facilitating IOS based on EDI is well documented [15, 16, 17] and it has also been pointed out that the cost of change are relatively high [9]. The EDI based IOS are utilized between some fragmented parts of the supply chain for international trade, for example communication between the shipping lines, terminal operators, port authorities. The aim with the shipping information pipeline is to provide a less costly solution than EDI message based IOS and the shipping information has to cover the end-to-end supply chain for international trade. IS design theory [6, 23] includes: a) requirements b) a set of system features c) kernel theory, and d) design principles. The proposed design principles for information infrastructures are a kernel theory ("theory-in-use" by practitioners) informed by the insights of "How Do Infrastructures Evolve" [7]. They consist of a set of refined properties for information infrastructure with *emergent properties*: Shared, Open, Heterogeneous, and Evolving; and *structural properties*: Organizing principle, and Control. Formulated theoretically, information infrastructures is defined "as a shared, open (and unbounded), heterogeneous and evolving socio-technical system consisting of a set of IT capabilities and their user, operations and design communities." [8]. Based on the kernel theory, a set of five design principles and nineteen design rules for II has been suggested as design strategy addressing two generic problems for IIs: bootstrap and adaptability. Based on the design theory for II several examples of failure and success have been given to validate the theory[2]. Both the EDI message based IOS and the shipping information pipeline is a business / industry sector information infrastructure and accordingly the design theory for information infrastructures should be applicable.

4 Design

In the following we report the early conceptual design phase, the prototype design phase and the instantiation phase of the prototype. Early in the design phase the practitioners recognized that the administration barriers for the supply chain for international trade can be best described as a "black box" and that no one can provide an overview of all the actors. Accordingly, recording all the essential and desired requirements is nearly impossible. Further, only very few of them have IT capabilities which enable them to propose futuristic requirements. The traditional IS design theories where the starting point is the requirements seemed not to be applicable since the user requirements are unknown. Detailed requirements cannot be determined prior to the design but have to evolve. Therefore, the researchers undertook the task to analyze the current situation for a specific trade lane which could form a basis for deep understanding of the domain [11,

12]. Additionally, a search for alternative design approach was initiated by adopting a more evolutionary approach that involved presentations and discussions within the business eco system. Several of the involved organizations reported engagement in standardization work with the purpose of harmonizing the data used for international trade and to be able to exchange data. Given the multiple organizations and the number of nationalities involved, the progress and results are rather limited especially regarding actual implementations. Accordingly, the design of the shipping information pipeline should depend a little as possible on standards. The central design objective was to enable collaboration among all the actors in the supply chain for international trade and thereby lower the barriers for international trade. Many of the organizations involved already have IS solutions for optimizing their part(s) of the activities (e.g. most authorities have implemented single windows system) and accordingly the potential gains are to focus outside the organization (e.g. by enabling collaboration with other organizations). Our analysis showed that this collaboration already takes place utilizing a range of communication channels based on peer to peer communication which means that very few actors holds updated information [12]. As such, a core design principle was to offer one shared information infrastructure. The authorities would like to improve the data quality by getting access to source data[2] which typically are located in another nation outside the authorities' area of control. The authorities are crucial for the collaboration since it's them that's blamed to be the cause of the barriers and are best positioned to enable a lowering of the barriers not by lowering their demands but by mandating collaboration regarding the information they need and by provisioning additional information (e.g. green lane for trade lane for shipments). Given that authorities are crucial then the design and development efforts need to include and engage the authorities. One of the major logistic service providers has attempted to facilitate to provide the source data for the authorities but their customers became reluctant to share more the information. One of the large terminal operators have attempted to create a collaboration platform but the leading stakeholders could not agree on the set up because they feared lock-in situations. It seems that a single organization in the eco system will not be successful at developing solutions for the end-to-end supply chain. As such, we proposed to form a collaboration of stakeholders behind the shipping information pipeline. Note that to a large extent the organizations' IT is outsourced to IT vendors and the IT capabilities within the organizations are limited. One way forward is to design and build a prototype to demonstrate the solution and engage actors from the various organizations utilizing the IT artifact for real shipments for one specific trade lane as a demonstration case. Towards this end, we decided to start with one trade lane crossing three continents instead of starting with one organization or one geographical location because our design focus is on opening the "black box". Future implementations and demonstrations will include an increasing number of trade lanes and geographical locations. The design of the prototype actively involved many stakeholders in various settings and focused on a set of design properties (Jensen et al 2015 forth coming). The design properties comply with the design properties proposed for information infrastructures [8]: open, shared, heterogeneous, and evolving whereas the structural properties regarding organization and control have been postponed. Additionally, the design has also focused on what the shipping information pipe-

[2] EU Annex 30A specify the data of interest for the European authorities

line is not going to encompass. For example to avoid 'big brother' perception (1), the shipping information pipeline will not service commercial arrangements, not have a central database with all trade information, will not exchange detailed shipping data in a standardized format and will not be an EDI broker. In this way the shipping information pipeline differentiates itself from other existing IOS solutions. Note that the installed base for collaboration solutions within international trade mainly are IOS based on EDI messages where the control is centralized. None of the stakeholders behind the installed base have taken the initiative in this regard. Additionally the SIP shall be inexpensive to use or even free (2) and allow partners to develop applications and service on top of the SIP and charge for this (3).

The design theory for information infrastructure' design principles and rules addressing problems of bootstrapping evolution have been reviewed but haven't been used. One reason could be that there is no installed base that provides a critical mass. Neither researchers nor practitioners have been able to formulate the kernel theory for the shipping information pipeline. Instead, the theoretical formulation keeps being adjusted (e.g. to the audience for the design evaluation). Another reason could be that the shipping information pipeline has not been bootstrapped yet since it's only in the very first initial phase of design. To be able to reference the same shipment, the focus on id's (4) early became one of the key design principles of the prototype. Inspiration to rethink came from IS literature on the topic [3], a presentation of a case on id [2] and various standards (e.g. GS1 and WCO data model). Another key design principle is to focus on event types (5) which was inspired by a European information infrastructure case presentation for traffic information and the issues experienced (Lyytinen 2015 forth coming). This led to the proposed trade lane specific taxonomy[3] (6). Another key design principle for the shipping information pipeline is that it should be service based (7). To explore and inspire the possible services to be offered by the shipping information pipeline, the concept of affordances (8) used in modern IT solutions e.g. "like" on Facebook have been used to simulate the future solution (Jensen and Vatrapu 2015 forth coming) which provided adjustment in the services with regard to the design scope. Trust is critical for organizations utilizing the shipping information pipeline and accordingly the information stored and shared is kept to the essential minimum and for more details the actors need to follow an URL (9). The design principles for authentication (10) are planned to be based on already available standard services/components [20] . The shipping information pipeline need to work similar as the internet with free access to information (11) and simple to use (12) for the actors that do not have to care about the technicalities. The instantiation of the first prototype has now been completed based on the above discussed design principles and continually being refined. For the first prototype the authentication has been left out and replaced by a log on window. The next step is to try and evaluate the use of the prototype of the shipping information pipeline on real shipments.

[3] Cassandra Living Lab White Paper May 2014 DASC methodology: Data Analysis for SCs

5 Evaluation

The evaluation of the shipping information pipeline is an ongoing process where various potential stakeholders evaluate typically at different abstraction levels. The abstraction levels include actor or user level, organizational level, country / society level as described below. The evaluations are rather positive even so no single organization seems to be tempted to front up the costs for the shipping information pipeline. The public authorities do not see the implementation of a shipping information pipeline as their task and each of the private organizations have other projects with higher priority and/or potential. The individual actor using the shipping information pipeline will be able to get more insight into events in the supply chain for international trade for the shipments in which he or she is potentially interested. Today none of the actors have transparency. Accordingly, when asked they find that the service provided by the SIP very useful especially when things do not go as planned. The private organizations involved are the traders and the service providers. The traders foresee that the shipping information pipeline can improve the possibilities for more efficient logistical coordination and lower the risk which will impact the international trade cost. The administrative border related part of international trade cost addressed by the SIP is significant-approximately 20% of the retail cost [1]. The service providers (e.g. a major shipping line) are the main driver behind the shipping information pipeline and obviously they are interested in mainly foreseeing that lower international trade cost will increase trade volume resulting in more business especially when being a first mover. The authorities derive value from the shipping information pipeline with the possibility to get data directly from the source which results in data quality increases compared to today which enable the authorities to improve their risk assessments and the accuracy for the calculation of tariffs etc. Several IT vendors are offering products and have an installed base that facilitate information interexchange for international trade and they have been positively engaged in communication about the shipping information pipeline but none of them have seen a business opportunity which they pursue yet. At country level the impact of reducing the administrative barriers are estimated to have significant impact on trade volume which affects the economic positively. The World Economic Forum (WEF) estimates that an improvement to half-way of regional best practice and of global best practice will have resulting in increased Gross Domestic Product (GDP) by 3% and 5% [25]. The success of the SIP depend on the capability to secure benefits as described above to the actors and organizations involved to a degree that they will use the SIP.

6. Discussion

Since there are multiple actors and organizations potential utilizing the shipping information pipeline and evolutionary design approach was chosen. Further, since the requirements specification for the domain is rather difficult, we developed and evolved the design principles for the shipping information pipeline in one specific trade lane as a demonstration case. The design principles were informed by extant literature as well as empirical work. That said, our research addresses a knowledge gap in DSR with regard to design principles for IT artifacts with multiple stakeholders across organizational

boundaries and national borders. The design properties have guided the coding of an early prototype which has been presented and evaluated, and currently is tested on shipments from Kenya to Europe, which will inform the future the evolution of the prototype. Next step is to expand the design implementation and evaluation to more shipping trade lanes.

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Developing a Health and Wellbeing Platform in a Living Lab Setting: An Action Design Research Study

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Abstract. The world's population is rapidly aging, which affects healthcare budgets, resources, pensions and social security systems. Although most older adults prefer to live independently in their own home as long as possible, smart living solutions to support elderly people at home did not reach mass adoption, yet. To support people age-in-place a Living Lab is established in one of the metropolitan areas in the Netherlands. The main goal of the Living Lab is to develop an online health and wellbeing platform that matches service providers, caretakers and users and to implement that platform in one particular city district. In this paper we describe the narrative of the action design research process that will give researchers insight how to deal with complex multi-stakeholder design projects as well as cooperation issues to develop an artifact in a real-life setting.

Keywords: aging-in-place, platform, action design research, smart living

1 Introduction

An aging population can be explained by the increasing life expectancy due to improved public health and a declining fertility rate. Both trends are expected to continue the coming decades. Life expectancy at birth will increase globally with ten years, to reach an average of 76 years by 2045 – 2050. In the same timespan the average global fertility rate will drop to the replacement level. Next to that, the United Nations predict that within thirty years the older adults will even outnumber children under the age of 15 [1]. One policy to reduce healthcare expenditures is to encourage people to live longer at home (i.e., aging-in-place) [2]. While, most elderly prefer aging-in-place instead of living in an institution [3], to maintain a certain quality of life [4], it is a challenge to make this happen. Declines in cognitive and functional abilities, social exclusion, digital divide as well as time pressure on the caregivers, are typical hurdles. Besides these general difficulties end-users are not aware of what products and services are available to fulfill their needs at a certain point of time. To assist the elderly, considerations need to be given to housing, transportation, social interaction, cultural engagement and activities [5]. Aging-in-place also implies that elderly maintain social connections to the neighborhood and the community, as well as in socio-cultural contexts [6].

The focus of this paper is on how aging-in-place can be supported by ICT-enabled solutions. For instance solutions related to smart living involve connecting our daily activities at home, along the way, or anywhere else, through integrated ICT. Although smart

living has been on the agenda of policymakers for quite a long time, smart-living services have not reached the diffusion phase and did not make it into the mass market, yet [7]. Creating awareness among end-users about existing solutions to support them age-in-place is challenging. We propose that such awareness may be increased, by offering an online service platform to find all relevant applications within the smart living domain [8, 9]. How to design, implement and roll-out such platforms is unclear as existing literature on digitals platforms is merely based on ex-post studies of successful platforms [10]. Therefore, the objective of this paper is to describe a narrative how to develop, a health and wellbeing platform within a real-life setting, in an agile iterative way.

Designing such a health and wellbeing platform is highly complex as many stakeholders are involved. We draw on Action Design Research (ADR), which has been suggested by Sein, Henfridsson [11]. ADR is particularly appropriate because 1) it combines action research (AR) and design research (DR) to generate prescriptive knowledge 2) it is problem-driven and 3) it aims to build design principles based on iterative cycles. Action Design Research should generate knowledge that can be applied to a class of problems that the specific problem exemplifies. Next to that, ADR is based on an artifact and emphasizes the interdependence of building, intervention and evaluation. As a result, the research activity is problem-inspired and combines thinking with doing [12, 13]. To use ADR in practice, we develop an artifact in a real-life context while constantly reflecting on the process. To track the iterative design steps, the action design researcher kept a logbook on a daily basis over the period 2013 – 2015 amounting up to 650 pages.

2 Earlier work on designing the artifact

In earlier research [14] we elicited three main features of an online platform for health and wellbeing based on 59 interviews with stakeholders 1) an **online community** for contact, social wellbeing and interaction with the neighborhood (consumer to consumer) driven by the need for social cohesion; and 2) a **portal** for bundled smart living services and solutions (business to consumer), driven by the one-stop-shop philosophy for 'aging in place' and 3) an **intervention instrument** for the municipality (government to consumer) to interact with citizens about needs for services and questions about the different health care arrangements. Ultimately, such a platform should enable end-users to enhance self-management (i.e., independency) by the provision of relevant information and support in matchmaking between different stakeholder groups (i.e., consumers, providers and government). Eventually the platform has to enhance the quality of life of end-users. While the initial phase sets the generic scope and functional requirements for the platform, the next step is to instantiate the design in a municipal setting.

To elaborate on the main features we arranged four focus group sessions and introduced personas as vivid descriptions of the potential platform user [15]. The aim of the focus group sessions was to assess whether using personas, as a user-centered design tool, would lead to a better understanding of the end-user [16]. During two expert meetings these personas were further improved and applied as an input for scenario descriptions. For instance, frail elderly people like Annie (See fig. 1), who have no kids and are not *tech-savvy*, need an intermediary that can guide them through the complexities of the Dutch health and social care system. The goal of the personas and their associated task

scenarios is to describe what the current customer journey looks like from different perspectives and, next to that, if and how a platform could help to support people age-in-place.

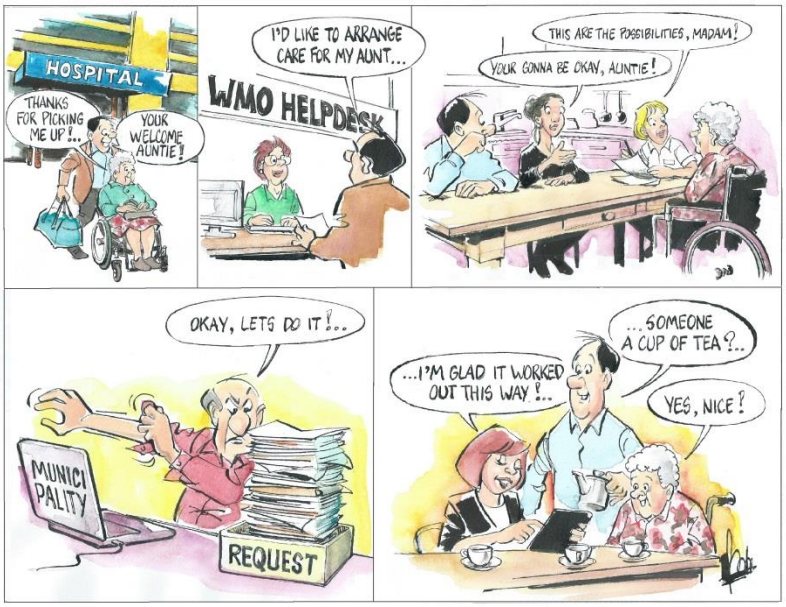


Fig. 5. One of the scenarios, according to Persona 2: elderly person called Annie. (The WMO helpdesk is the Dutch Social Support Act).

Both tools (i.e., personas and scenarios) are used to focus attention on problems and opportunities of a specific target audience.

3 Action Design Research Project

In a Living Lab, research and development moves from a pure academic environment into a real-life setting, with a multi-disciplinary network of people and organizations. We argue that designing a multi-sided platform can only done by addressing end-users' as well as external stakeholder needs in concert. It demands collaboration of stakeholders from multiple sectors to contribute to the required resources. Since the municipality is our launching customer, it was important to assemble the Living Lab according to a local community setting. To acquire commitment from stakeholders establishing a Living Lab required a lot of effort and resilience of the research team. After several attempts and initial failures, we managed to assemble a consortium with multiple stakeholders from different disciplines (i.e., municipality, multinationals, SMEs and end-users). Based on a short questionnaire and additional interviews, the functions, roles and expected gains were elicited from the stakeholders. See table 1.

Table 1. Description of functions, roles and value propositions from a stakeholder perspective.

Stakeholder	Core function	Role in the project	Expected gains from the project
Municipality	Launching customer	Problem owner	Interaction with citizens Lower transaction costs
Multinational 1	ICT firm	System integrator	Market access Health domain Competitive advantage
Multinational 2	Telecom operator/Cable company	Hosting and infrastructure	Market access Health domain Competitive advantage
SME 1	eHealth solutions	Owner platform building blocks	Business opportunity Competitive advantage
SME 2	ICT developing firm	Platform developer/ project leader	Business opportunity Competitive advantage
Governmental Foundation	Intermediary digital process	Architecture	Governmental pilot project Use case Project Architecture
Non-profit Foundation	Intermediary process/ finance	Platform owner	Exploit platform idea Capture the long-tail
Elderly society	Intermediary end-users	Elderly connection	Elderly engagement Support elderly to age-in-place
PhD researcher	ADR	Overall project leader	Research and valorize platform idea

Important drivers for the stakeholders to invest in the Living Lab are related to 1) market access to the health and care domain 2) competitive advantage and 3) business opportunities. Importantly, the stakeholders in the Living Lab do not receive subsidies or other monetary compensation for their efforts.

3.1 Design workshops

The project draws on a set of reference platforms for inspiration and practical guidance. Next to that, the architecture is based on existing, successful online platforms, recognizing their value, the tensions and dilemmas around trust, privacy and security, that users encounter every day. In order to track real-time problems during the design process we are using the agile scrum method based on flexibility, adaptability and productivity [17]. To do so, we arranged three workshops with the Living Lab stakeholders to elaborate on efforts prepared in different scrum teams in parallel.

In a first workshop a list of main features were set to specify the critical design issues (CDIs) of the platform that were already gathered during previous research iterations [14, 16] See table 2. Table 2 illustrates the multiplicity of requirements for platform functions, ranging from basic information exchange towards active recommendations for services and matchmaking, and from pure focus on transactions towards inter-active communication with end-users. Based on the aforementioned features, the platform would be a first mover in the Netherlands to combine and offer 1) matchmaking between smart living products and services 2) finding local activities 3) connecting with others (e.g., family, caretakers) 4) information about aging-in-place and 5) integration of successful, existing platforms in the health and wellbeing domain.

Table 2. List of main features for the platform.

	Domestic	**Health**	**Wellbeing**
Products	Security Home automation	Nursing aids	Entertainment Comfort products
Services	Renovation (i.e., installer) Maintenance (i.e., gardner)	Personal care Health care	Comfort services (i.e., grocery, cooking, housekeeping)
Local activities	Every day activities Education	Daycare Care related activities	Sports and entertainment Cultural In/outdoor activities
Contacts	Family Friends	Patient bonds Health care	Elderly bonds Municipality
Information aging in place	Advisors Renovators	Municipality	Advisors Caretakers
Integration existing platforms	Radio and broadcasting Restaurants and takeaway	Governmental	Caregivers Volunteers

In a second workshop, the technical architecture was further specified, by designing a Project Start Architecture (PSA) based on NORA, which is an acronym for the Dutch government reference architecture [18]. The reason to use this framework is to embark on a growth curve in maturity and to take the scalability potential of the platform into account. The PSA contains ten basic principles that relate to the provision of public services, and includes all activities by or through which service-providers carry out public tasks. The PSA is meant to ensure an adequate and sustainable solution for services that comply with 40 architecting principles, regarding technologies, service orientation and roles and responsibilities for providing digital services from the Dutch government.

3.2 Critical design issues

In a third workshop the Living Lab stakeholders elaborated on the critical design issues. Next to that two new CDIs were identified as the discussion moved towards ensuring adoption of the platform by end-users. The first CDI is *trust*; it aims to ensure that the users believe in the reliability of the online platform, the accuracy of the information displayed, and the delivery fulfillment and service between consumers and providers of products. In further discussion during the workshop the participants translated this CDI into two requirements for the platform. The first requirement is a *rating/review* mechanism for products and services offered in the platform; reviewers are end-users who provide a rating and/or review after a transaction (e.g., the act of consuming a product or service or attending an activity offered in the platform) to present the feedback to other users in order to reduce the customer's perception of risk. The second requirement is a *moderator* who oversees the transactions and performs actions to enforce the rules set and quality of the products and services offered; this requirement also enhances confidence in the platform by supporting dispute resolution and mediation services between consumers and providers. The second CDI is *user data privacy*; there should be a clear separation between 'social' data in the context of the platform and the data (e.g., medical) that must remain private to the user or those who are authorized (i.e., care takers, relatives). Next to that, the data privacy policy of the platform should be concise and

transparent to create trust related to the platform. The proposed platform is a multi-sided platform offering services to individuals and to providers who offer services to the individuals. Such platforms require special attention to privacy because each transaction within the platform is somehow related to personal data of the individual. The platform will be compliant with privacy-by-design principles throughout all the development phases and the entire lifecycle. Consideration of appropriate use of existing Privacy Enhancing Technologies (PETs), as well as the EU Data Protection Directive (Directive 95/46/EC) will be made. In a multi-sided platform, one user contract for all the different types of services offered by all the different service providers will not be enough. In fact, one has to decide to implement a system based on approval for each single transaction within a general overall contract. Systems based on this design scheme like OpenPDS take care of the technical implementation, but the legal aspects should be taken in consideration in the design as well. For instance, approval for the delivery of personal data for each transaction, between a service provider and an individual, requires special software comparable with banking software for financial transaction (which can be considered as a subset of personal data).

To make sure the ADR team was on the right track with the proposed artifact, eight potential end-users were involved in the development phase of the mock-up and the first clickable model. Based on their recommendations, a mock-up of the design could be included in a widespread survey (i.e., elderly and informal caretakers) for further data gathering on the subject. In parallel with the data-analysis of the survey, field tests of the clickable model of the platform are foreseen with different groups of informal caretakers, district nurses and potential end-users (age group 55 – 75). These evaluation moments are part of the iterative design steps of the overall ADR project.

In the same workshop, we developed a first template to get an initial idea of the platform architecture. The proposed platform should contain an Application Programming Interface (API) as well as an Application (APP) store, and the emphasis is on a web-based application as the main interaction point with the users. Because compliance with rules on data protection and security is vital for healthcare applications, the platform will be compliant with the highest available Dutch standards for data security on a database level (i.e., NEN 7510) to share medical information. All authenticated pages must be exclusively accessed secured HTTP (i.e., HTTPS). Therefore all data throughout the platform send via the Internet will have Transport Layer Protection through the Transport Layer Security (TLS).

4 Reflection of the design process

Most of the theoretical and empirical research on multi-sided platforms has focused on mature platforms and less attention has been given to issues starting up a new platform. Therefore, the challenge is how to deal with the small iterative design steps, going back and forth in a rather complex design project. We formulate the following tentative propositions on the process of setting up and realizing a Living Lab setting, based on our smart living case experiences:

1. *Maintain a logbook on a daily basis to track actions of the design process.*

2. *Interview essential stakeholders from different disciplines related to your initial ideas about the artifact and include end-users as one of the stakeholder groups as well.*
3. *Use different methods of data collection (e.g., interviews, focus groups, survey) to get to the core of the design problem.*
4. *Include the goal of the user of the artifact: for example develop personas and scenarios to keep grip of the customer journey and use this during the whole project.*
5. *Select stakeholders from different disciplines with realization power and empower them to create a Living Lab or a similar case setting (e.g., multidisciplinary team with a launching customer, industry, end-user group and academy).*
6. *Develop a project plan to back up the artifact and the roles, functions and tasks of stakeholders.*
7. *Collect requirements for the artifact and prioritize the critical design issues.*
8. *Define the scope of the project and set up boundaries to develop a minimal viable product to test in real life.*
9. *Work in different groups in parallel, to get things done in small iterative design steps, according the agile scrum methodology.*
10. *Involve the end-user in the design process to validate and evaluate the artifact from the very beginning.*

5 Conclusion

Our design project contributes to current research on how ICT can support end-users aging-in-place. We are following an Action Design Research approach, with a focus on the understanding of the stakeholders and their needs in relation to a health and wellbeing platform. We are using the Living Lab setting to place the values of the stakeholders into a real-life context. This paper proposes a way of using ADR in design science to bridge the gap between theoretical propositions and successful adaptation of smart living platforms in daily practice. Accordingly, ADR gives us the opportunity to get a close look at the complexity of the design process when multiple stakeholders including end-users with different value propositions are involved. This understanding contributes to the design knowledge that is generalizable to other design projects. Based on our study, we propose a first practical guideline how to develop an artifact (i.e., an online platform) in a complex environment using ADR: in this specific case related to a highly sensitive health and wellbeing environment.

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Towards a Situation-Awareness-Driven Design of Operational Business Intelligence & Analytics Systems

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Abstract. With the swamping and timeliness of data in the organizational context, the decision maker's choice of an appropriate decision alternative in a given situation is defied. In particular, operational actors are facing the challenge to meet business-critical decisions in a short time and at high frequency. The construct of Situation Awareness (SA) has been established in cognitive psychology as a valid basis for understanding the behavior and decision making of human beings in complex and dynamic systems. SA gives decision makers the possibility to make informed, time-critical decisions and thereby improve the performance of the respective business process. This research paper leverages SA as starting point for a design science project for Operational Business Intelligence and Analytics systems and suggests a first version of design principles.

Keywords: Operational Business Intelligence & Analytics, Design Science, Situation Awareness

1 Introduction

In today's business world, information represents a major competitive factor [1]. The provision of the right information to the right person at the right time is crucial to stay ahead of competitors and is a key concern of Business Intelligence and Analytics (BI&A) [1, 2]. The concept of BI&A represents a data-centric approach using historical data to provide an organization's management with relevant information to support strategic or tactical decisions [1, 3]. Case-specific technological architecture and implementation concepts established decision support from strategic level to operational decisions which we coin Operational Business Intelligence and Analytics (OpBI&A) [2]. However, using systems realizing such OpBI&A concepts can result in serious challenges in the business world of operational decision makers (also referred to as actors). Actors at the operational level face the challenge to meet business-critical decisions in a short time at a high frequency with high volumes of data [4]. For instance, in algorithmic trading, actors have to make sell or buy decisions within 0.5 milliseconds in order to prevent information decline [5]. Furthermore, the swamping of data tends to aggravate the problem of information overload for operational decision makers [6] and requires adequate decision support by information systems (IS) [4]. Thus, the number of time-critical decision-related situations for an actor rises constantly due to the timeliness and density of

data consumption at the operational level [7]. The supply of task- or situation-specific information represents a necessary, but not a sufficient condition to solve these issue [8]. To provide actors the possibility to take an appropriate decision alternative in time-critical situations, a decision maker must achieve an adequate level of Situation Awareness (SA) of the current situation [9]. The construct of SA has been established in cognitive psychology and is considered as an essential antecedent of an individual's decisions and actions [10]. Thereby, SA describes a constantly updated state of an actor's (external and internal) knowledge of the environment in relation to a particular task [9]. Studies show that as much as 88% of human error is due to problems with SA [11]. For instance, in August 2003 inadequate SA caused the largest power blackout in North America and led to costs between $4 billion and $10 billion for the United States alone [12]. As cognitive concerns have great impact on the individual level, it seems reasonable to study adequate situational decisions from this perspective. Accordingly, we propose that OpBI&A systems are sought to anticipate the actors' SA in their design. However in the exploration of the IS research area, we could not find any artefact aiming to support decision making for operational process execution that (1) explicitly considers specific cognitive concerns, and (2) bases on a sound theoretical foundation. Only a limited amount of IS research addresses cognitive issues as important design factor. For instance, Schieder [8] labeled the area as an promising research direction, whereas Leite and Cappelli [13] complain that software engineers deport this issue to other research areas. The identified literature for designing OpBI&A systems focuses mainly on technological blueprints. This literature neither provides assistance in the design of such systems nor considers the impact of the resulting systems to the user's work environment from a cognitive perspective. Consequently, this design science research (DSR) project aims to create a SA-driven design for the class of OpBI&A systems to increase decision making performance. In order to address the practical relevance of the topic, this DSR project is conducted in cooperation with a large software vendor. The industry partner developed a software product situated at OpBI&A. In the project, we will enrich the system with SA-driven design concerns. Thus, we formulate the following overarching research question for our research:

Which design principles for operational BI&A systems support situation awareness of decision makers and increase their decision-making performance?

The remainder of the paper is as follows. First, related work and the theoretical foundations are discussed and the research method is shown. Next, the first version of the meta-requirements (MRs) and related design principles (DPs) for the software artifact, grounded by literature, are presented, before the paper is concluded.

2 Related Work

Traditionally, BI&A represents a data-centric approach which supports strategic and tactical decisions on the basis of (mainly) retrospective analysis aligned to a limited audience of managers and BI experts [1, 3]. Instead of associating data with business processes, traditional concepts, e.g., online-analytical processing, separate the data analysis and information retrieval from process execution [1]. Currently, BI is facing a paradigm shift towards providing day-to-day decision support during process execution to

overcome these obstacles [1, 5]. Examples for such innovative BI approaches, technologies and architectures are described by the following concepts.

Operational BI leverages BI methods and provides analytical information in order to manage and optimize daily business operations [2]. Research highlights increased performance gains through the provision of analytical information to operational decision makers [14]. Due to the narrow time frame for the analysis on the operational level, the provision of up-to-date information is needed [14]. The support of (near) real-time decision making with minimal latency is commonly referred to as *Real-time BI* [7]. Another capability is related to settle analytical information to its process-context to support the transformation of enterprise strategies from the strategic to the operational level [1]. For instance, *Process-Centric BI* (PCBI) describes functionalities (data analysis and information provision) for decision support in connection with the execution of business processes [1]. Thus, there is a range of technically oriented proposals to design innovative BI architectures supporting operational decision support. However, it is assumed that the outlined software packages will support additional technologies in the future and that their boundaries will disappear [5]. Although these architectures focus on different content areas, they all share the common goal of exploiting, integrating and providing information from very heterogeneous sources for operational decision support, while maintaining the lowest possible time latencies [8]. This includes analytical information on the basis of historical data from traditional data warehouse systems as well as current data from process monitoring and/or from external data sources and information. The specific requirements resulting from the operational context, especially cognitive influencing factors, are considered (at most) rudimentary in the identified articles. Potentially the construct of SA could provide fruitful insights to address cognitive concerns in the OpBI&A systems design.

3 Situation Awareness

Operational decision makers in daily business are more dependent on a current, intuitively understandable description of the situation regarding the choice of decision alternatives than this is the case for the strategic level [4]. It must be ensured that the relevant information for a given situation can be perceived by the actor in the amount of incoming signals [4, 6]. Research on decision-making in highly complex and dynamic decision-related situations identified SA as dominant factor for success [10]. The construct of SA describes the state of an actor with respect to three, coherent set of levels [9]: Level 1 is described as the actor's perception of the characteristics, status and dynamics of relevant elements in a situation. Level 2 is defined as the actor's comprehension of the meaning of the objects and events for its situation. Level 3 is characterized as the actor's ability to project (near) future actions of the elements in the environment. These three levels of SA are determined by task or system factors on the one hand (e.g. human-machine interface design, actor's workload), and individual factors on the other hand (e.g. actor's capacity of attention, working memory) [9]. Consequently, SA is formed through the interaction of an actor with his environment. This interaction strongly influences subsequent decisions and actions taken by a decision maker. Thus, changes of the task/system or individual factors require an adjustment of SA [9]. However, due to this

interaction, forming and maintaining SA can be a difficult process for actors [15]. Endsley and Jones [16] defines these difficulties as "SA Demons", such as data overload or complexity. Based on these considerations, Endsley [9] developed a taxonomy of errors affecting SA at each of its three levels. In order to tackle down the SA Demons [16], IS should support decision making and preparation by assisting the actor in obtaining the above mentioned three levels of SA [17]. However, despite their close connection, decisions and actions represent independent stages that pursue directly from SA [16]. In addition, actors with perfect SA could still take the wrong course of action, for reasons such as lack of training or an inability to carry out the necessary actions [9]. SA does not guarantee optimal situational decisions and actions. Rather, SA describes an important antecedent to enhance the probability to arrive at better decisions and actions [9]. To further improve our understanding of SA and the design of systems to improve operational decision making, we examine the applicability of SA in the context of OpBI&A. We expect, that our work will yield useful insights into the design of user interfaces suited for operational decision making.

4 Research Method

The research project follows a design science research (DSR) methodology process as described by Peffers et al. [18], applying the design and development-centered approach. This approach is usually taken if an already existing artifact might have not been reasoned out as a solution for the identified problem, have been leveraged to solve a different problem from a different research domain, or have been appeared as an analogical idea [18]. Currently, our industry partner provides an analytical application that does not consider cognitive concerns regarding SA. Thus, this project aims to enrich its design by incorporating DPs that specifically address SA. The application of DSR was chosen since this project should address both, developing a theory-grounded SA-oriented design for OpBI&A systems and evaluating its impact on a user's decision making. As shown in the previous sections, the existing body of knowledge lacks a theory-grounded SA-oriented design [19] for the entire class of OpBI&A systems. From a practioner's point of view, the operational decision maker's SA represents an important issue to meet business-critical decisions in short time and at high frequency in order to prevent expensive mistakes. Our industry partner is highly conscious of the issues relating to decision maker's SA and its customers serve as real business cases.

5 Situation-Awareness-Driven Design

Following the conceptual foundation and principles suggested for SA (e.g. by [9] [16]), we present a first version of SA-driven DPs for an OpBI&A system which enforces the needed information to an operational decision maker without inconsiderable cognitive effort. Thereby, the identified DPs build on all coherent sets of SA levels: **perception** (level 1), **understanding** (level 2) and **projection** (level 3). A SA-oriented design supporting all levels of SA has shown to increase the probability to develop effective and efficient systems, which in turn foster decision making and performance [12]. In order to achieve a high SA level, the corresponding SA Demons need to be addressed [16]. Ends-

ley [9] developed a taxonomy of SA errors to address these Demons. We suggest MRs based on the SA Demons and the taxonomy to inform our DPs.

Level 1. From the cognitive science perspective, OpBI&A systems should support the actor's perception of all relevant data and information of the system environment, its elements and their relationships within the relevant socio-technical system. As a first step in providing such perception, data needs to be made available to an actor (**MR1**) [20]. However, the continuously increasing heterogeneity of data elements (e.g. historical data from data warehouses or real time data in form of sensor feeds or RFID scanner units) perceived by operational decision makers represents a major challenge to achieve MR1. Accordingly, the design of OpBI&A systems should address these concerns when presenting information to an actor. In other cases, data is available, but data detection and discrimination is problematic [20]. This phenomenon is often associated with the SA Demon "Misplaced Salience" [9]. Salience is defined as the compellingness of specific shapes of information which largely depend on its physical characteristics [12]. Certain signal characteristics are more affected by an actor's perceptual system than others [15]. The color red, movement and larger noise represent examples which are more likely to attract an actor's attention [16]. Salient properties represent important features to denote actors to important cues in a system and to promote SA. However, if such properties are utilized too often or inappropriately, it may lead to actors' confusion and errors since the actor would not be able to identify the critical information [16]. Such issues would draw an actor's attention unintentionally to less certain information and make it more relevant to the actor than it actually is. Accordingly, OpBI&A systems should leverage salience without overemphasizing to support an actor's ability to detect and discriminate data (**MR2**). Our third MR facilitates an actor's ability to monitor and observe data by tackling the SA Demon "Attention Tunneling" [16]. Actors have to switch their attention between different sources of information to maintain a high level of SA [12]. However, decision makers often lock their attention on only certain aspects of the environment that they attempt to process, while neglecting unintentionally their scanning behavior [16]. As a result, decision makers will achieve a high SA in the area of their concentration, while becoming outdated in areas they are not watching [15]. Thus, dynamically switching attention between different areas of interest remains a challenge for actors and needs to be considered explicitly in the design of OpBI&A systems (**MR3**). Another SA Demon is called "Requisite Memory Trap". In many situations, actors leverage short-term (working) memory to store, put together and organize units of information [15]. Essentially, the working memory represents rather a restricted repository to store information [12]. Common SA failures arise from not sufficient space or the natural information dissolution over time in the working memory. Given abstract information (e.g. a phone number or sign) such dissolution may occur in 20-30s [16]. Accordingly, the design of OpBI&A systems should not heavily depend on the actor's short-term memory when presenting information to an actor (**MR4**). The volume and frequency at which data is changed, generates the need for quick information absorption which quickly exceed the sensory and cognitive abilities of an actor to provide this need [12]. This SA Demon is called "Data Overload". In a given state, an actor can only intake and process information to a certain degree at a time [15]. When the auditory or visual information exceeds the cognitive threshold of an actor, the decision makers SA will generate gaps or become outdated [16]. Often such issues arise in areas where systems fail to provide a

fair degree of accuracy of the relevant cues in data sampling [9]. Thus, the system has to prevent such data overload (**MR5**). Another SA Demon refers to ”Workload, anxiety, fatigue, and other stressors” (WAFOS) affecting the actor’s ability to intake information as well [12]. Such stressors can affect SA significantly by reducing the already restricted short-term memory capacities of an actor to collect information efficiently [16]. This effect increases the probability to succumb to attentional tunneling and make a decision without considering all available information. Particularly, stress environments with low latencies and high information volumes are influenced negatively by WAFOS [15]. The efficient absorption of information by an actor should be considered in the OpBI&A design (**MR6**). We summarize the MRs by formulating our first DP:

DP1: *OpBI&A systems should support an actor’s perception of a current situation.*

Level 2. The dynamics of operational decision-making situations usually require a timely integration and provision of necessary knowledge for the decision making [2]. Only if this goal is met, actors can achieve an understanding of the current situation [9]. To provide a high comprehension of perceived data, MR7 addresses the SA Demon “Errant Mental Models”. Large knowledge units in the long-term memory are referred to as mental models which help actors to comprehend how something work [16]. However, errant mental models might cause errors during the execution of a task [12]. Such errors are typically insidious since an actor might not recognize that the utilized model is incorrect [15]. For instance, decision makers tend to use even far-fetched explanations to fit conflicting information to their incorrect mental model [16]. Consequently, the design of OpBI&A systems has to support situations where decision makers form and maintain correct mental models (**MR7**). In addition, the reliance on default values in mental models has to be reduced as well [9]. Default values describe general expectations of an actor about how certain parts of the system work [20]. For instance, in the absence of real-time data, decision makers often leverage these defaults for decision making and actions [20]. However, in new situations the default values might be inappropriate or outdated which could cause significant SA errors [9]. Consequently, OpBI&A systems should provide an actor with appropriate data (e.g. in real or right time) to overcome the reliance on an actor’s default values (**MR8**). The SA Demon ”Complexity” represents a further problem for developing an adequate level of comprehension [12]. Many systems incorporate complexity by introducing too many features [16]. This feature escalation makes it difficult for actors to create and maintain a correct mental model of how such systems work [15]. Thus, keeping complexity to a minimum should be addressed in the OpBI&A system design (**MR9**). Another SA Demon is the “Out-of-the-Loop Syndrome” referring to a system’s automation degree. The higher the degree of automation and the state of elements the automation is alleged to control, the higher the probability that an actor will form a low SA level [12]. An actor’s state of being out-of-the-loop represents no problem as long as automation is performing well [16]. In case of automation failure, however, actors which are out-of-the-loop are often not able to identify problems, understand the information displayed and anticipate in time [15]. Thus, an appropriate level of automation in the design of an OpBI&A system is needed (**MR10**). We summarize the four MRs by the following DP:

DP2: *OpBI&A systems should enable an actor’s understanding of a current situation.*

Level 3. From a cognitive perspective, OpBI&A systems also need to support the projections of probable future states of an environment. Actors may fully understand the

current situation, without being able to anticipate the current future [20]. Mental projection represents a challenging task [9]. Explanations are miscellaneous ranging from poor mental model development to overreliance on a decision maker's mental simulation abilities [20]. Thus, OpBI&A systems need to facilitate the formation of a correct mental model (**MR7**) as well as the prevention of overreliance on an actor's mental simulation abilities (**M11**). Thereby, the design of OpBI&A needs to support both, lower SA levels in order to identify possible outbreaks or data patterns and higher levels of SA to examine the future effect of information. For instance, the application of predictive analytics could be leveraged to build and assess models in order to identify patterns and to make empirical predictions about business situations [21]. Such BI practice includes tools and techniques of statistical process control, data mining and simulation and offers support for the analysis of the impact of various alternatives of action to an actor. Accordingly, the operational decision maker could anticipate immediately the perceived trends without being highly dependent on its mental simulation abilities. The required information would be derived, for instance, by predefined regression analysis, which are generated by including various environmental factors and using trend lines for visualization. However, the complexity of these tools is a major obstacle for their effective use [8]. Thus, complexity issues need to be addressed accordingly (**MR9**). Based on the above mentioned MRs we formulate the following DP:

DP3: *OpBI&A systems should assist an actor's abilities to predict future situations.*

6 Conclusion

Applying the DSR approach, this paper contributes to BI&A research. The construct of SA is used as a starting point for the development of DPs for OpBI&A systems. SA represents a well-established construct in psychology for understanding and explaining the interconnectivity of external knowledge components in dynamic, time-sensitive and decision-related situations in on-going, cognitive processes [10]. The conceptualization of SA shows an analogy to OpBI&A since extraction, consolidation and delivery of information for time-critical situations describes a core responsibility of OpBI&A. This paper discusses issues in SA including the actor's perception, understanding, prediction capabilities and the related SA Demons. We derive eleven MRs informing three DPs for OpBI&A systems based on these foundations. As next steps we conduct interviews with BI experts and customers of the industry partner to refine the DPs and implement a prototype by incorporating the redefined DPs into the exiting OpBI&A product.

7 References

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Biased Group Decision-Making and the Effect of Computer-Mediated Communication: Separating the effects of Anonymity, Voting and Blind Picking

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Abstract. The influence of communication technology on group decision-making has been examined in many studies. But the findings are inconsistent. Some studies showed a positive effect on decision quality, other studies have shown that communication technology makes the decision even worse. One possible explanation for these different findings could be the use of different Group Decision Support Systems (GDSS) in these studies, with some GDSS better fitting to the given task than others and with different sets of functions.

This paper outlines an approach with an information system solely designed to examine the effect of (1) anonymity, (2) voting and (3) blind picking on decision quality, discussion quality and perceived quality of information.

Keywords: Hidden Profile, Group Decision Making, Computer-Mediated Communication, Computer Support, Information Sharing, Design Science, Anonymity, Voting, Blind Pick, Social Validation, Conformity Pressure, Ownership Bias.

1 Introduction and Motivation

Decisions today are getting more and more complex, so most decisions are made in groups [1, 2]. The idea behind this is simple; more people got more unique information and should therefore make better decisions. Thirty years ago Stasser & Titus [3] have shown, that most of the unique information is not shared in group discussion which leads to poor decisions. This has impact on e.g. companies, public institutions, governments and individuals, everywhere where decision means an investment of resources, time or money.

In 2004 Wittenbaum et al. [4] made a review of the literature on collective information sharing and predicted that communication technology may address these problems and help increase the decision quality and the sharing of information during group discussion. In addition to these predictions Lu et al. [5] published a meta-analysis of the last 25 years of hidden profiles in group decision-making in 2012 and described an effect of computer-mediated communication on discussion quality and decision quality. But the results of these studies are inconsistent and neither of these effects could be reported in the meta-analysis. Some studies report that computer-mediated communication improve information sharing compared to face-to-face (FTF) communication during group

discussion [e.g. 6, 7]. Other studies have shown a decrease in information sharing and group performance compared to FTF communication [e.g. 8–10]. A possible explanation for these inconsistent results could be the use of Group Decision Support Systems (GDSS) in these studies. Different GDSS have been used with a different set of features each. Some of them could have assisted the given task less than others, leading to negative results. The fitting of communication technology to the given task is important to provide any benefit [11]. In addition to this it is difficult to separate different effects for single features e.g. anonymity because each GDSS offers a bundle of features.
This paper will outline a theoretical approach to design and evaluate an artifact, which will encounter these problems and separately examine the effect of anonymity, voting and blind picking on decision quality, discussion quality and perceived quality of information.

2 Theoretical Framework

Group decision-making research has shown that different kinds of biases influence group decision-making and therefore reduce decision quality. This study will focus on three of these biases. (1) The ownership bias, which describes the effect of the ownership of information on the perceived quality of information. The owner of a information rates the quality of his own information higher than the information from others [12, 13]. (2) Another type of bias is the effect of conformity pressure. Group members tend to only share information, which is consistent with the opinion of the majority to keep group conformance. Sharing of information supporting a minority opinion is prohibited [14, 15]. (3) And the social validation bias which assumes, that shared information is discussed more frequently than unshared information because shared information can be socially validated from more people [16–18] and thus leads to a higher perceived quality of this information [19].

As stated before computer-mediated communication may help to improve these impairments. In particular the effects of anonymity, blind picking and voting. Anonymity may lead to a decrease in conformity pressure and an increase in sharing of information supporting a minority [20]. Additionally anonymity may decrease the effect of the ownership bias because the shared information is assigned to the group instead of a single person. Another possibility to decrease conformity pressure is to use computer-mediated communication to avoid letting group members know if they are part of the majority or minority. They have to pick their option blind, without knowing the preferences of the other group members. To assist social validation and therefore increase the acceptance and perceived quality of information a voting system will be used where the participants can up-vote helpful information and social validate them in this way. Table 1 gives an overview of the presented hypotheses in this chapter.

Table 3. Hypotheses overview

H1a	Anonymity may decrease conformity bias and increase information sharing
H1b	Anonymity may decrease ownership bias and increase the perceived information quality of not-owner pieces of information
H2	Blind picking decreases conformity pressure and increases information sharing
H3	Up-voting increases social validation and the perceived quality of information

3 Research Method

The research described in this paper will be structured after the Design Science Research Methodology Process Model[21]. Following this model, the first chapter of this article has shown the problem identification and motivation, followed by a definition of objectives for a solution and a theoretical framework for the artifact design. The next chapter will describe the design and implementation of the artifact. In chapter five a detailed explanation of the artifact evaluation and measurement of performance is given using hidden profiles paradigm as a methodological approach.

4 Artifact Design

To encounter the problem of getting different results for different available GDSS a new web-based artifact is solely designed for this research project. The artifact will allow multiple instances of group decisions with a group size of four. A moderator can then assign participants to these group decisions. Each group decision provides basic functionalities to vote for one of two options and share information with the other users. Additionally each group decision can be configured with a different set of three possible features (table 2), which can either be enabled or disabled. Information can be shared anonymously or with the full name of the user. The second feature shows or hides the result of a pre-discussion voting and the user have either no option to rate the shared information of other users or the option to up-vote shared information. Depending on the experiment there can be none of the options enabled or any possible combination. The following Table 2 shows the possible features in an overview.

Table 2. Overview of the artifact features

		Disabled	Enabled
Features	**Anonymity**	Information is shared with the full name of the group member	Information is shared anonymously
	Blind Pick	Results of the initial vote are visible to all group members	Results of the initial vote are hidden to group members
	Voting	No option for rating shared information	Option for up-voting shared information

5 Performance Evaluation

The artifact has to be evaluated for different feature sets. In a first setting the artifact will be evaluated in the basic configuration with no features enabled (table 2). This consists of information sharing by full name, a group wide result of the initial voting and no up-voting option for shared information, versus groups discussing the same options in FTF meetings. The results will be used as reference values for the forthcoming evaluations. In a second setting only one feature (table 2) per group decision will be enabled and evaluated. The evaluation results of each feature will be compared to the results of the basic configuration to measure the effect of each feature. In a final setting each possible combination of the features will be evaluated. Compared to the results from the single-feature evaluation the interaction effects of the features can be described. Finally all evaluated feature combinations will be compared to the FTF group results to find the best possible feature combination. To provide any benefit for group decisions the performance of the best configuration of features has to be at least as good as the performance of the FTF groups.

For performance evaluation the decision quality, discussion quality and the perceived information quality will be measured for different feature sets of the artifact. Therefore the hidden profiles paradigm will be used with a decision task consisting of two options [22, 6]. The first option contains eight positive, four neutral and four negative pieces of information. A second option is given with only four positive, eight neutral and four negative pieces. Taken all pieces of information together the first option is more positive than the second option and should be preferred. To validate the valence (positive, neutral, negative) of the information pieces a pretest will be held with a larger set of information pieces and only the pieces with the highest reported valence will be selected for artifact evaluation.

At the beginning of evaluation the participants will be assigned to groups of four participants each and get a written introduction, which contains a predefined set of information. The containing information is either shared or unshared. Shared information is

common and known to all group members. Unshared information is unique and only possessed by one group member. The initial information distribution is manipulated to favor option B and only if the unique, unshared information is shared with the other group members option A can be identified to be the better option. Now the group members start to use the artifact. In an initial vote for one of the options the pre-discussion preference of the group members is determined. After voting the group members can start using the artifact for discussion. Therefore the artifact provides predefined features (Table 2). When the group members have decided that enough information is shared or a given amount of time has passed, all group members have to vote again for one of the options. After post-discussion voting every group member has to rate the perceived quality of all information, shared and unshared, for both options to determine the perceived quality of information [18]. Decision quality will be measured at which ration the group members succeeded to detect the hidden profile and vote for the better option A [4]. Additionally the discussion quality will be measured at which ratio unshared information is mentioned through group discussion.

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Design History: Exploring Corporate Communities

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Abstract. A design history is a narrative involving a multitude of social groups, interpretive flexibility, and eventual stabilization of shared understanding. Design history surfaces the practices that help shape and define engagements and can increase not only our theoretical understanding of what design is, but also our capacity to realize this understanding in practice. We use a design history perspective to examine how corporate technology initiatives establish and support open source communities and the crafting of relevant design practices that enable their advancement. We foster an evolving expression of design research that treats artifacts not as stable objects to be singularly evaluated, but as evolving systems contingent on historical trajectories.

Keywords: Design History, Corporate Communities, DSN, Open Source

1 Introduction

Design is an argument that a specific goal is worthy of pursuit and that routines involving specific artifacts provide an appropriate means to accomplish that goal. Design persuades through technical reasoning, the scientific premise for its functions, as well as the human premises by which functions make sense within material, social, and linguistic practices of people [4]. Further, design is a practice that entails a convergence of values and modes of thinking to accomplish a worthy goal.

However, design does not spring full-grown into the world but rather originates as a vision of how patterns of action could be, such that needs of people are met through new practices. Design persuades through people imagining a future in narratives, and metaphors, and the practices though their lives are shaped and interconnected. Thus, design entails much more than a particular form or function; it entails the social groups, interpretations, and stabilized environments that shape its history. Thus the aim of this research is to better understand how design trajectories are understood as historical constructions.

Sociological perspectives conceptualize design as a mangle in an eco-system of actions, competing perspectives, and value identification (Pickering, 1995). Design has fluid and constantly changing character shaped by an ongoing engagement with social groups [1]. To better understand this view of design as an evolving process, we examine data from a three-year engagement with open source com-munity members and corporations involved in the development of li-cense compliance standards and tools. We navigate and explain the complex obligations that corporations accept as they engage within open source communities, illustrating the interpretive flexibility and stabilization actions taken to evolve design practices in the advance-ment of open source software.

2 Design History

In placing design in the context of history, we contend that design is "charged with making the material culture conducive to engagement" [2, p. 18], such that artifacts themselves do not carry intrinsic properties of efficiency or effectiveness. Instead, artifacts are designed within the ongoing practices of the world and are positioned into the lives and actions of individuals and groups.

Our research responds to a call to engage with industry practices of design [5]. Organizations engage in design as part of a history in which they shape the technical and social environments within which design unfolds. In this, design becomes an evolving endeavour, grounded in competing ideas of control, values for human well-being, and the improvement of material and social conditions [4]. Within this evolution, design is shaped by both ma-terial and societal histories, positioning design as occurring because of an environment within which it is situated [7].

Thus, design does not begin with an identified problem but rather with an engagement to the world, in which people envision what the world can be. All participants in the design bring unexamined assumptions about the nature of the world, the opportunities worth attending to, and the ideals and values worth pursuing. Design history reveals the eco-system in which design occurred (e.g. configurations of organizations, foundations, designers, and governance).

As design history unfolds, it reveals differences in the meaning of lived situations, the stabilization of the social ecosystem of people who in-terpret their world, and the background of values against which actions are considered reasonable. To illustrate this point we shift attention to the specific social constructions, interpretations, and stabilizations that are present in design, arguing for a depth of design by considering design as an evolving history of shared practices.

2.1 Design History: Social Groups

Design history results from interrelated social and material actions of people. The actions of planning, problem creation and solution, and the construction and evaluation of artifacts, are only comprehensible in relation to shared social practices. Design integrates styles of thinking and ways of doing, against the shared background in which a problem and its solution make sense.

Design involves a multitude of social groups: those whose practices will be affected; those who develop patterns of action to address needs; and those who seek stabilized processes associated with design. Each social group has different practices enfolding what is most pragmatic, engaging, or aesthetic. People attach different meaning to technical artifacts, both current and historical, and have different experiences of encountering artifacts. Thus design itself occurs through practices by which social groups struggle discursively and materially to comprehend and to construct their future reality [9]. As the objects and actions to which design points do not yet exist, this socio-historical view recognises the collective construction toward an agreed upon problem of an an imagination composed of "specific forms, functions, and reinventions that might, or ought to appear" [9, p. 2] as well as an articulation of a social potential .

2.2 Design History: Interpretive Flexibility

Design is contested [4] through the interpretation of meanings and the translation of multiple worldviews into a shared un-derstanding. Interpretive flexibility is necessary as design involves de-veloping common concepts and language which are adequate to envisioning something that does not exist [3]. Interpretive flexibility results in the integration of thinking styles and reconciling the tensions between materials, controls, and ideals. Design is positioned within "an unsettled region, a zone of potential, that nonetheless con-tains the real material or content, and above all the idea of what will become the technology-enabled innovation" [9, p. 4].

People are not blank slates reacting to features of technology but rather have their own interpretive frames through which they translate the meanings and capabilities in design. Interpretive flexibility is critical because people create problems they will solve against a taken-for-granted background. In its earliest form, the problem-state and the de-sign solution may be nebulous, difficult to communicate, and shifting even for the people who envision it. It is likely that design will not ap-pear to other social groups in the same way – given different worldviews and activities, the problem or the design may not appear important, relevant, of value, or even possible. As such, design only becomes comprehensible as people gain an understanding of particular situations such that alternative worlds appear desirable.

2.3 Design History: Stabilization

Design entails a collective effort from which shared understandings – the shared background - can emerge. Without shared understanding, a collective realization of design is not likely to emerge from across social groups. Design translates different interpretations into shared un-derstandings, shifting design in new and interesting ways [8] as elements from different interpretations are brought together. As these shifts occur, social interpretations undergo modification as translation continues [11]. For example, a kernel theory will not directly determine how an artifact is instantiated. A theory is first translated from its linguistic form into a principle that is then further informed as it is reified into material components of a system. These translations, from interpretations of the situation, enable the situated goals to be articulated, social groups in design to be enrolled, and ideas to materialize as action patterns as they become stable across people and groups.

Design occurs through the situated actions among people in a world. As people come from different social, political, and material worlds with unique viewpoints, power structures, and embedded meanings, design may be undertaken by disparate and heterogeneous groups of con-sultants, technical experts, business management, and employees who act with varying degree of involvement. These intersecting social groups comprise an ecosystem that shapes design practices, often with a focus on becoming stabilized for clear and cogent interpretation and translation from all [6]. As design includes heterogeneous participants and worldviews, design becomes recognizable and approachable "as systematic disciplines of integrative thinking, within which diverse techniques and methods are given direction and pur-pose" [4, p. 37]. Stabilizing the interpretive flexibil-

ity of social groups allows design to be an engagement between people, objects, and practices, supporting a deeper picture of what design is [7].

3 Methodology

As open source ecosystems become increasingly relevant in corporate development strategies, the clarification of license information remains a complex endeavour. To understand design history, we examined a specific corporate-communal engagement in the context of open source software development. Participant observation was used in working with corporations engaged within open source communities to advance open compliance standards and establish the SPDX (Soft-ware Package Data Exchange) community in 2011.

The SPDX community is a Linux Foundation workgroup, comprised of 32 organizational participants advancing open compliance standards. Members of the research team have participated with the SPDX open source community in developing open compliance standards, open compliance tooling, and open compliance literature. Our involvement allowed us direct access to the member base, strategic decisions within the community, and value creation activities by community members. In all, we have gathered an extensive set of interviews, recorded communications, meeting minutes, listserve mail exchanges, and con-ference notes.

In approaching our corporate-communal data set, we used the princi-ples of social groups, interpretive flexibility, and stabilization as our descriptive framework to discover insights regarding design history. We believe that these principles provide necessary but not sufficient descriptions of design history considered across a temporal period. We use the principles to present design as involving not just configurations of the material but also the social and technological issues regarding what problems are important, what values are held, what technology means, and how goals should be accomplished.

4 Findings

Design history reveals that designs are not fixed configurations with specific functions that solve specified problems but are open to inter-pretations that may result in the same object being interpreted and translated differently in different practices. We found that design history within the SPDX corporate-communal setting, based on social groups, interpretive flexibility, and stabilization, revealed three considerations of design as an ongoing, negotiated, and shared activity.

4.1 Fixture Groups

Design science research has accounted for a diversity of social groups that are present in design. However, a closer examination into the na-ture of these social groups reveals that membership can be comprised of groups having long-term strategic and economic interest in the ad-vancement of design activities. Economic interest can stem from organizations selling fixtures that both inform and result from stabilized design practices.

Fixture groups are evident across sectors including light pole manufac-tures selling fixtures based on light bulb standards [1] and telecommunications companies selling fixtures based on wireless standards. In the SPDX community, organizations are engaged to un-derstand the emergence, evolution, and evaluation of open compliance standards in an effort to align communal and corporate practices. The nature of the relationship carries ongoing design activities forward in the development of practices, technologies, and services (i.e. fixtures) provided by community participants.

4.2 Fixtures as Power

Naturally, fixtures can instill directional control over communal design. If communal and corporate practices become divergent, stabilizing mechanisms may be required to align the two. In the case of corporate-communal engagement, communities are not often responsive to the stabilizing needs of individual members. In response, the most sensible solutions are to be respondent to communal decisions or to shape and influence the community itself.

Within the SPDX community, organizational participants take contribu-tory and advisory roles to maintain a voice within the community, par-ticipating in the ongoing design activities, and controlling the direction of SPDX technologies. More importantly, organizational participants seek to shape the direction of open compliance by situating communally guided design into organizationally defined fixtures. This allows others to observe design-in-practice, reducing the interpretive flexibility (and advancing stabilization) around design practices, enabling fixtures to become powerful representations for organizations.

4.3 Fixtures as Practice

The socio-historical view discloses how design invokes new practices oriented toward "shaping society, changing the course of individuals and communities and setting patterns for new action" [4, p. 6]. Our perspective helps us understand design as entailing the rou-tinized ways of discovering, understanding, and acting [10] in regards to licencing, open source compliance, and organizational commitments to the ethos of open source communities. The SPDX artifact enforces interpretation, information, and language which consti-tute the practice of compliance with the aim of routinizing compliance activities and goal.

Challenges remain as organizations modify their software management practices to accommodate the intake and egress of open source software. In response, the implementation of SPDX has been increas-ing as membership in the community grows and organizations find ways to incorporate the standard into daily activities. In these instances, SPDX serves as one fixture in growing practices of open source compliance.

5 Discussion

Design history incorporates technology into the broader argument about the lives and actions of individuals and groups by shifting focus from the production of artifacts to the creation of patterns of thought and action. The view developed in this research essay highlights the contingent aspects of design (what may occur) rather than what must necessarily occur. Recognizing the practices in a design history reveals the manner in which participants initiate and maintain design as part of routinized work and creates a sensitizing framework and vocabulary in the investigation of design as deeper than any single artifact. By decentering the focus on artifacts and instead locating design in the ways people enact and discuss design in relation to their world, we seek to provide insight into how corporations engage open source communities to negotiate practices. Ongoing analysis must illuminate the political, structures upon which design practices are navigated and negotiated and how the corporate-community engagements change over time.

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Biomimetics in Design-Oriented Information Systems Research

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Abstract. Modern information systems (ISs) are becoming increasingly complex. Simultaneously, organizational changes are occurring more often and more rapidly. Therefore, emergent behavior and organic adaptivity are key advantages of ISs. In this paper, a design science research (DSR) question for design-oriented information systems research (DISR) is proposed: Can the application of biomimetic principles to IS design result in the creation of value by innovation? Accordingly, the properties of biological IS are analyzed, and these insights are crystallized into a theoretical framework to address the three major aspects of biomimetic ISs: user experience, information processing, and management cybernetics. On this basis, the research question is elaborated together with a starting point for a research methodology in biomimetic information systems.

Keywords: Information Systems, Design Science Research, Biomimetics

3 Introduction

Information systems (ISs) are socio-technical systems that involve users, information and communication technology (ICT), and organizational processes [1]. Current ISs in large organizations are becoming increasingly complex. Therefore, innovative design approaches that yield more adaptive and robust ISs will facilitate the management of that complexity. Biology provides existing examples of highly complex systems that run smoothly without the need for human intervention. Technological ISs that exhibit biologically inspired features (e.g., emergent, organic and autonomous behavior) have the potential to greatly facilitate complexity management. *Biomimetic ISs* are defined as complex socio-technical message systems whose designs are based on the principles of biological information processing. Organizations can be regarded as complex evolving systems in co-evolution with other systems [2]. Accordingly, organizations are co-evolving with information technology (IT). Therefore, the ability of technical ISs to adapt to that co-evolution, a feature embodied by *emergent application software* [3], could become a key advantage for the organizations that use these systems. For these reasons, we pose the following as our main research question: How can biomimetics enhance IS design?

4 Related Work

Information systems research (ISR) is often based on behavioral science research (BSR), in which empirical observations of existing ISs in real-world organizations lead to theories that can be applied for IS design and management. Thus, BSR is a scientific paradigm in the sense of Kuhn [4]. Such paradigms are collections of beliefs shared by scientists, namely, sets of agreements regarding how scientific knowledge is to be understood.

March and Smith [5] and Hevner et al. [6] proposed a research methodology that is complementary to ISR, called *design science research* (DSR). The motivation for introducing design questions into ISR is progress. Theories do not create innovation; only design leads to technological advances. Therefore, there is a need for a rigorous scientific methodology for treating IS design as research. There is a complementary research cycle (a synthetic methodology, in the sense of Pfeifer and Scheier [7] p. 21) in which BSR, which is based on empirical science, provides truth, and DSR, which is based on engineering science, provides utility.

A similar but more radical approach proposed by Österle et al. [1] is called *design-oriented information systems research* (DISR). The cited memorandum goes so far as to state that ISR ought to be design-oriented, that is, DSR is considered to be the primary goal of ISR. The reason for this assertion is the (normative) assumption that ISR is intended to be beneficial to society. Discovering true propositions using BSR alone does not create value; therefore, designing innovative solutions using DSR methodologies is regarded as the primary orientation of ISR. Projected onto biomimetic DISR, this means designing and studying biology-inspired artifacts (frameworks, prototypes, methods) that provide solutions and thus create value for IS users and/or managers.

To implement DISR artifacts, we turn to Reis [8], who asks, "Who better than Nature can design complex structures and control the intricate phenomena (processing routes) that lead to the final shape and structure (from the macro to the nano level) of living creatures?" The term *biomimetics*, meaning to imitate (*mimesis*) life (*bios*), was introduced by Otto Schmitt [9]. Bar-Cohen [10] defines biomimetics as "the study and imitation of nature's methods, designs, and processes." It can be described as the abstraction of good design from nature [11]. Biomimetics has been successfully applied in many design disciplines (e.g., sensor engineering [12], business management [13], and robotics [7]).

Biologically inspired ISs apply biomimetics for information processing, user interaction, and social collaboration. For example, IBM's vision of autonomic computing [14], [15] encompasses an organic, self-organizing approach to IT systems management inspired by the autonomic nervous system. IBM recently launched a cognitive computing initiative [16] with the purpose of developing a unified computational theory inspired by insights from neuroscience.

The EU project titled Nature-inspired Smart Information Systems (NiSIS) created an umbrella term, *biomimetic intelligence* [17], which is defined as "the ability of an information system to mimic nature-inspired adaptive and intelligent behavior to better pursue its goals, to improve the robustness, efficiency and usefulness of its functionalities and enhance its interfacing capabilities to the external world."

Dressler and Carreras [18] have studied the application of biological principles in ISs (e.g., wireless networks, service lifecycles, and peer-to-peer networks), which can be

regarded as an approach to biomimetic IS engineering. Others have applied biomimetic principles to various socio-technical problems (user interaction and organizational processes). For instance, William and Huggett [19] explored a biomimetic information retrieval system that utilizes associative network structures analogous to that of human episodic memory for data organization in information management systems. Kampfner [20] suggested a biologically inspired approach to information management that utilizes implicit control, such that power is delegated to the smallest possible subsystem to reduce the organizational costs of information processing and decision-making.

An important aspect of life is its *emergence*. In this context, the *emergent properties* of living systems (and of complex systems in general) are attributes that arise out of more fundamental subsystems yet cannot be completely reduced to these subsystems [21]. *Emergentism* is the view that in complex systems, the whole is more than the sum of its parts. In the words of Anderson [22], "Psychology is not applied biology, nor is biology applied chemistry." Life can be seen as an emergent property of the interaction of the Earth's matter with the Sun's energy. There are two aspects of emergence that are important to engineering:

- *Design for Emergence.* This concept [23] refers to the creation of artifacts that exhibit emergent properties; the design itself is intended to allow patterns to arise that cannot be reduced to the initial design but rather come into existence only through the interaction of such an artifact with its environment. An example of design for emergence in ISs is Wikipedia. The design of Wikipedia itself determines only the structure and function of the Mediawiki software. The content, that is, the actual encyclopedia with its collection of the world's knowledge, is an emergent property of the interaction of that software with its millions of users.
- *Emergent Design.* This concept [24] refers to an engineering approach that uses evolutionary, iterative processes for artifact implementation. Initially, the design is not fixed. The design of an artifact develops only over several iterations during the process of implementation. Emergent design has been proposed for application in learning environments [25], architecture [26], and even IS management [27], [28].

Although the emergent design of ISs and design for emergence in ISs are indeed biomimetic approaches, these concepts can be generalized further for the application of general principles of biological ISs to DISR

5 Biomimetic Information Systems

According to Österle et al. [1], an IS encompasses three layers: users, ICT, and organization. Biology-inspired IS research thus means the application of biological principles not to computational methods per se but rather to *socio-technical ISs.* This is a more general approach that extends questions of computing to aspects of social science (e.g., user experience and real-world organizations). Therefore, we wish to analyze the properties of biological ISs with the intent of developing a theory of biomimetic IS design. Our proposal is to apply biomimetic principles to all three layers: (1) user interaction, (2) information processing, and (3) organizational processes.

A system is an interaction of entities that form an integrated, complex whole. In contrast to energy systems, the components of an IS interact via *information interchange*. Meanwhile, a computational system is a system that emulates a Turing machine. Not all computational systems interchange information, and not all ISs compute. The central aspect of information is a message that is transported from a sender to a receiver. In biology, ISs co-evolve with energy systems. A broad range of media are available for the transmission of information messages, such as electrical charges, hormones, DNA, pheromones, airwaves, and electromagnetic waves. Examples of biological ISs include nervous systems, immune systems, human societies, and ant colonies. Discussing the properties of biological ISs enables the application of these principles for the design of innovative socio-technical ISs.

- *Emergence.* "The mere term "organism" expresses the fundamental role that interactions, self-organization and emergent behavior play in all biological systems (…) Biological systems on many different scales exhibit emergent behaviour" [29]. In fact, the concepts of information and semantics themselves have emerged in biological evolution [30].
- *Learning.* "Processing and use of information in biological systems can be said to have evolved out of the need for survival in the face of an uncertain environment. Accordingly, biological information processing can be said to support function to the extent to which these systems are able to adapt" [20].
- *Evolution.* "Nature builds from accidents that happen to work and creates new mechanisms on top of old ones" [31].
- *Fitness.* "Biological organisms use information about the environment to stimulate or drive responses that boost the likelihood of survival and successful reproduction" [31].
- *Networks.* "In biology, networks depict how molecules (metabolites, proteins), cells (bacteria, neurons), or organisms (ants) interact to jointly solve problems and coordinate responses" [32].
- *Autonomy.* "Autonomous systems are those that perform the necessary operations to maintain their own identity. This notion of autonomy provides a powerful way to conceptualize what is special about living systems" [33].
- *Tolerance.* "Robustness is one of the characteristics of biological systems that is most admired and most desired for engineered systems" [31]. Biological ISs are tolerant to unexpected events occurring in their environments.

Biomimetic ISs are artificial socio-technical ISs that are designed with biology as a source of their operational principles. Thus, these seven principles can be applied in IS design. Table 4 summarizes these principles and compares each of them with a corresponding aspect of conventional IS design. Based on Table 4 and the three layers of IS as defined by Österle et al. [1], three aspects of biomimetic IS design can be identified.

Table 4. Comparison of the principles of biomimetic versus conventional IS design

Biomimetic IS	**Conventional IS**
Emergence	Planning
Learning	Programming
Evolution	Determination
Fitness	Function
Networks	Hierarchy
Autonomy	Control
Tolerance	Rigidity

- *(A) Biomimetic User Experience.* If a system is allowed to learn through interaction, then the user experience of that system can become one of interacting with a tolerant, learning, adaptive system. Social and knowledge structures are based on networking. Instead of requiring every aspect to be controlled through user interaction, the system is able to operate in the background and perform many tasks autonomously. The system is tolerant to inconsistent user inputs.
- *(B) Biomimetic Information Processing.* The content and even the functionality of a system can be allowed to emerge through interaction and artificial intelligence reasoning. Instead of every action of such an IS being deliberately programmed, many behaviors are incorporated through machine learning, thus making biomimetic ISs more adaptive to organizational changes. Biomimetic ISs can operate on network structures, both for knowledge representation and for user interaction. Finally, the application of tolerance principles (e.g., approximate reasoning) makes biomimetic ISs much more robust.
- *(C) Biomimetic Information Management.* To avoid over-planning, emergent properties can be deliberately included in an IS such that both the design and the behavior of the IS may emerge through interaction, thereby significantly reducing manual configuration costs. Instead of all aspects being determined prior to implementation, such systems are allowed to evolve iteratively. Instead of IS design being treated as a function of the goals of an organization, ISs are optimized for their fitness, with user experience and acceptance serving as the fitness function.

6 Research Methodology

Computing is both an engineering task and a science [34]. Both methodologies complement each other. Through the implementation of artifacts using existing technology, new insights, principles, and theories can be formulated, which, in turn, lead to new and improved artifacts. In the field of computing, DSR closes the loop of engineering design and scientific analysis by allowing for the study of artifacts as part of the process of their creation. Nonetheless, "computer science is a field of empirical inquiry" [35]. Through the design of computing machinery and algorithms, the computational universe is observed, and theories are formulated empirically.

By projecting these principles to the realm of ISR, the scientific analysis of IS design can also be regarded as an empirical inquiry, thus adding to computer science the social dimensions of user experience and organizational processes. According to Österle et al. [1], the aim of DISR is normative, serving the purpose of being *beneficial to society*. "Design-oriented IS research aims to develop and provide instructions for action (i.e., normative, practically applicable means-ends conclusions) that allow the design and operation of IS and innovative concepts within IS (instances)." For this reason, to find new methods of formulating potentially beneficial IS concepts and to add a new dimension to the solution space, we propose the following research question*: How can the application of biomimetic principles to information systems design lead to the enhancement of value creation through innovation?*

This question is also a knowledge question, not only a design question. We want to know whether, and if so, how, the application of biomimetic principles to IS research can create value for users. Yet, in accordance with the principle of "knowing through making" [36], we can only answer this question if we can design and evaluate biomimetic ISs. Accordingly, the intended research anticipates successive iterations of the following partially overlapping research activities:

- *Conception:* Creation of designs, including foundations, for biomimetic ISs. This encompasses the identification of biological principles to address IS challenges and the transformation of these principles into designs with regard to specific solutions.
- *Prototyping*: Implementation of these biomimetic ISs as software systems, if possible, in real-world settings and in organizations with productive users.
- *Evaluation*: Analysis of the properties of biomimetic ISs in (inter-)action.
- *Conclusion*: Formulation of theories based on the underlying principles. To that end, we allow for not only analytic but also synthetic approaches to theorizing.
- *Publication*: Dissemination of the developed concepts, prototypes, evaluations, and conclusions to the scientific community.

This general method is merely a starting point for addressing the central, challenging task of transforming the descriptive account presented in this paper into actionable prescriptions for the design process. Further theorizing towards this end will be informed by findings from future case studies and informed argumentation.

7 Conclusions and Outlook

This paper introduced a research question concerning the application of biomimetic principles in DISR. A short literature survey was conducted, operational principles of biological ISs were theorized, and a conceptual framework for biomimetic IS design was derived. Based on these premises, the research question to be investigated was stated, together with a starting point for a possible methodology to answer it. This paper merely offers a research design, and our research is a work in progress; therefore, not many conclusions can be drawn at this point. One conclusion that can be shared is that although much research has been undertaken in the field of biologically inspired computing, there has been much less activity in the area of biomimetic ISR. Bio-inspired methodologies have been applied to IS engineering; yet, to our knowledge, there has not been

any in-depth design science research into the question of how biomimetic designs can create value for socio-technical ISs. Therefore, in the future, the proposed research may fill this gap.

The authors are investigating emergent behavior and networked knowledge structures for enterprise search, combining existing top-down methods with biomimetic bottom-up approaches to knowledge interaction [37]. This research effort is but one aspect of the broader context depicted in this paper. Furthermore, several DISR projects will be undertaken to investigate our research question by designing biomimetic ISs to evaluate the effects of the application of biomimetic principles to IS design.

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Dealing With Emergent Design Science Research Projects in IS

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Abstract. Multiple models, methods and frameworks have been proposed to guide Design Science Research (DSR) application to address relevant classes of problems in Information Systems (IS) discipline. While much of the ambiguity around the research paradigm has been removed, only the surface has been scratched on DSR efforts where researcher takes an active role in organizational and industrial engagement to solve a specific problem and generalize the solution to a class of problems. Such DSR projects can have a significant impact on practice, link theories to real contexts and extend the scope of DSR. Considering these multiform settings, the implications to theorizing nor the crucial role of researcher in the interplay of DSR and IS projects have not been properly addressed. The emergent nature of such projects needs to be further investigated to reach such contributions for both theory and practice. This paper raises multiple theoretical, organizational and managerial considerations for a meta-level monitoring model for emergent DSR projects.

Keywords. Design Science Research, Emergent Settings, Research Projects, Information Systems

1 Introduction

The ways of incorporating Design Science Research (DSR) in solving practical organizational and design-oriented problems continues to raise discussion. DSR can result in variety of design artifacts ranging from implemented systems and services to DSR methods, constructs and organizational support structures, e.g. business models [1], [2]. The basic activity of DSR has been repeatedly seen to consist of build and evaluate – activities where design solutions are proposed and addressed as a solution to overcome persistent real-world challenges [3], [4]. Despite the iterative nature of DSR [5], [6] and the direct relation to organizational challenges, a majority of DSR studies include retrospective evaluations of existing implementations [7]. In principle, DSR is not just evaluation of an existing component [3], [7]. It is an approach for developing ways of understanding and working with technical systems and to questioning existing structures and processes [2]. As emphasized by Avison et al. [8], researchers should study and apply their theories in practice.

The implementation of full DSR cycles in design and development efforts can be very time consuming and vulnerable to not succeed [9], [3]. From this perspective it is no wonder DSR projects that are initiated and carried out in an organizational context have not been as prominent in DSR. As argued by Iivari [9], DSR research lacks evi-

dence how to successfully plan and conduct DSR research efforts in organizational collaboration.

The connection of DSR and Action Research (AR)-method has been proposed and implemented previously by Sein et al. [5] and Markus et al., [10]. DSR projects that incorporate the organizational cooperation between researcher(s) and a client organization are emergent in nature [9], [10], [5]. Such projects have to deal with many uncertainties as they evolve through common contracts to the implementation and evaluation of the created artifact in real-life contexts [5], [11]. Projects can be seen as temporary organizations that are created to fulfill a special purpose and exist only a limited time [12]. While no information exists to the author's best knowledge on the failed emergent DSR projects, the harsh reality is that up to 70% of IS-projects fail to reach their goals [13].

Apart from distinguishing the type of client-initiated DSR that shares similarities to AR [14], [5], [9], and presenting a method to run such as Action Design Research [6], proper guidance and evidence is lacking how to deal with the emergent nature; rapid changes in the market and within IS-projects and organizations where DSR is addressed. What is not addressed in DSR research is 1) the role of the researcher in the interplay of the DSR- and the IS- project, 2) the types of IS-projects that are favorable to DSR, 3) how to address theorizing and DSR artifact building and evaluation in such emergent environments.

Based on the lessons learnt from 3 case studies, this article extends and challenges the current understandings of emergent DSR projects, presenting considerations towards a meta-level monitoring model METADSR to emergent DSR projects. The model explains how DSR researcher can monitor and deal with fundamental challenges of emergent DSR.

2 Operating DSR Efforts in Collaborative Research Projects

Multifold organizational and management theories have been discussed over the past years to explain organizational development, and the organization of tasks and activities in a form of projects. IS-projects often are interdisciplinary in nature, bringing together researchers and practitioners from both academia and companies [10], [9]. An underestimated or even neglected aspect in emergent DSR is the *organizational and managerial side* of such research projects. Commonly in DSR articles only the results of research efforts are reported. Therefore the organizational boundaries and the ways of dealing with compromises and contextual disruptors are not considered within. While many DSR projects implemented into organizational context have been initiated with the design artifact as the expected solution of the project, the reality is that the *DSR activity drives the projects only on a handful of cases*.

IS-projects are *vulnerable to many types of internal and external factors* that make them unexpected and vulnerable to changes. As emphasized for contingency theory, the organization of work and the processes cannot be optimized in a way that it would be effective in any situation [15]. The optimal solution has to comply with various internal project and its organization specific as well as external contextual and domain specific

constraints [15]. Similarly, the *emergent nature of systems design* is bound to the context where its being planned, designed and deployed [16].

Within project management research, Shenhar and Dvir [17] as well as Brocke and Lippe [18] have been discussing the types of development as well as Research and Development (R&D)-oriented projects from industrial as well as from public funding perspectives. Each of the types of options has several managerial and organizational challenges when it comes to running a successful collaborative project [18]. An unexpressed form of DSR lies in addressing the class of problems in multiple real-life projects [9]. In this study, the alignment of the DSR activities between 3 separate IS-projects demonstrates this approach.

3 Case Descriptions and Methodology

Between 2009 and 2015, three IS-projects were executed to design and develop service-oriented architectures to enable the integration of educational technologies to support virtual communities of educators and researchers. Within these IS-projects, DSR projects were embedded to study the IT use of educators as well as behaviors and attitudes on exchanging knowledge beyond their local context. Each project was 1) interdisciplinary, 2) consisted of project teams ranging from 6 to 50 organizations, including companies and research institutions, 3) was public funded, 4) Research was either supported or the DSR artifact was embedded in to a development-project. The projects were operating in similar domain area but not fully depending on each other. The DSR efforts and their alignment to several IS-projects was planned and implemented by the researcher.

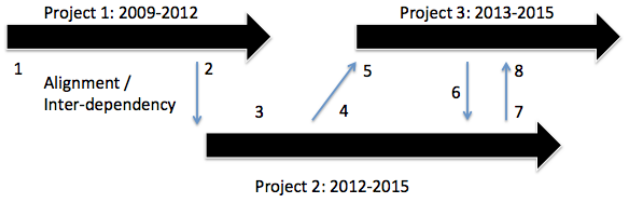


Fig. 6. Timing of the IS projects and the alignment of the DSR activities

The DSR activity/process was aligned as follows within the cases (IS-projects):

1. The problem and objectives set. Class of problem defined for critical disruptors for contributing in virtual communities for education. Objectives set for the IS-project for development of distributed services and the behavioral study to inform a design theory on knowledge exchange disruptor management. Implementation of the DSR cycle not successful; contradicting emergent aims of the DSR and the IS-project.
2. Negotiation of the DSR focus to a new IS-project, embedding detailed plan. Refining the research approach to allow adaptation on the way.
3. Refining objectives through contextualization to IS-project focus.

4. Initial definition and implementation of both meta-requirements and running system of integrated services to support virtual communities in education. Evaluation and refinement of the focus. Identification of problems to reach DSR objectives within the project.
5. Negotiation of the DSR focus to a new IS-project, embedding detailed plan with class of problems divided to enable comparative study and investigation on emotional and behavioral factors.
6. Merging evaluation activities within two IS-projects. Comparative study.
7. Further analysis within project 2 leads to refinement of the theory and need to adapt theoretical model and refine objectives.
8. Negotiation of refined evaluation objectives and changing project plan to support the adapted process.

This article does not intend to brief on the objectives and results of each DSR effort embedded to the IS-projects. The remainder of the article highlights critical issues on emergent DSR-projects that are not reflected within previous research articles in detail. These considerations are refined through the lessons learnt within the three cases, proposing a new METADSR model that allows meta-level monitoring and alignment of emergent DSR efforts in IS-projects.

4 Considerations for Monitoring Emergent DSR Projects

Reflecting on the theoretical background and the cases included in this study, the following types of IS projects will be differentiated and discussed from emergent DSR project- perspective: **1) Collaborative R&D projects** that either are industry or public funded; are either national or international; most likely interdisciplinary; involve both academia and companies **2) Development or network oriented projects** where research is not funded; including similar criteria as above, and **3) Array projects**; the types of comparative or longitudinal DS research projects that are linked to multiple IS projects.

Various considerations should be given to designing DSR projects in close collaboration with researchers, practitioners and industries. While lessons learnt in the three case studies guide the section, the considerations from managerial perspective are extended from the work of Shenhar and Dvir [17] and Brocke and Lippe [18] in terms of operational and interdisciplinary matters. Critical aspects for DSR come from the role of theorizing and emergent role of DSR as discussed by Lee et al. [19], Sein et al. [5] and Peffers et al. [14].

Table 1 presents some of the key considerations and extends the discussion for each of these on related critical issues that need to be monitored and dealt with.

Issue 1 – Contract and planning: No matter which type of organizations are involved in IS-projects from the industry and academia, *a form of contract* is written between the parties. Embedding DSR activities and the responsible researcher(s) to such contract is vital, no matter if deviations of work would occur during the IS project. The

projects that are in the planning stage generally apply high-level decision-making, leaving room for fine-grained, low-level decision-making to take place during IS projects. The challenge for DSR is to continuously be alert when tasks and activities are discussed that can affect the research process, leading to **Issue 2 – Decision making**. In many cases, such *decision-making processes are out of reach for a researcher*. It is crucial to identify the key actors in the network during negotiation and planning. The critical issue still remains on the actual *stakeholders who will be handling the daily work* within IS projects.

Table 5. Key considerations for the implemented DSR activities embedded to IS-projects

	Collaborative R&D project (case 1&2)	**Development projects (case 3)**	**Array Projects (between cases)**
DSR embedding to project	As a separate mission outside the contract (case1). DSR process defined (case 1 and 2)	Cut-down class or problem addressed. Partial DSR study aligned to objectives	DSR cycles not matched, activities cut based on the context and project
Stakeholders /decision making	Interdisciplinary, DSR concepts not embedded (case1) – no leverage in emergent DSR	DSR concepts and constructs embedded. Context allowing separate goals from IS-project	Implications from one case to all others. Constant alert and awareness needed
Role of theory	Theory development, emergence allowed but not fully supported by the project (case1)	Theory refinement. Separate language and communication in DSR and in IS project	Theory formed, refined and tested through several projects.
Role of intervention	Technical and organizational interventions disconnected from DSR artifact (Case1) – leading DSR away from IS-project	Org. Intervention matched to DSR artifact while additional evaluation activities addressed beyond the scope of the project	Intervention and theory aligned throughout the process of planning new IS-projects. Not all objectives link to DSR

Issue 3 – DSR linkage to the IS-project: One of the biggest challenges for DSR is when technological uncertainty is high and project is at risk to fail, how to ensure and to some extent separate the DSR project from the IS-project. If the DSR artifact is a key component of the IS-project, the DSR success is fully tied to the IS-project. However, the higher the risk, the better the changes for multifold data collection and workforce to support the research activity. Such was attempted in cases 1 and 2 but only succeeding in the latter. Therefore, the key success factor and the objective to monitor is that the *DSR artifact needs to be linked to the implementation of the IS project while not being fully tied to either the success or failure of the project*.

Issue 4 – Over optimism: A major challenge that was faced in each of the cases was that the preparation phase that links the DSR activities to a larger IS-project is likely to be more optimistic than the achievement of the project activities in reality. The occurring internal or external factors are persistent and cause deviations that need constant moni-

toring. **Issue 5 – Evaluation:** In-depth evaluations can be challenging to accomplish in development projects if partners require closed settings. In emergent DSR efforts, researcher is depending on the commitment and cooperation of other stakeholders. Within cases 1 and 2 the concepts relating to the DSR artifact and its objectives were embedded to the contract of the IS-project, which enabled a strong leverage when discussing priorities for both development and evaluation. This was needed for large IS-projects with multiple research institutions sharing the evaluation responsibilities and cooperating on the tasks. Biggest challenge from operational side is in development projects where the research activities are not in focus and the researcher must ensure ways to evaluate the artifact outside the scope or without the supports of the IS-project.

Issue 6 – Role of intervention: Commonly in IS-projects as for AR in general, an intervention or a set of interventions are defined, implemented and evaluated in organizational context. The *critical factor for DSR is whether the design artifact studied is also the intervention or a major component of it*. Regardless if it's a physical implementation, a method or an organizational support instrument.

Issue 7 – Theorizing: *design theorizing and theorizing is likely not to follow a certain pattern* but can emerge through grounded rigid steps or through reflection and emergence from the data [19], [6]. Key questions for DSR have been whether theory informs DSR activities, or should the activities develop or refine the theory [6]. One of the major challenge for successful implementation of DSR is IS-projects is *whether the key concepts of the upcoming design theory or artifact are embedded to the core of the IS-project*. Concepts are in the center of grounded theorizing [20] but also set boundaries to the investigation to be handled within the IS-project by a clear explanation – what are we studying.

Issue 8 – Unexpected re-alignment: As emphasized for AR, there needs to be room for theory refinement through iterative work [21]. When new phenomenon or user behavior is detected that causes a need to refine the approach, negotiation processes are set in place and much is depending on the *competences of the researcher* in charge of DSR to explain and argue why the new constructs, concepts and refined focus have to be implemented within the IS-project. On one hand only individuals with great influence or a management position can ensure the continuation and success of the DSR project. On the other hand, iterative build-evaluate activities and refinement of the DSR process are necessary in such situations. Such changes are necessary to ensure novelty and originality of the DSR artifact [2] and contribution towards design theorizing [6], [7].

Issue 9 – Parallel projects: Iivari [9] discussed the potentials for addressing the classes of problems in parallel organizational settings. This approach was approached especially in cases 2 and 3. The alignment process of DSR meta-artifacts to varying settings might cause methodological problems and disrupt a rigorous research approach. However, such array projects can also be hugely beneficial since the design science researcher harmonizes, validates and proves the applicability and the novelty of the artifacts in differing settings.

5 Conclusions and Further Work

This research in progress-article serves as a discussion starter for managing the role of the researcher in within emergent DSR activities that are embedded to temporary IS-projects. The article presented considerations towards a meta-level monitoring approach on how to deal with the emergent nature of DSR once embedded to organizational and interdisciplinary activities. The DSR community needs to widen the discussion on organizational involvement to increase the practical value and the contribution of the research attempts to businesses by direct integration of DSR artifacts to solve organizational problems through interdisciplinary research efforts.

The next steps to take include the widening of the perspectives on epistemology and theorizing by deepening the discussion on emergent DSR. The work towards a METADSR model will be extended to consider different types of artifacts and to form a linkage between the issues to be monitored with a solution space offering DSR interventions to solve the particular challenges.

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Action Design Research: A Comparison with Canonical Action Research and Design Science

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Abstract. This research in progress paper addresses the IS issue in relation to conducting relevant research while keeping academic rigor. In particular, it contributes to the ongoing academic conversation around the investigation on how to incorporate action in design science research. In this document the philosophical underpinnings of the recently proposed methodology called Action Design Research [1] are derived, outlined and integrated into Burrel and Morgan's Paradigmatic Framework (1979)[6]. The results so far show how Action Design Research can be considered as a particular case of Design Science Research (rather than a methodology closely related to Action Research) although they can assume two different epistemological positions. From these philosophical perspectives, future works will involve the inclusion of actual research projects using the three different methodologies. The final goal is to outline and structure the divergences and similarities of Action Design Research with Design Science Research and Canonical Action Research.

Keywords: *Action Design Research, Paradigmatic Framework, Design Science, Canonical Action Research.*

1 Introduction

This paper addresses the well acknowledged issue in Information System (IS) research about conducting relevant studies while keeping academic rigor. To date, several research streams and academic conversations have sought to address these problems. More specifically, this paper seeks to extend the debate around the philosophical differences between Design Science Research (DSR) [2] and Canonical Action Research (CAR) [3] by including a recently proposed methodology named Action Design Research [1]. Particularly, this paper shows how its introduction to the IS community can be seen as a fundamental step towards solving the relevant methodological issue on how to embed action components in design science projects [4]. In order to achieve this goal, this study aims at comparing these three methodologies at both the philosophical and practical levels. This research in progress paper tackles the first perspective. In detail, with this document we aim at extending the work published in [5], in which Burrel and

Morgan's Paradigmatic Framework (1979) [6] was adopted to analyze the differences and commonalities between DSR and CAR, by including Sein *et al.*'s (2011) methodology. Additionally, Action Design Research (ADR) will be positioned in relation to DSR and CAR.

After this brief introductory section, a review of relevant related works will be presented in section 2. Subsequently the main features of DSR and Action Research will be described. In section 4, which represents the core of this document, the philosophical underpinnings and assumptions upon which Action Design Research is situated will be investigated and interpreted. Finally, before some conclusions are drawn, a reflection and comparison with both DSR and CAR will be presented.

2 Related Works

The debate around the existing relationships and the comparison between DSR and Action Research has been relevant for at least the last two decades among IS researchers [7]. Different levels of analysis have been involved in such academic conversation. One of the most cited contributions in this way is represented by the work published in [8]. Here the author took into account the research activities that are typically implemented in these two approaches, concluding that DSR and Action Research are similar. His suggestion aimed at moving conceptually Action Research from a purely qualitative approach to a more Design Science-oriented one. Two years later, a relevant contribution to this conversation was added by Ivari and Venable (2009) [5]. In their study, in order to further compare the DSR and Action Research (in this work [3]'s Canonical Action Research paradigm was taken as reference), the authors went at a more abstract level by providing a structured philosophical analysis. In detail, they used [6]'s Paradigmatic Framework to highlight the different philosophical assumptions that underpin the two methodologies. Their conclusions strongly contradicted the claims made in [8]. In addition, Ivari and Venable (2009) tried to outline a range of possible situations in which the two approaches can overlap. They concluded by accepting that DSR and CAR are "*compatible with each other, (but) they may be difficult to combine for more practical reasons*" [5, pp.10]. In detail, CAR principles can be consistent within DSR projects especially in the evaluation stage of already developed artifacts. However, in their opinion, this match can happen only if the evaluation is of the type "natural", as opposed to the "artificial" one which should be prioritized in DSR projects [4].

Another contribution that is relevant to this discussion is ingrained in the basic forms of Engaged Scholarship outlined in [9] (see Figure 1). Particularly, DSR and Action Research are shown in relation to the scope of Engaged Scholarship. Here the two axis upon which the matrix is built are clearly referring to ontological and epistemological differences. Again, the similarity between DSR and Action Research proposed in [8] is contradicted.

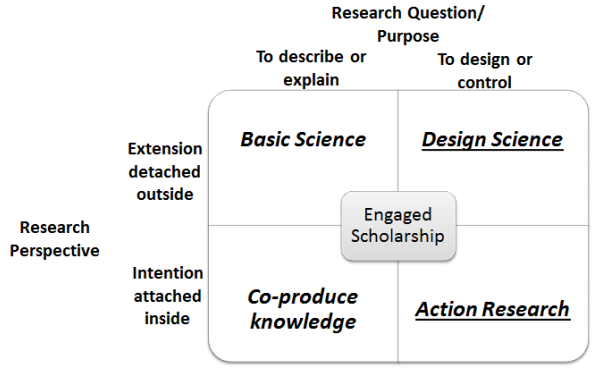


Figure 7. Alternative Forms of Engaged Scholarship [9, pp.27].

More recently a new research methodology named Action Design Research [1] was introduced to the IS community. Its name suggests its suitability to solve these issues around "incorporating action" in DSR.

This paper aims at adding to the analysis published in [5] the philosophical underpinnings of this recently proposed methodology. An accurate look at the results will help us both in gaining insights about positioning Action Design Research in this conversation and in reflecting upon questions such as *"Is Action Design Research similar to CAR? Or is it a particular case of DSR? Or, finally, is it a completely new research perspective?"*

3 Design Science Research and Canonical Action Research

Design Science has its origins in the work of Herbert Simon [10] but entered mainstream IS academic literature following the seminal paper by Hevner *et al.* (2004) [2] which provided "*a concise conceptual framework and clear guidelines for understanding, executing and evaluating (design science) research*" (pp. 75). The authors state that design science is fundamentally a problem-solving paradigm that seeks to "*create innovations that define the ideas, practices, technical capabilities, and products through which the analysis, implementation, management and use of information systems can be effectively and efficiently accomplished*" (pp. 76). Hevner *et al.* describe the primary goal of their paper is "*to inform the community of IS researchers and practitioners of how to conduct, evaluate, and present design science research*" [2, pp. 77]. The research activities of design science within the IS discipline are described via a conceptual framework for understanding information systems research and a clear set of seven guidelines are proscribed for conducting and evaluating good design science research.

On the other hand, Action Research originated from the work of Kurt Lewin during the 1940s and has been summarized as an approach that "*combines theory and practice (and researchers and practitioners) through change and reflection in an immediate problematic situation within a mutually acceptable ethical framework*" [11]. This definition entails a view of the methodology as an approach aiming at contributing to both the existing knowledge base and practice in terms of providing a solution to a specific entity. As a consequence, Action Research *"is highly context dependent while attempting to*

address the specific client's concerns" [5]. Despite the plethora of "versions" in which Action Research was formulated (e.g. [12], [13]), this study considers Canonical Action Research [3] as reference. In this seminal article, the authors defined the methodology through the formulation of five distinct principles, which are: (1) the principle of the researcher-client agreement, (2) the principle of the cyclical process model, (3) the principle of theory, (4) the principle of change through action, and (5) the principle of learning through reflection [3].

In reflecting upon philosophical assumptions of these two methodologies, Ivari and Venable (2009) contextualized Burrel and Morgan's Paradigmatic Framework to explore and understand similarities and differences of the two methodologies at the philosophical level. Their conclusions are summarized in Figure 2.

Figure 2. Paradigmatic Assumptions of CAR and DSR [5, pp.8].

From this study it could be learnt how DSR can assume a variety of positions, while CAR is more limited in this way. Notwithstanding, Action Research can be applied (also consistently with [14]) as part of the evaluation stages of DSR projects, and so be considered as a "special case of DSR" [5].

Paradigmatic dimension	**Action Research**	**Design Science Research**
Ontology	Anti-realism	Realism or anti-realism
Epistemology	Mainly anti-positivism	Mainly positivism, but also anti-positivism especially in evaluation
Methodology	Idiographic	Constructive (building) Nomothetic (evaluation) Idiographic (evaluation)
Ethics	Means-end Possibly interpretive Unlikely critical	Means-end Possibly interpretive Possibly critical

4 Action Design Research

The Action Design Research (ADR) methodology is defined as "*research method for generating prescriptive design knowledge through building and evaluating ensemble IT artifacts in an organizational setting"* [1]. Its particular contribution was also described as the implementation of design science research to solve an organizational-related problem defined as an instance of a class of problems, in which the evaluation is conducted in a highly participatory process [15]. The ADR cycle is based on four main research stages: (1) Problem Formulation, (2) Building Intervention and Evaluation, (3) Reflection and Learning, and (4) Formalization of Learning. The first step involves the definition of the problem that is required to be solved. Here, the problem has to be identified, articulated, and scoped. Particularly important at this stage, is to relate the organizational problem to a broader class of problems. This first stage of the methodology is drawn upon two principles: (1) *Practice Inspired Research* and (2) *Theory-Ingrained Artifact* [1]. The second stage of the ADR methodology is related to the process of building, intervention, and evaluation (BIE) of the artifact. Again a number of principles are proposed in this seminal article, and these are: (3) *Reciprocal Shaping,* (4) *Mutually Influential Roles*, and (5) *Authentic and Concurrent Evaluation*. After discovering initial theo-

retical contribution targets, the methodology also distinguishes between an IT-dominant-BIE (that is mainly focused on innovative technological design) and an organization-dominant-BIE (this format is related to the decision making processes within the organization). Both of these BIE types identify a highly participatory design process. The third step of ADR is crucial to ensure the contribution to knowledge of the research project. This stage is drawn on the principle (6) named *Guided Emergence*. Finally, the last stage proposed in [1] emphasizes once again the importance of having a (7) *Generalized Outcome* that can be further developed into general solution concepts for a class of field problems. The research outcome is then a theory-ingrained artifact, where theories allow the research team to both structure the organizational problem as an instance of a class of problems in literature, and guide the design [16]. The generalized outcome is achieved through the ongoing reflection and learning step, and the final formalization of learning one. In this way, the organizational related problem can be solved without precluding the creation of an original contribution to existing knowledge.

Based on this overview of the methodology, we will now attempt to derive some conclusions about the philosophical underpinnings and assumptions of such approach. Again, in order to be able to compare these with the ones of DSR and CAR [5], Burrel and Morgan's Paradigmatic Framework (1979) [6] will be adopted. Thus, starting from the ontological standpoint, we believe the ADR methodology sits in an Anti-Realistic position in the continuum between the two extremes, i.e. Nominalism and Realism. As a rationale for this statement we underline once again how ADR aims at the creation of a "theory ingrained artifact", which excludes the total nominalistic view of the world. On the other hand, the action design researcher actively inscribes theoretical elements in the ensemble artifacts thus manifesting theory in a *"socially recognizable form"* [17] (cited in [1]). As a consequence, we rationally conclude that ADR adopts an Anti-Realistic ontological position as reality is seen as something socially constructed that can be changed, as opposed to a view of the world made of immutable, hard and tangible structures (i.e. typical Realistic position).

Epistemologically, the assumptions behind ADR can be compared to the ones made in literature on DSR. Particularly, it has been discussed that in DSR both positivistic [2], [18] and anti-positivistic [19] positions can be relevant. In detail, the latter is considered as important especially in the evaluation stage of already developed artifacts. Similarly, we believe that ADR can assume both these positions too. However, the rationale behind this thought sees an anti-positivistic assumption regarding the problem formulation and the BIE stages, reflected in addressing a problem situation encountered in a specific organizational setting by an intervention and an evaluation of the designed artifact. In other words, the world from this perspective can be understood from the point of view of the individuals that are directly involved in the activities to be studied. Notwithstanding, by implementing the ongoing Reflection and Learning stage, the researcher (or researchers) moves conceptually "*from building a solution to a particular instance to apply that learning to a broader class of problems*" [1]. This movement from the specific solution to the class of systems typified by the ensemble artifact seeks to provide an explanation and a prediction around what happens in the reality by defining regularities and causal relationships between its constituent elements (typical positivistic epistemological perspective). As a result, we can suggest that the contribution to knowledge of ADR can also have a strong positivistic nature.

Regarding instead the methodology dimension within Burrel and Morgan's Paradigmatic Framework (1979) [6], it is relevant to consider that the action design researcher *"should generate knowledge that can be applied to the class of problems that the specific problem identifies*", and the "*outcomes can be characterized as design principles and as refinements to theories that contributed to the initial design*" [1]. So, the aim of designing a "*Generalized Outcome*" (ADR, Principle 7) led us to conclude that the methodological approach is underlined by nomothetic concepts (as opposed to idiographic ones that are focused on a particular case and not on the formalization of general laws). Finally, regarding the ethical (or axiological) perspective, the prescriptive-knowledge-generation-oriented process of ADR makes it clear that its ethical philosophical underpinnings are far away from being Critical (in which critical research subjects goals to a critical analysis) and Interpretive (in which goal statements do not precede actions; rather they are re-constructed retrospectively to assign a meaning to these activities). Thus, we are confident in stating that ADR assumes a Means-End ethical position. Consistently, in ADR the research questions and the subsequent research goals (or ends) are defined within the problem formulation stage. Therefore they precede the BIE cycle (i.e. actions); finally it should be noted that the ADR artifact to be developed is assumed to have some purpose (this thought is ingrained in the artifact-oriented research).

5 Reflections, Conclusions, and Future Works

In this last section of the paper the preliminary findings achieved through the analysis previously presented will be highlighted and briefly discussed. In Table 3 the Paradigmatic Framework contextualized in [5] is expanded with the ADR philosophical assumptions previously derived. As shown in Table 2, ADR and DSR research cover the same philosophical underpinnings. This result suggests how, in first approximation, ADR can be considered as a particular case of DSR, rather than a methodology closer to Action Research. The reason of such interpretation is found mainly in the scope of ADR projects, i.e. "*building and evaluating ensemble IT artifacts"* [1].

DIMENSION	POSITION	CAR	DSR	ADR
ONTOLOGY	Realism			
	Nominalism	(non-realistic)	(non realistic)	(non realistic)
EPISTEM.	Positivism	●	●	Knowledge Contr.
	Anti-Positivism.		●	BIE Cycle
METHOD.	Nomothetic		●	Generalized Outcome
	Idiographic	●		
ETHICS	Means-end	●	●	Goals-driven
	Interpretive	(rarely)		

Table 2. Paradigmatic Assumptions of DSR, CAR, and ADR.

However, some paradigmatic divergences are in place also between ADR and DSR. Specifically, while ontologically, methodologically, and ethically the two approaches are very similar, there is a substantial epistemological difference between the two methods. Particularly, DSR aims at the design of general solution concepts which are applicable not just to a specific organizational context. In other words, in the so called "*build and then evaluate*" path of DSR, the first stage involves a positivistic epistemology (especially in the engineering field), while anti-positivistic assumptions are likely to emerge when the artifact is instantiated. On the other hand, because of the nature of ADR, the design process within it is more likely to have as underlying assumptions anti-positivistic positions. In fact, in a typical ADR project the problem as well as the artifact are conceived from the point of view of the individuals who are directly involved in the activities which are to be studied. Thus, the design stage (or stages) is (unlike DSR) underpinned by anti-positivistic paradigmatic assumptions. The positivistic side of the methodology emerges in both the ongoing Reflection and Learning stage, and the Formalization of Learning one, when the specific organizational-related solution is related to a broader class of solutions, or, in other words, to a generalized outcome. We believe that an explanation for this epistemological difference that exists between ADR and DSR is given by the different role that the organizations play in the two approaches. In detail, while in DSR the organizational intervention is considered to be secondary [20], in ADR projects the organization is part of the ADR team since the beginning and the design process is highly participatory. As a result the ADR artifact is "socially constructed", thus not consistently with positivistic epistemology.

Overall the paper contributes to the IS literature by extending Ivari and Venable's study [5] towards including the ADR perspective into their contribution. Future works

will ingrain in the analysis actual research projects to leverage this discussion and derive significant conclusions.

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Effectuation and Its Implications for Socio-Technical Design Science Research in Information Systems

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Abstract. We study the implications of the effectuation concept for socio-technical artifact design as part of the design science research (DSR) process in information systems (IS). Effectuation logic is the opposite of causal logic. Effectuation does not focus on causes to achieve a particular effect, but on the possibilities that can be achieved with extant means and resources. Viewing socio-technical IS DSR through an effectuation lens highlights the possibility to design the future even without set goals. We suggest that effectuation may be a useful perspective for design in dynamic social contexts leading to a more differentiated view on the instantiation of mid-range artifacts for specific local application contexts. Design science researchers can draw on this paper's conclusions to view their DSR projects through a fresh lens and to reexamine their research design and execution. The paper also offers avenues for future research to develop more concrete application possibilities of effectuation in socio-technical IS DSR and, thus, enrich the discourse.

Keywords: effectuation; causation; socio-technical artifact; socio-technical system; emergence; transformation

1 Introduction

The current design science research (DSR) in information systems (IS) literature commonly understands DSR as a structured search process for the solution to problems (or a class of problems) of real-world socio-technical systems. The solution takes shape in form of an artifact/design theory, which draws on and should contribute to extant descriptive and prescriptive knowledge [1]. The artifact is to be introduced into one or more real-world application context(s) and evaluated as to how well it can solve the (class of) problem(s) while providing measurable utility [2]. On this basis, the designed artifact can be refined iteratively in cycles to provide a superior solution for the given problem [3]. Current thinking regards factors from within the artifact's application context which threaten an artifact's utility (such as unexpected developments, contingencies, or surprises) as factors the designers' skills need to mitigate [4].

This straight orientation towards finding an optimum (or at least, satisfactory) solution for a given problem within an exogeneous environment mirrors, to a certain extent, the causal perspective of explanatory-oriented research. This type of research seeks to identify, validate, or falsify causes for a given effect in the likewise exogenous real world [5]. Applied to DSR, the artifact is the cause embodying the intended effect (solve the problem) and the design goal is to strive for the most effective cause. Gregor and Jones even develop their design theory elements on the grounds and terminology of Aristotelian causation [6]. Such a cause-effect perspective has DSR oppose and not embrace contingencies and emergence in dynamic social artifact application contexts.

However, an alternative school of thought coming from entrepreneurship research proposes to consider thinking not in causation, but effectuation logic [7]. Effectuation does not focus on identifying or triggering specific cause-effect relations, but on using the means at hand to achieve desirable effects and, thus, shaping and controlling the future. Effectuation has been loosely connected (and found to be conforming to) organizational DSR [8], but has, to the authors' knowledge, not yet been discussed in the context of designing socio-technical IS. We intend to fill this gap in this research-in-progress paper by first giving a brief overview of effectuation itself and its past application in the context of entrepreneurship research as a science of the artificial. Afterwards we discuss general implications for socio-technical artifact design as well as for corresponding DSR processes and outline further research avenues.

2 Effectuation and Its Role in Sciences of the Artificial

In this section, we briefly summarize the effectuation concept and show its application in another science of the artificial: entrepreneurship research.

2.1 The effectuation concept in a nutshell

Sarasvathy conceptualized effectuation as the opposite of causation [9]. Unlike causation, effectuation does not focus on finding causes that explain or achieve a given (intended) effect, but considers available actions through given means and their spectrum of possible effects. Effectuation therefore is about generating alternatives with differing effects (and choosing one of them) instead of choosing among given alternatives which all lead to the same effect. Thus, effectuation logic constitutes a logic of control [7], specifically controlling the future by actively shaping one's environment within one's possibilities, while being open to the direction of one's actions.

In effectuation, the choice of action depends on the three given means of 1) the actors (*effectuators*) themselves and their traits ("who I am"), 2) their knowledge ("what I know"), and 3) their social connections ("whom I know") [7]. It also depends on what the effectuators can imagine to be possible effects and what they perceive the corresponding risks or potential losses to be. These risks and losses are matched with effectuator's set of human aspirations, leading to the eventual choice of action. Neither the means nor the aspirations are treated as invariant, leading to a concept that embraces flexibility and dynamism, allowing the exploitation of emerging contingencies [10].

2.2 An effectuation lens on entrepreneurship

Effectuation is the cornerstone Sarasvathy uses to reconceptualize entrepreneurship research as a science of the artificial [8]. In her view, entrepreneurs design firms or even markets – which she therefore considers as human artifacts. This design perspective in effectuation also extends to a more micro level as generating alternatives effectively means designing them.

In positing that firms are tools that entrepreneurs use to shape or even create their future market(s), Sarasvathy, in fact, reverses the common view on firms as the cornerstone or foundation of entrepreneurial action [10]. In her view, firms and markets are not exogeneous entities, but human artifacts that start to exist at some point in time, continuously evolve, grow, shrink, change their purpose or their evolutionary direction, and may eventually fail and cease to exist. The overall process usually starts with a path-creation incident in the form of an initial entrepreneurial decision and continues path-dependent from there [9]. Even the lessons the artifact users (entrepreneurs) learn from failing may contribute to their future successes with new and different artifacts (firms). Sarasvathy further states that entrepreneurs first find possibilities in the world, turn possibilities into opportunities, and go from there to start an ongoing, typically path-dependent, process of designing new and transforming products, services, firms, and, eventually, markets in ways they perceive as suitable to exploit the perceived opportunities and implement the possibilities [10]. Thus, in this entrepreneurship perspective, the entrepreneurs' perceptions of extant possibilities in the world set the whole process of artifact (firm) design in motion.

Moving forward, Sarasvathy et al. [8] identify three crucial factors limiting entrepreneurial design decisions: 1) Knightian uncertainty (with impossibility to calculate probabilities for consequences of future actions), 2) goal ambiguity (no given ordered set of preferences), and 3) environmental isotropy (lack of clarity which information about the environment entrepreneurs should pay attention to for decision-making). Based on a strategy type framework developed by Wiltbank et al. [11], Sarasvathy et al. [8] further distinguish four different strategies entrepreneurs can apply to actually go about designing and transforming products, services, firms, and markets: 1) by planning, 2) by adapting to the environment, 3) by following a clear vision, and 4) by being transformative in the sense of applying effectual logic. In a sample case, Sarasvathy et al. illustrate that the successful Starbucks coffee shop chain has employed all four strategies to varying degrees [8].

Linking their findings to organizational DSR, they conclude that effectuation logic corresponds to van Aken`s postulation of the need to develop theoretically grounded and empirically validated design principles [12], that effectuation logic provides a coherent set of such principles, and that effectuation logic allows their users to cope with emergence during their design effort better than with traditional planning-oriented approaches that seek to identify causes to reach desired effects.

3 Implications for Design Science Research in Information Systems

With this basic understanding of effectuation, we now discuss implications for IS DSR first with a focus on single socio-technical artifact design, second with a focus on artifact populations (applicable to mid-range artifacts which are applied to a number of contexts), and finally for the overall DSR process.

3.1 Implications for the design of socio-technical artifacts

We see effectuation's greatest potential for socio-technical artifacts that contain a dominant social component and social context. These two elements add the necessary space for opportunities, contingencies, flexibility, and emergence that is a prerequisite for applying effectuation. Thus, the scope of the subsequent discussions is limited to, for example, traditional business information system artifacts where the technical IT component is a means to an end, to IS artifacts for social domains such as smart cities, or to purely social artifacts such as project management frameworks.

Looking at the three crucial factors for entrepreneurial decisions that Sarasvathy et al. [8] identify, Knightian uncertainty and environmental isotropy apply to IS DSR projects as well. It is impossible to calculate probabilities for an artifact application's consequences for a social context and, given its complexity, unclear which information about a social context is relevant to assess the consequences. The third factor, goal ambiguity, does not apply as directly since utility goals are typically well-defined in IS DSR. This may seem to limit the effectuation concept's applicability to IS DSR at first. However, it may well be the case for an IS DSR project that other goals would be viable as well, which is something that researchers can establish early in the DSR process. Also, this draws attention to the actual problem formulation stage of a DSR process which has not received a lot of research attention yet. Finally, the two formerly named factors are limitations of the traditional causation perspective on DSR as well. Therefore, they serve as (often unspoken) limitations in traditional IS DSR endeavors anyway.

Regarding an artifact's social application context, effectuation highlights that this context is not static and that goals may change. Also, the existence (or implementation) of artifacts may create new goals. Overall, this conveys a more dynamic perspective to the normally static depictions of DSR processes in the literature that often do not match the reality of design projects. Whereas current IS DSR revolves around a stable problem, effectuation in its pure form lacks such a stabilizing element. The closest counterpart to given goals are probably the human aspirations which act as a yardstick to generate and evaluate alternatives. For effectuation-oriented DSR, this would mean not having problems or goals, but human aspirations to drive the DSR process. Such aspirations may lead to quite different resulting designs (effects) which would then be evaluated in terms of which design is most desirable to satisfy the human aspirations.

Taking this aspiration orientation further, effectuation-oriented DSR is not about maximizing the intended effect of the designed socio-technical artifacts, but treating artifact design as well as artifact application to a specific context as a journey along the path of achieving the underlying aspirations. The lack of a set goal as a yardstick also leads to

the question where this leaves artifact utility as a dependent variable[4] [13]? What would be its effectuation counterpart? Artifact utility could be, for example, evaluated ex-ante as artifact potential to reach the aspirations with a given set of means within a particular context. An ex-post evaluation could interpret artifact utility as its power to change a socio-technical system in concordance to the aspirations, regardless whether the actual changes were planned or emerged by themselves. Thus, following Sarasvathy [10], when individuals' perceptions of real-world possibilities form the starting point of effectuation processes, another form of artifact utility could be an artifact's power to let its users perceive and exploit such possibilities in the first place. Even these three abstract examples for artifact utility make it clear that replacing measurable goals with human aspirations adds – almost paradoxically – a strong human (and thus, subjective) element to artifacts and artifact utility. In addition, the dynamic and emergence-oriented nature of effectuation leads to a requirement for socio-technical artifacts to cope with this nature. This requirement reinforces the importance to consider artifact fitness in addition to artifact utility [13].

For actual artifact design, current IS DSR does not only follow a causal pattern in general, as discussed in the Introduction, but design researchers also draw on explanatory and often causal theories to arrive at design decisions. To bridge the two realms of explanatory theories and design artifacts, researchers often rely on an intermediate step which Gregor and Hevner call *prescriptive knowledge* [1]. This type of knowledge often takes the basic form of "if you want to achieve Y in setting Z, then do (something like) X" [14]. The term *prescriptive knowledge* and the previous specification pattern clearly have causal notions. For an effectuation counterpart to capture and specify such action-oriented knowledge, one would have to turn the format around, for example "in setting X with resources Y and Z at hand, one could achieve A, B, or C. Which effect would best match your aspirations and pose an acceptable risk?" The less prescriptive nature of effectuation also points toward the use of softer terminology such as *design proposition* [15] instead of *technological rule* [16], or *suggestive knowledge* instead of *prescriptive knowledge*.

3.2 Implications for artifact populations

While in the previous section we limit our perspective to a single socio-technical artifact, in this section we will focus on implications of an effectuation perspective on artifact populations. To make it clear what we mean with artifact populations, we first need to distinguish 1) abstract (or mid-range [1]) socio-technical artifacts (concepts, models, methods [17]) and 2) their local instantiations in specific application contexts. The former promise a potential possible future reality for socio-technical systems, while the instantiations are actually part of reality of at least one particular socio-technical system. Effectuation now draws our attention to the process between these two artifact states – an abstract artifact becoming an instantiated one, or, in other words, a potential future reality becomes an effective, actual one. An instantiation of an abstract artifact in several contexts now leads to an artifact population.

[4] Note that even the metaphor *dependent variable* which Gill and Hevner [13] use to highlight the role of artifact utility is derived from causal-oriented language in statistics.

This artifact instantiation process has not yet received much research attention in IS DSR. In the management DSR discourse, van Aken proposes to consider not only the object design (the actual abstract artifact), but also a corresponding implementation or realization design prescribing two redesign stages to tailor the abstract artifact to the application context and a final phase of learning to perform [12]. This distinction between these two artifact types opens up a possibility of combining causation and effectuation-oriented DSR: causation-oriented DSR for abstract artifacts and effectuation-oriented DSR for the artifact redesign and instantiation processes. This shields the particulars of each local application context (and thus, the challenge of achieving actual artifact utility) from the abstract mid-range artifact, while still maintaining a connection between the mid-range artifact and its local application contexts.

In addition, in an artifact population perspective, the properties of different contexts for artifact instantiation become a research concern. Here it is conceivable that for the same abstract artifact, the redesign process for different contexts will need to turn out quite differently to maximize artifact effectiveness in terms of changing the context in a desired way. For stable contexts, a traditional causation oriented change process might stay the paradigm of choice, while for dynamic contexts a stronger emphasis on effectuation will allow the exploitation of extant contingencies as opportunities to realize the underlying goals or aspirations even better.

3.3 Implications for the design research process and the designers

The points raised in the two previous sections made it clear that an effectuation perspective on IS DSR has profound implications on our understanding of socio-technical artifact design. In this section, we want to highlight corresponding implications for the DSR process as well as the persons executing it – the designers.

Viewed in a DSR context, Wiltbank et al.'s [11] four strategies mentioned in Section 2.2 can serve as general strategies to design socio-technical systems. Of the four strategies, the planning strategy corresponds to traditional IS DSR, while the transformative strategy corresponds to a pure form of effectuation-oriented DSR. Different forms of DSR do not only lead to different design artifact types but also to the need to execute the design research process differently. Following Wiltbank et al.'s advice, a transformative approach promises to be more suited for dynamic contexts than a planning approach. In such a context, a more feasible guiding question for the DSR process is not how to design and execute a process to reach an actual solution, but how to foster the (possibly continuous) effectuation process to look for an improvement of the current situation (a local optimum, so to speak) through socio-technical artifact (re)design.

When differentiating more distinctly between artifact design and instantiation, the distinction between artifact designers and users also needs a cleaner differentiation. In an effectuation lens, during an artifact instantiation a transformation of the actual reality into a different future reality takes place. Here, the abstract artifact just serves as part of the extant means to guide this transformation by highlighting an alternative future. This allows the isolation of a novel role in the DSR process: the *transformers* who control this artifact instantiation process. This role may be filled by the abstract artifact's designers, by the artifact end-users, or by a separate group of people who take the abstract artifact, tailor it to and implement it within a specific application context.

We contend that effectuation further highlights the importance of creativity for the designers [18] (and, consequentially, also for the *transformers*). Here, effectual logic provides a frame to stimulate creativity as Sarasvathy et al. demonstrate in several instances throughout their papers [7–9]. When artifact design and instantiation is a journey into the unknown (see Section 3.1), a key question for the DSR process is when and how the design researchers should evaluate their journey? How can one differentiate an effective journey compared to a journey following the adage of "we are lost, but making good progress" – ideally, *while still being underway*?

4 Discussion and Conclusion

Our goal in this paper is to illustrate how the effectuation concept from entrepreneurship research can provide an alternative and novel lens of viewing and understanding socio-technical DSR and artifact instantiation processes. We also suggest that effectuation has the potential to be an alternative positioning that design researchers can employ to conduct IS DSR in the context of complex socio-technical environments. We do not claim that effectuation is a replacement for traditional causation-oriented DSR, but we see potential in coexistence between both paradigms in the future. It is difficult to see where, when introducing an artifact, it would make sense to stop trying to cause intended reactions of a socio-technical system in stable, predictable, and well-known contexts. However, for unknown and dynamic contexts or wicked design problems, an effectuation-oriented design approach may prove to be complementary or even superior to traditional DSR. In any case, taking and considering the alternative effectuation perspective may provide design researchers with fresh insights necessary to deal with design for a challenging environment. A clear limitation of the effectuation perspective exists when clear goals are set which cannot be changed or may not be deviated from during a DSR project. As we have not employed an effectuation lens to an actual DSR effort yet, this paper itself has a clear limitation in remaining purely conceptual.

We therefore see one avenue for further research to re-examine past DSR projects through an effectuation lens and see whether and to which extent the conceptual issues raised in this paper correspond to DSR reality. Throughout Section 3, this paper further raises many questions and provides open-ended opportunities for further research, such as the search for new compatible evaluation methods. The same applies to connecting the highlighted issues to extant literature, for example to action design research [19] or critical realism [20] and its generative mechanisms. Also, many IS DSR endeavors double as entrepreneurial projects, designing innovative products or services as theory-driven artifacts. Future research could apply the effectuation perspective simultaneously to both the artifact driving the entrepreneurial endeavor as well as the entrepreneurial endeavor itself. Such interplay has the potential to advance our understanding of artifact-driven entrepreneurship and organizational innovation activities [21].

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Activity Patterns in Design Processes of IT Standards

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Abstract. Contemporary IT standards are *designed*, not selected. Their design enacts a complex process that brings together a coalition of players. We examine the design of the SOAP standard to discover activity patterns in this design process. The paper reports these patterns as a precursor to developing a micro-level process theory for designing IT standards.
Keywords: IT Standards, Design Process, DSN, Activity Patterns

1 Introduction

IT standards can be a source of cost consumption or revenue generation for corporations. They are anticipatory (yet-to-be implemented [1]) and open (allowing input from industry and citizenry [2]). These attributes make them different from *de jure* standards and also different from vendor-specific *de facto* (opaque and proprietary) standards. The process for designing these IT standards involves a large number of players who appear to "design by committee" (notorious for sub-optimal outcomes [3]). Despite this, many IT standards succeed - they are well designed, widely adopted, and even spawn new firms and industries. The objective of this research is to investigate the IT standard design process. A better understanding can help an organization shape its strategy about its participation in this voluntary process. It can also shed light on how IT design processes can work in the context of large groups where the individual participants may be in active conflict elsewhere in the marketplace. This paper examines the design process for SOAP (Simple Object Access Protocol), developed by the W3C [4] by investigating the proceedings of meetings of the technical working groups [5] through the design, sensemaking and negotiation framework [6]. We describe the outcomes as a precursor to developing a micro-level process theory for designing IT standards.

2 Prior Work

Garud et al [7] define standards as: "codified specifications that detail the form and function of individual components and the rules of engagement among them." This definition emphasizes the role IT standards play in an increasingly connected world: they provide rules for interoperability among devices, systems, and organizations. Moen defines a standard as: "an agreed upon response to a recurring problem, perceived, anticipated or real, that is codified for the purpose of communication" [8]. He emphasizes agreement

among participants as more important than the specification itself. This emphasis is also reflected in the manner in which contemporary IT standards are created [9]. They are no longer *de facto* (e.g. Microsoft Windows) or even *de jure* (e.g. FAA reporting procedures). Instead, IT standards are consensus-based (e.g. XML), created by voluntary consortia. This makes the process of designing an IT standard an important research concern [10-12].

IT standards have a legal structure because they represent a form of regulation covering performances ranging from professional conduct to technical interoperability. OMB Circular A-119 [13] and the Standards Development Organization Advancement Act [14]) clarify the principles governing the formulation of standards e.g. open-ness, a consensus-based approach, and the importance of due process [15]. An alternative perspective that underlies IT standards is their anticipatory nature, which characterizes standards development as similar to new product development [16]. Scholars [17] describe it as cooperative, multi-actor R&D [similar to] collective engineering, where designers create new capabilities. Seen in this manner, the design of IT standards challenges the conventional trajectory (first R&D, then patents, and finally standards). Instead, participants combine individual R&D efforts and existing patents to design the new standards [18].

The IT standards design process is, thus, characterized by the interplay between these two perspectives: (a) one that values due process, participation, and open-ness, and (b) the other that values creativity and technical problem-solving. Organizations like the ISO [19] and the W3C [20] prescribe processes with a stage-gate structure to help technical committees navigate their work. However, these structures cannot account for the reflective and iterative elements inherent in the IT standard design process. Our concern in this research is this descriptive (instead of prescriptive) perspective of the IT standards design process.

3 Conceptualizing the *Design* Process

Scholars (e.g. [21]) have argued that IT standards are artifacts that need to be "designed." Although tautological, the view is important because it emphasizes that standards-making is designing, not simply picking the best from the available alternatives. This view characterizes standards-making as a process of "designing the specification," similar to software engineering [22]. Standards design, then, involves communication among team members through face-to-face or virtual meetings and design specification reviews [23]. Standards design, however, differs from (software) product design because it is designed by members who belong to different organizations who may be competing in the marketplace. Lyytinen et al. [6] suggest a more nuanced perspective, acknowledging this context. Their framework recognizes design as central but complements it with two further components: sense-making and negotiation.

In the DSN framework, the first component, Design [24] describes a cognitive process carried out to solve wicked problems. It includes tasks described as design steps, and strategies such as divide and conquer. This component presupposes substantial technical input from participants and integration of contributed ideas. The second component, Sense-making [25] is the process participants engage in to interpret changes in the environment. It includes predictive sense-making, i.e., attributing meaning to not-yet-

invented technologies by assessing potential benefits or threats. The third component, Negotiation, involves the recruitment of actors to create and sustain a network in which the new technology will be introduced and stabilized [26, 27]. Here, actors bargain the distribution of future outputs to reach an agreement [26]. The DSN Framework [6, 28] integrates the three elements to describe standards development as an emergent, recursive process that reaches closure with the creation of the final specification.

This conceptual move, from a linear, stage-gate model to one that emphasizes cycles and closure holds significant promise. Although early empirical analyses [29] following this framework have not yielded definitive accounts, recent work [6] shows that techniques such as event grammars and process logic [30, 31] hold considerable promise [6]. This desire to contribute further to understand standards design is at the core of our research.

4 Research Method

We study the design of Simple Object Access Protocol (SOAP) [32] over three years. Figure 1 shows the timeline and the data gathered.

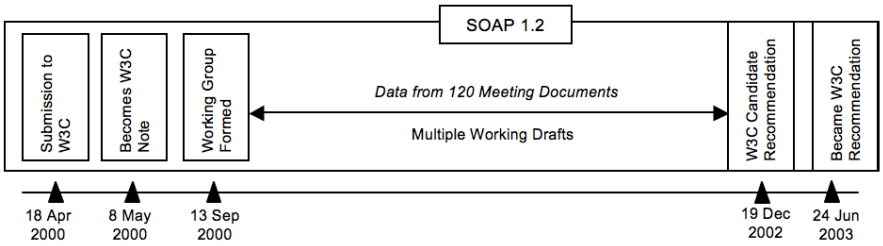


Fig. 1. SOAP standard development: Timeline and Data gathered

The data consists of meeting transcripts from the working group (in-person or remote, one or multiple days). Figure 2 shows the data analysis process.

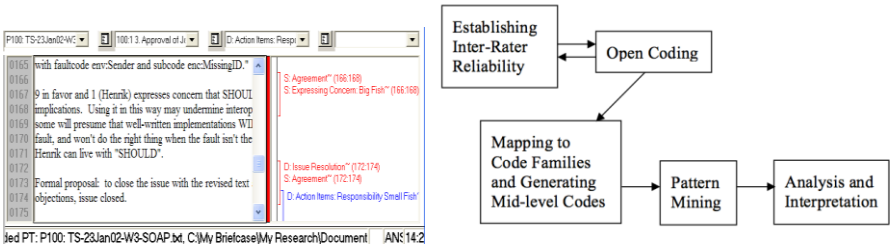


Fig. 2. The Data Analysis Process and an Example

The transcripts capture a precise record, i.e. they provide a faithful account of what transpired during each meeting. They cannot reveal personal agendas, informal communication or any secret caucus results. However, they do provide a rich source of data that has been shown by organizational scientists as valuable in spite of the above caveats

[33]. We used an open coding process to analyze the documents [34, 35]. First, multiple raters delineated and coded text fragments, treating the transcript of each meeting as a distinct unit. Consistency across raters was achieved (81%) via comparison and negotiation, which produced primary codes (98), clustered into mid-level codes (28), and finally mapped to the top-level (3) (see Table 1).

Table 6. Illustrative mid-level codes generated from data coding

Mid-level Code - Description
For code-family: "Design" (12 mid-level codes, examples shown)
- action item to be performed; D3 - voting to select a design alternative
- providing a design alternative; D7 - rejecting a design proposal
For code-family: "Sense-making" (10 mid-level codes, examples shown)
S4 - expressing concern; S5 - expressing confusion and frustration
S8 - expressing individual interests; S10 - questioning a design proposal
For code-family: "Negotiation" (5 mid-level codes, examples shown)
N2 - requesting or assigning participants to address a design issue
N3 - accepting responsibility to address a design issue
Z - behaviors that could not be captured in any code family

The event grammar technique [30] was then used to locate permutations of codes with a customized software program.

5 Findings

The frequencies of binary grammars of the top-level codes (see Table 3) provided first clues about the standardization process (see Figure 3 below).

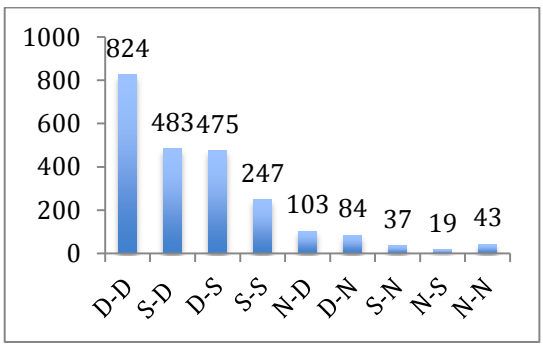


Fig. 3. Frequencies of binary grammars for top-level codes

Even this gross level of analysis shows the intensive design effort (DD grammars), accompanied by the efforts to assess potential design outcomes (SD, DS and SS grammars). Although efforts to recruit partners in future networks were fewer (ND, DN, SN, NS and NN grammars), they point to the mediating role of negotiation. We examined

these further via mid-level codes. For example, the DS grammar (475 occurrences) contains 70 occurrences of D5-S1 (resolving a design issue-followed-expressing agreement). Tables 2 through 4 show these mid-level binary grammars and their interpretation.

Table 7. Selected D-event-initiated binary grammars with mid-level codes

Grammar	Description	Frequency
DD event grammars (Total 824)		
D1-D1	action item to be performed-action item to be performed	219
D1-D5	action item to be performed-resolving a design issue	61
D1-D2	action item to be performed-cooperation for problem solving	47
DD grammars describe how the group works to decompose and specify a solution as well as test and evaluate it. It also demonstrates behaviors such as traversing across abstraction levels [36].		
DS event grammars (Total 475)		
D5-S1	resolving a design issue-expressing agreement	70
D10-S1	suggesting a design alternative-expressing agreement	63
D3-S1	voting to select a design alternative-expressing agreement	57
DS grammars describe how sense-making follows design, e.g. by justifying design feature [6]; evaluating use scenarios [37]; and imagining new contexts for using technology [38].		
DN event grammars (Total 84)		
D8-N5	reporting progress on action items-discussion of w3c process	15
D1-N3	action item to be performed-accepting responsibility to address a design issue	13
The DN grammars aim at creating or restricting networks of participants, e.g. by compromising between designs, and reaching final agreement on designs [21].		

Table 8. Selected S-event-initiated binary grammars with mid-level codes

Grammar	Description	Frequency
SD event grammars (Total 483)		
S1-D1	expressing agreement-action item to be performed	155
S7-D10	raising a design issue-suggesting a design alternative	54
S1-D5	expressing agreement-resolving a design issue	32
S1-D10	expressing agreement-suggesting a design alternative	31
SD grammars signal a return to design considerations after an attempt to reach agreement on a particular issue [21].		
SS event grammars (Total 247)		
S1-S1	expressing agreement-expressing agreement	20
S7-S1	raising a design issue-expressing agreement	23
S1-S7	expressing agreement-raising a design issue	26
S6-S7	discussion on design issues-raising a design issue	20
SS grammars describe the behaviors as they attempts to reach agreement about a design issue, e.g. by using scenarios to trigger sense-making [39].		
SN event grammars (Total 37)		

S1-N5	expressing agreement-discussion of w3c process	6
S1-N2	expressing agreement-assigning participants to address a design issue	5
SN grammars describe actions that lead to a new design cycles by turning to new issues or assigning responsibilities to smaller groups or by changing context to negotiate options [40].		

Table 9. Selected N-event-initiated binary grammars with mid-level codes

Grammar	Description	Frequency
ND event grammars (Total 103)		
N5-D8	discussion on w3c process-reporting progress on action items	35
N5-D1	discussion on w3c process-action item to be performed	21
N3-D1	accepting the responsibility to address a design issue-action item to be performed	11
ND grammars suggest moving from closure on an issue to the next design cycle, including the search for a negotiated solution, or a solution to counter an existing solution [7, 39].		
NS event grammars (Total 19)		
N5-S1	discussion on w3c process-expressing agreement	4
NS grammars capture a possible closure on a recursive cycle [6] by engaging in predictive sense-making [7] including attempts to make sense of technology evolution.		
NN Grammars (Total 43)		
N2-N3	requesting or assigning participants to address a design issue-accepting responsibility to address a design issue	13
NN grammars elaborate how participants may be co-opted into a network, manifested as negotiation rules [21], actor composition [7, 38] and entering into new negotiation cycles after disagreement.		

We are investigating additional analyses with longer grammars at this time. The first set (tables 2-4 above) provide a glimpse into possible interpretations that our (confirmatory and exploratory) analyses are likely to provide.

6 Implications and Next Steps

This paper contributes to research on standards design by providing initial findings about activity patterns during design. Our work builds on the DSN framework from prior research. Studies like ours can be undertaken to identify core vocabulary that can complement design science efforts. The efforts in this paper are meant to provide such a bridge, to contribute design theories for new classes.

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Practice-Based Personas: Integrated User and Practice Models

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Abstract. Practices are routinised behaviours with social and material components and complex relationships over space and time. Practice-based design goes beyond interaction design to consider how these components and their relationships impact on the formation and enactment of a practice, where technology is just one part of the practice. Though situated user-centred design methods such as participatory design are employed for the design of practice, demand exists for additional methods and tools in this area. This paper introduces practice-based personas as an extension of the persona approach popular in interaction design, and demonstrates how a set of practice-based personas was developed for a given domain – academic practice. The three practice-based personas developed here are linked to a catalogue of forty practices, offering designers both a user perspective and a practice perspective when designing for the domain.

Keywords: Practice-oriented design, practices, personas

1 Introduction

Practice-based approaches to the design of software systems have attracted increased attention in the fields of information systems [1], human-computer interaction (HCI) [2], [3] and computer-supported collaborative work (CSCW) [4], [5] over the past decade. These approaches go beyond designing for human interaction with a software artefact, to consider instead how the human, the software and multiple other actors contribute to the formation of a *way of doing* something. The interest in designing for practice follows the so-called *turn to practice* in the social sciences [6] and in studies of technology [7]. This approach decentres the human and assumes an analytical symmetry between the social and material components of the practice, arguing that such components are *constitutively entangled* in the formation of practice [8].

Kuutti and Bannon [2] distinguish between the *interaction paradigm* and the *practice paradigm* in HCI research and call for a formal practice based research agenda, proposing that the development of methodological tools and guidelines is the next step. Such tools should facilitate the observation and modelling of practice and the envisioning of future performances of practice as part of a creative process. As such, the tools and methodologies currently most popular for practice-based design involve ongoing interaction with human actors in natural settings, typically under the banner of participatory design or action research (see [4] for example). Ongoing engagement with users

throughout a design process is potentially expensive and often infeasible. Within the interaction paradigm, personas [9] have been adopted in some quarters as a way of addressing this cost. Personas are rich, data driven characters developed through user research. Well-developed personas can provide designers with user models to whom they can relate on a human level and for whom they can better predict behaviour in future scenarios, akin to characters in a book or movie.

This paper explores the requirements for adapting personas to the practice paradigm. While lacking in a formal definition, a practice based approach to design must consider a broad set of relationships that exist across space and time between humans, technology, material, meaning, and other co-existent practices. Practices are particular ways of doing things shared by practitioners who collectively create and respond to the *meaning* of the practice. A practice is not formed or performed by a single individual independently of a broad set of relationships, so the modelling of a practice requires more than the modelling of the individual, and thus requires an extension of the single-character persona approach.

This paper introduces *practice-based personas* as a tool for software design teams. Practice-based personas are developed by modelling the practices in a given domain and examining the bundling or clustering of practices by individual practitioners to form user models. Practice-based personas can potentially provide a means of switching between a *user perspective* – from which the benefits of the persona approach such as human empathy and envisioning of future behaviour can be embraced, and a *practice perspective* – from which the elements of social and historical motivation, the role of material and technology, and variation in performance can be explored.

The development of practice-based personas is demonstrated through the modelling of practices and practitioners in a given domain - academic practice. 150 lecturers in a higher education institute in Ireland were surveyed using a questionnaire with qualitative and quantitative components, and a further six lecturers were interviewed for a total of six hours. The data collected from this exercise was used to develop the first version of a practice catalogue for the domain under study, with forty separate practices identified for inclusion according to criteria set out in this paper. Each entry in the catalogue is documented according to its *description*, *meaning* (the reason for the existence of the practice), *material* (the things and technology that are needed for the practice) and *competence* (human skills and abilities) components, as well as its *career* (its history and relationship to other practices) and *variation* (differences in performance among practitioners and/or over time). This follows Shove et al's [10], [11] model of social practice which has been applied previously in HCI [12] and for the practice-oriented design of products [13].

The populated practice catalogue was used as a starting point for the development of the practice-based personas. These emerged from a clustering process which explored the performance of sets of practices by the survey respondents and interviewees. The study resulted in three personas, identified for the purpose of this paper as *traditional educator*, *fundamental educational technologist*, and *advanced educational technologist*.

By providing both a practice and a user perspective, practice-based personas have the potential to support the "*operationalization of practice-orientation in design projects*", as called for by practice-oriented product designers [14], designers of information systems [15] and interaction designers [2]. Practice-based personas, like Cooper's personas

[9], [16] are generative tools that provide the designer with a way to creatively envision future enactments of practice. As Pruitt and Grundin put it "*Well-crafted Personas are generative: Once fully engaged with them, you can almost effortlessly project them into new situations.*" [17].

2 Practices

Practices are routinized behaviours with social and material, or technological, components. They are carried out by different people at different times in different places while remaining essentially the same as entities for long periods of time. Schatzki describes practices as "*a temporally and spatially dispersed nexus of doing things*" [6]. Reckwitz's widely used definition of practice defines them as "*a routinized type of behaviour which consists of several elements interconnected to one other*" [18]. Shove et al [11] identify these interconnected elements of practice as *meaning*, *competence* and *material*, with all three required to be present at the moment of doing for the enactment of the practice. *Meaning*, in this context, refers to the motivation for the practice – the shared understanding among practitioners of the reason why the practice exists. *Competence* refers to the skills, knowledge and abilities required by practitioners for the enactment of the practice. *Material* identifies the tangible entities – technological and otherwise – which form part of the practice. Practices, in Shove et al's model, possess *careers* which trace how practices-as-entities have evolved over time when repeatedly enacted by practitioners.

Bjorn and Osterlund [15] argue that practices are not designed but instead emerge from the enactment of their components. Their proposed *sociomaterial design* looks to design the components of practice, in particular the material components, to influence the emergent practice. This mirrors what Shove et al [10] describe as the "*indirect but potentially decisive hand in the constitution of what people do*".

Following Shove et al's model [11], our approach to cataloguing practices requires the identification of the following elements from the data collected form users:

- **Meaning**: What motivates enactment of this practice?
- **Material**: What material components are required for enactment of the practice?
- **Competences**: What skills and abilities are required for enactment of the practice?
- **Career**: How has the practice evolved, what has it replaced, why and how?
- **Variation**: Under what conditions does the practice vary when performed?

A practice catalogue is a collection of practices documented along these dimensions, accompanied by an illustrative narrative describing enactments of the practice, following the narrative approaches of Cooper et al [16]. In deciding whether a particular activity, routine or behaviour evident in the data represents a practice, the following filtering rules are applied:

- **Blackboxed**: Is this an atomic, recognisable, namable, practical entity?
- **Routine**: Has this been routinized? Is it repeated over time?
- **Recruitment**: Do several people perform this practice?
- **Meaning**: Does this practice have recognizable reasons to be performed?

- **Formation**: Would the practice be unformed by the disappearance of components?

There is a need, as Kuijer puts it, to "*operationalise a practice-orientation in design projects*" [14]. This, they argue, requires tools and methodologies, a point echoed by Kuutti and Bannon [2] in their research agenda for the practice paradigm in HCI. Such tools may include the *design fictions* of Wakkary et al [12], the *design case studies* of Wulf et al [4] and the *generative improv performances* of Kuijer et al [19], or a variation on the personas of Cooper et al, as argued for here.

3 Practice-Based Personas

Personas were introduced to the design community by Cooper et al [9] as a means to provide a "*precise description of our user and what he wishes to accomplish*". A persona is a named, composite, artificial user whose goals, motivations and other attributes are derived from ethnographic data collected from the user population. The persona is presented as an individual in order to encourage designers to develop a connection and empathy with the user, supporting designers as they envision future usage scenarios for the user with their product. Pruitt and Grundin [17] describe the use of personas in design processes in their organisation, highlighting how their personas are rigorously communicated throughout the design team and integrated throughout the design process. They relate personas to the creative aspect of design by showing how personas enhance the designer's ability to predict future behaviour.

Personas have been employed to model interaction with a particular product (see for example [20]–[23]), as per Cooper's goal-directed design methodology [16] and also to model users in a particular domain (see for example [24]–[27]). Criticisms often relate to their misapplication [28], for example, where they represent the only user centred aspect to a design project [20], [29], where they are only developed to address interface issues [21], or where they are superficial or stereotypical representations of users [30], [31]. Other criticisms of the persona approach include criticism of qualitiative data collection in general, and a perception that the use of personas mean that designers will never interact with real users [26], [32]. Bødker and Klokmose [33] introduced the *techsona* as an extension of the persona because they felt that personas alone did not sufficiently represent the material aspects of an interaction. Others have criticized personas for being too informally specified [34]. Faily et al [35] consider that personas are insufficient of their own to represent fully the tacit elements of a practice, describing them as "*problematic when accounting for hidden behaviours not obvious from their descriptions alone*".

Practice-based-personas are user models developed from the catalogue of practices documented for a given domain, rather than from simple behavioural patterns and goals. By mapping practices to users and identifying clusters, collections of practices are built up at successively higher levels. When no further clustering is possible, the final clusters are developed as practice-based-personas, each defined by their practices, including the meaning, competence, material and other elements that constitute the practice. Selected personas can then be integrated into the design process as design targets, with the design team enabled to study the entanglements between their various practices, and how the meaning, competence and material components of those practices currently influence, and can potentially further influence, each other.

4 Demonstration

The demonstration presented here illustrates the development of a practice catalogue and practice-based personas to model the use of technology by lecturers in an academic working environment. User research was undertaken through a survey of academic staff in a third level institution and in-depth ethnographic interviews of six academic staff in the same institution. The survey explored the use of technology and its role in the formation of academic practice. The survey questionnaire was completed by 150 academic staff across 10 disciplinary areas, age groups from 20s to 60s, experience from 1 to 32 years and technology experience levels from newcomer to expert. The interview was based on Spradley's ethnographic interview approach [40].

In the first stage of the analysis, the transcripts of the six interviews and all data returned in answer to the open ended questions in the survey were coded line by line. This resulted in the identification of 465 separately coded processes which were engaged in by the interviewees and respondents, including for example: *looking things up*, *emailing students*, *reading journal papers*, *keeping notes*, *publishing marks*, *supervising*, *finding own files*, *managing time*. The following five categories of practice emerged from the further analysis of these processes: *communicating*; *collaborating and sharing*; *managing teaching, learning and assessment activity*; *sourcing and managing knowledge*; and *organising self*. Data initially coded to the processes in each of the categories were revisited, leading to the identification of potential practices in each category. Using the filtering rules introduced in section 2 above, 40 separate practices were identified which were each shared across significant numbers of individuals from the 156 interviewees and respondents. Each of the practices were catalogued as described in section 2. The full set is as follows:

- Communicating (5): exchanging-individual-email, group-emailing, posting-on-social-media-and-blogs, exch-messages-through-vle, comm-using-phone
- Collaborating and sharing (5): sharing-cloud-based-resources, sharing-wiki-resources, sharing-real-time-online-sessions, writing-documents-on-computer, exchanging-change-tracked-documents
- Managing teaching, learning and assessment activity (11): tracking-student-performance-and-engagement-with-technology, providing-student-feedback-online, providing-student-feedback-by-email, designing-and-developing-learning-activities-and-materials-using-software-tools, developing-and-administering-online-assessment, developing-and-delivering-rich-media, distributing-learning-materials-online, distributing-learning-materials-by-email, presenting-and-facilitating-in-class-with-technology, facilitating-out-of-class-activity-with-online-resources, tutoring-and-guiding-students-through-electronic-communication
- Sourcing and managing knowledge (7): recording-ref-in-databases, rec-live-data-using-mobile-device, sourcing-publ-online, sourcing-mat-online, taking-online-training-and-courses-and-webinars, conducting-online-res, exploring-technologies
- Organising self (12): organising-files-on-cloud-space, back-up-files-on-hardware, developing-organised-folder-system, automatically-synchronising-multiple-devices, manually-synchronising-multiple-devices, managing-home-work-environment, re-

motely-access-work-resources, managing-email, loc-res-from-email, keeping-notes-for-self, using- calendar, using- to-do-list-and-reminders

Practices in each category were clustered by analyzing each of the 156 interviewees and respondents and clustering their practices by applying the K-Means algorithm. Clusters at that level represent types of persona but only for a given category of practice. They do not, for example, capture the relationship between communication practices and teaching practices. The clusters for each of the five categories are provided below. Each of the 14 clusters listed represents a distinct collection of practices in that category for which there is evidence in the data.

- Communicating: multi-m. communicator, vle communicator, trad. communicator
- Collaborating and sharing: multi-m. collaborator, cloud collab., document collab.
- Managing teaching, learning and assessment activity: learning author, learning administrator, learning enabler
- Sourcing and managing knowledge: online searcher, research locator, re-searcher
- Organising self: proactive resource manager, file manager

In the final step the personas are developed. Each persona is a top level user model who embodies practices in each of the identified categories. The K-Means algorithm and further analysis were again employed to cluster users according to which of the clusters for each of the five categories represented their practice in that category. The three personas which emerged had the following profile across the five categories:

- **Traditional Educator**: traditional communicator, document collaborator, learning author, research locator, file manager
- **Fundamental Educational Technologist**: vle communicator / traditional comm., cloud collab., learning administrator, re-search locator, proactive resource manager
- **Advanced Educational Technologist**: vle communicator / multi-media communicator, multi-media collaborator / cloud collaborator, learning administrator / learning enabler, online searcher, proactive re-source manager

5 Summary and Future Work

This work introduces *practice-oriented personas*, the *practice catalogue* and a demonstration of the development of both. It additionally describes the development of *practice-oriented personas* for a given domain – academic practitioners and their use of technology. This paper presents a typology of practices and users for the domain being studied and demonstrates how these can be linked, documented and have the potential to be used as part of the design process.

Each of the three personas developed here can be linked to their constituent practices at successive levels, providing the designer with an opportunity to understand the persona through the accumulated characteristics collected from their practices, and to understand a given practice at the moment of design. The next stage of this research is to engage the practice and persona models in design activities whereby, for example, opportunities will be sought for existing collaboration practices to influence the development

of knowledge sharing practices, and existing teaching practices are redesigned through their material components in the context of co-occurring practices. The personas provide an accurate view of the co-occurring practices for given user types. The practice models provide an accurate view of the material, meaning and competence components of the practice. Both views are grounded in data.

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Planning a Portfolio of Controls for Software Development

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Abstract. A growing number of software development projects successfully exhibit a mix of agile and traditional software development methodologies. Many of these mixed methodologies are organization specific and tailored to a specific project. Our objective in this research-in-progress paper is to develop an artifact that can guide the development of such a mixed methodology. Using control theory, we design a process model that provides theoretical guidance to build a portfolio of controls that can support the development of a mixed methodology for software development. Controls, embedded in methods, provide a generalizable and adaptable framework for project managers to develop their mixed methodology specific to the demands of the project. A research methodology is proposed to test the model. Finally, future directions and contributions are discussed.

Keywords: Control theory, Portfolio of controls, Method engineering, Design science

1 Introduction

Increasingly, software development teams want control and flexibility to co-exist in their development process. Such a controlled-flexible approach allows them to handle uncertainty in market and produce a better market-product match [1]. A recent industry trend report [2] on enterprise software quality reports that a mix of Agile and Waterfall (plan-driven) methods produces higher structural quality for business critical applications than either Agile or Waterfall methods alone. Similarly, Baskerville, Heje-Pries and Madsen [3] note that companies are successfully combining agile and plan-driven approaches, consolidating the lessons learnt, and developing an organizational software development process. Such an organizational development process can then be tailored to specific projects to meet project goals.

A mixed methodology is desirable for software development teams because they find that adhering to a specific software development approach may not provide an adequate fit to the project needs. For example, within agile methods, Fitzgerald, Hartnett and Conboy [4] combine extreme programming (XP) and Scrum to develop an effective software development methodology. They select 6 existing XP practices out of 12, based on their applicability to the project environment. These 6 XP practices are then supplemented with 6 practices from the Scrum methodology. The rationale behind such a com-

bination is that XP provides support for technical aspects whereas Scrum provides better support for planning and tracking for the projects progress.

In this research-in-progress paper, we aim to provide theoretical guidance on developing a mixed methodology that is tailored for a specific project. The key focus is a portfolio of controls that is initially developed based on the critical factors found in the project [5]. Controls, which are embedded in method fragments, are used to identify method fragments to develop the methodology. The focus of this manuscript, then, is to describe our research-in-progress on designing an artifact that provides guidance and understanding of controls needed to build a mixed methodology. Our goal is to improve current practices in developing mixed methods for software development, as positioned in design science research [6]. In the following sections we explore related literature, provide an example of mixed methodology development, develop our design artifact, propose a research methodology to evaluate that artifact, and discuss future work and contributions of our research.

2 Tailoring a Software Development Method

Traditionally, two method-tailoring (situational methodology) approaches have been employed to develop organization-wide and project-specific methodologies from existing methods: *contingency factors* and *method engineering* [4, 7]. Both emphasize that method-tailoring is driven by critical factors in the project and organizational context. Proposed by Davis [8], *contingency factors* require the development team to analyze the project environment (source of contingency). Upon analyzing the project environment, the project team would then identify critical contingency factors. Based on the identified contingency factors, methods of software development are compared that are available in an organizational repository of methods. Typically, organizational repository of methods is a function of successful prior utilization of methods. Based on the analysis and identification of a suitable fit, the methodology is chosen for software development, and is tailored to the project specific environment [4].

Method engineering [9] involves developing a software development methodology using method fragments from existing methodologies that are present in the organizational repository of methods [10]. Based on the project performance, an organizational method repository is continually updated with new method fragments. An important decision point in method engineering is the concept of situation specific selection of method fragments [10], where method fragments are replaced or added to the existing method based on particular situations that arise during project execution. The selection of method fragments is based on contingencies, similar to the previous approach.

Project teams face multiple challenges while employing contingency factors and method engineering approaches. First, these approaches advance an organization-specific development approach that can be challenging in situations where multiple organizations are involved. Distributed or culturally diverse teams can find it challenging to adapt to tailored methodologies. Second, these approaches to methodology development do not provide practical risk-benefit analysis of adding, substituting, deleting, and combining methods from different methodologies. Third, much rests on the project manager's experience about how the methodology can be tailored to situation specific needs. Finally,

these approaches lack formal theory to describe how the selected method achieves a balance between control and flexibility [1].

3 Control Theory

A central responsibility of any manager is to exercise control over employees and organizational activities. Control theory [11-13] explains different control modes available to managers, including project managers. It provides the lens that guides the development of a project-specific methodology. Control modes are categorized into two types: *formal* and *informal*. Formal modes of controls are viewed as performance rewarding strategies by the management [14, 15]. In formal control mode, the management specifies a goal and reward for the team upon completion of the project goal.

Two forms of formal control are outcome control and behavior control. *Outcome control* specifies establishing prior set of goals and determining reward levels based on the extent to which established goals have been accomplished. For example, specified software load time is a system goal. If such a load time is consistently achieved, the software team has met the outcome goal and can be rewarded based on a pre-specified contract. *Behavior control* specifies adherence to established processes that software development teams should follow in order to achieve the outcome goals. In such a control mode, management's emphasis is on observing team's behavior. For example, presence in daily Scrum meetings is expected from team members so that information can be shared.

In contrast to formal modes of control an informal mode of control relies on a social strategy to achieve the goal of aligning organizational and employee goals. Two forms of informal control are clan control and self-control. *Clan control* relies on the team to foster a unique set of rules, applying to all, that help in achieving the common goal for the team. Management has limited leverage on such a control since it is loosely coupled from the organization goals and is highly influenced by interactions within the team. S*elf-control* emphasizes individual autonomy to achieve goals set by the individual. In a software development team, individuals are required to be creative and govern their own individual processes to meet deadlines [16]. In professional settings like software development informal modes of control are also influenced by developers' education and socialization to the profession.

In order to extend Control Theory to handle situations with high risk and uncertainty, Harris, Collins and Hevner [1] propose a new mode of control: emergent outcome control (EOC). They identify two EOC mechanisms. *Scope boundaries* limit the feasible solution such that the development team has the flexibility to explore but is constrained within a boundary. However, the project team is unconstrained within the boundaries thereby maintaining creativity. *Ongoing feedback* is provided to the team, from users, or the market, to steer development so that specifications are closely met. For example, feedback can be provided to the team via meetings, documentation, user reviews, or market orientation. Such feedback allows them to adjust their development to specific needs of the market and achieve their goal.

Project managers employ *control mechanisms* to implement control modes [15, 17]. For example, delivering a working prototype every 2 weeks implements outcome control

by specifying a target for every development cycle. Also, it implements behavioral control by providing a sense of urgency within the team. In a software development project, control mechanisms are embedded in method fragments [18].

Kirsch [15] posits that construction of a portfolio of controls is driven by four influencing factors: availability of pre-existing mechanisms, task characteristics, role expectations, and project-related knowledge and skills. This critical factor focus is congruent with the contingency theory and methods engineering approaches to selecting project methods. However, there are three limitations with this approach. First, the approach is highly biased towards selecting preexisting mechanisms without any analysis of their aptness to the project. Second, the approach does not focus on what controls are needed for the successful completion of the project. Rather, the approach is focused on factors that aim to fit existing controls to project needs. Finally, as the project unfolds, Kirsch [19] attributes changes in the configuration of portfolio of controls, across project phases, to the influencing factors, but does not explain how project teams can proactively change the configuration to steer project development towards its goal.

Thus, there is still a gap in our understanding about which controls should be included in the initial portfolio of controls, and how the portfolio should be manipulated over the execution of the project to best adapt to change. Addressing the first gap here, we now discuss our process model to develop an initial portfolio of controls.

4 Designing a Portfolio of Controls

Figure 1 describes our work-to-date on a process model for developing a portfolio of project controls. Initially, the project manager should analyze the project needs for control, based on the critical factors in the context. Boehm and Turner [5] provide five critical factors to analyze a project's needs for its suitability to plan-driven or agile approach: size (number of personnel), criticality (loss due to impact of defects), level of skilled personnel, dynamism (change in requirements), and the culture (people feel comfortable under chaos or order). Three of these factors overlap with Kirsch's influencing factors of *project-related knowledge and skills* and *role expectations* (size, level of skilled personnel and culture). An influencing factor to add to Boehm and Turner's factor set is *task characteristics*. Analyzing the project on the resulting six critical factors using a polar graph [5], the project manager can identify needed controls to accomplish the project goal.

Based on the analysis using critical factors, the project team selects desired control modes and mechanisms (controls) from the controls base. The control base is the repository of control modes and mechanisms available to the project manager. At this point, the selection of controls is completely based on the desired outcomes envisioned by the project manager. Selection of desired controls is due to the high temporal distance between the present state of the project and the project goal. For example, in Intel Shannon [4], the development team had formed a cohesive group over many years of working together. For such a project, relying primarily on informal controls while supplementing it with formal controls would maintain the comradery and cohesion, and help attain the project goal.

Following the initial selection of controls, the project manager then selects method fragments from the methods base [9]. The selection of method fragments is governed by desirability of the method fragment and the extent to which the method fragment embeds the control mechanisms identified.

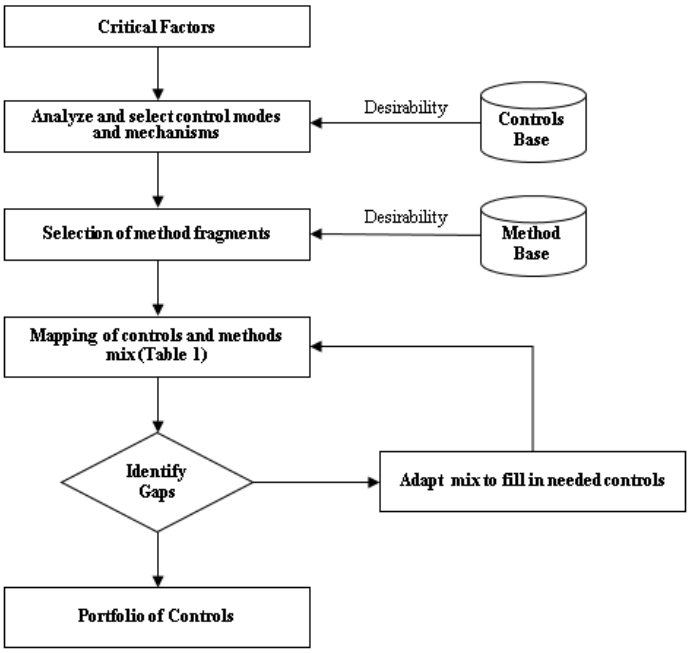


Figure 1. Process Model for a Portfolio of Controls

After selecting the required method fragments that embed the desired control mechanisms, the project manager should conduct a mapping analysis of needed controls versus support available for them via method fragments. Table 1 demonstrates such an analysis using Intel Shannon as the example [4]. Note that we have not included all method fragments and control mechanisms due to space constraints. Columns represent the required control modes. Rows represent method fragments which are selected to support the control modes. Mapping of controls and supporting method fragments reveals high reliance on informal control modes in the selected methods. Though such a portfolio is beneficial based on the cohesive group, inclusion of formal controls will allow the project manager to provide product demos and delivery dates to the customer. After identifying such a gap in control-method mapping, the project team can add appropriate method fragments to fill those gaps. During instances where appropriate method fragments are not available, the project manager can adapt existing control mechanisms to fill those gaps. For example, *on-site customer* method fragment was not feasible for the Intel Shannon team. They can adapt the *post-game closure* fragment to incorporate customer feedback after every sprint.

Table 1. Mapping Controls and Method Fragments (constructed from [4])

Method Fragments	**Control Modes**					
	Outcome Controls	**Behavioral Controls**	**Clan Controls**	**Self-Controls**	**Scope Boundaries**	**Ongoing Feedback**
Pair Programming		Work together	Activities transparent to team members			New ideas tested with partner
Testing				Provides feedback On required work	Development bounded by test constraints	
Post-Game Closure	Specify completes and incompletes at the end of each sprint					Progress visible
Scrum Sprints	Specify sprint outcomes at the start					

5 Future Research Directions and Contributions

Our on-going research plan is to first validate the process model design in Figure 1. In the selection of the portfolio of controls, we need to: (1) determine if the six critical factors set is both accurate and reasonably complete, (2) understand the processes of analyzing the need for controls and the selection of method fragments, and (3) develop the mapping of controls and methods. In addition we need to understand how the role of a need for flexibility is balanced against control in this process. Our goal is to design a model that is prescriptive in nature. Interviews with project managers that have experience in developing mixed approaches for software development will provide rich data for model evaluation. Organizations that have a specified organizational-methodology and allow managers to customize it based on the project would be ideal places for conducting interviews. Also, projects with multi-organizational or multi-cultural involvement provide additional testing areas for our process model.

This project provides multiple avenues for future research. The research proposed in this paper supports the planning stage of a software development project. Our future directions will develop a similar process model that adapts the initial control portfolio to the changes found while executing the project. Specifically, we will draw upon Construal-Level Theory [20] which argues that objects that are at a higher temporal distance are perceived as abstract concepts, whereas objects with lower temporal distance are perceived as concrete concepts. Evaluation of a decision alternative for an abstract concept tends to focus on a holistic and desired view for the object. On the other hand, evaluation of a decision alternative for a concrete concept tends to focus on feasibility and precise view of the object. Desirable alternatives are the long-term ideal actions that are coveted

at the outset when temporal distance between the decision and the goal is greater. Feasible alternatives, on the other hand, are the short-term actions that are required to attain the desired goal which is temporally close. With increasing temporal distance, desirable alternatives are preferred over feasible alternatives. Conversely, decreasing temporal distance to the goal leads to greater acceptance of feasible alternatives [21]. For example, Liberman and Trope [22] find empirical evidence for student's preference for a desirable (interesting) assignment over feasible (simple) assignment as a choice over distant future. In software development projects, the initial portfolio of controls consists of desirable control modes since the project goal is at a higher temporal distance. However, as the project is being performed and the project goal is at a lower temporal distance, project characteristics change over time. This requires changes in the control portfolio that can adjust to the changing project characteristics. With decreasing temporal distance, desirable controls are replaced by feasible controls to attain the project goal. Thus, it is important to identify the conditions under which method fragments need to be added, deleted, or replaced with other fragments over time. In addition, the impacts of adverse situations like time or budget pressure on portfolio of controls and possible mitigating strategies are other important areas that need further research.

Adhering to a single software development approach is increasingly challenging when project characteristics and market needs change [9]. We have presented our artifact as a model that guides the process of constructing an initial portfolio of controls. The application area for our model is the development of mixed methodology but with guidance of using controls as the driving force rather than methods fragments themselves. Further, our process model provides a risk-benefit analysis for project manager that can be used to develop mixed methodologies. We have also proposed a research methodology to evaluate our process model that will serve as an evaluation mechanism.

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ITSM ProcessGuide – A Longitudinal and Multi-Method Field Study for Real-World DSR Artifact Evaluation

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Abstract. Process guidance supports users to increase their process model understanding, process execution effectiveness as well as efficiency, and process compliance performance. This paper presents a research in progress encompassing our ongoing DSR project on Process Guidance Systems and a field evaluation of the resulting artifact in cooperation with a company. Building on three theory-grounded design principles, a Process Guidance System artifact for the company's IT service ticketing process is developed, deployed and used. Following a multi-method approach, we plan to evaluate the artifact in a longitudinal field study. Thereby, we will not only gather self-reported but also real usage data. This article describes the development of the artifact and discusses an innovative evaluation approach.

Keywords: Process guidance, Longitudinal field study, Multi-method evaluation, Design science research

1 Introduction

Design Science Research (DSR) is about solving a problem by designing and evaluating a possible solution iteratively. In his work, Hevner [1] proposes the three cycle view on DSR in order to address the research problem from (1) a practical, (2) a theoretical, and (3) a design perspective. Within the design process, the solution of a research problem should base on theoretical findings – referred to as kernel theories [2]. Existing (research) knowledge should be leveraged in order to propose a solution to the given problem and to increase the rigor of the solution [1]. In addition, the designed solution should be evaluated to demonstrate its feasibility. The real world can and should be included in this process improving the relevance of the design process [1]. Thus, DSR has the capability to connect researchers and practitioners in order to solve problems from two distinct perspectives: the practical and theoretical perspective [1].

Looking at existing research, one can observe a rare communication of multiple iterations of a design. Moreover, the evaluation in a real-world setting improving the relevance, is done scarcely [3]. In line with Hevner [1] and Peffers et al. [3], we believe DSR should ultimately attempt to solve a problem having practical and theoretical relevance. Thus, an evaluation in a real-world environment is an important necessity.

In this paper, we present our ongoing DSR project addressing the concept of process guidance. Thereby, the overall DSR project follows the suggestions by Kuechler and Vaishnavi [2] and is divided into three design cycles – each of them having an evaluation stage. The results of the first cycle base on the one hand on theoretical findings already existing in research and on the other hand on a qualitative interview study conducted with experts. In the second cycle, we adapted the design principles and evaluated the resulting artifact by conducting a laboratory experiment having high internal, but only low external validity [4]. While in the first cycle, our case company served as input for the problem analysis and the evaluation of the artifact design, in the second cycle undergraduate and graduate students have been employed to evaluate the validity of our design principles. In the third cycle, a new artifact will be evaluated again by engaging employees of our case company in order to provide feedback on the artifact as proposed by Peffers et al. [3]. Thereby, the evaluation of the third cycle bases on the framework for explanation use by Dhaliwal and Benbasat [5] as theoretical foundation. In addition, the artifact is used to solve existing challenges in the case company.

Summarizing, in this paper we briefly report our research results of the first two cycles and present the planned evaluation of the third cycle in more detail. By reporting our research results and planned activities, the article contributes to the DSR as well as Information Systems (IS) community. First, the article contributes to research since it applies the explanation use framework in a real-world environment for the context of process guidance. To our knowledge, such an application of Dhaliwal and Benbasat's [5] framework in the process guidance context is the first attempt to evaluate the effects of process guidance in a real-world setting. Second, our research aims to develop a design theory [6] for the class of Process Guidance Systems – which is at the moment missing in the current body of knowledge. Third, the presented DSR project serves as an example describing how to conduct a DSR project in a case company in order to improve the relevance of the research. The remainder of the paper is structured as following. First we present our DSR project and shortly summarize the first two cycles. Next, the ITSM ProcessGuide design and development is discussed. Subsequently, we introduce the multi-method evaluation approach before we conclude the paper.

2 The DSR Project Process Guidance

Process guidance supports users in increasing their process model understanding, process execution effectiveness as well as efficiency, and process compliance performance. Users are supported in their process execution by visualizing the process model and the provision of additional information as well as explanations about the process. Building on existing research addressing the concept of guidance in IS research (decisional guidance [7], explanations [8], and decision aids [9]), our research project aims to design a Process Guidance System (PGS) enabling its users to execute the processes properly and thereby increase their process execution effectiveness and efficiency, process model understanding, and thus their process compliance performance. Overall, our research is guided by the following research question:

Which design principles of process guidance systems increase the users' process compliance performance?

In order to ensure not only high theoretical but also high practical relevance, we conducted the entire research project in collaboration with an industry partner which also serves as our case company. Our industry partner is a global supplier, development, and service partner for customers in various sectors such as automotive, civil aviation, and engineering. In 2013, the case company employed 13.301 employees and had sales of more than 1.7 billion €. The company provided input for various activities in all three cycles and supported us in the evaluation of the research outcomes.

The research project described in this paper follows the DSR methodology as proposed by Kuechler and Vaishnavi [2] and is divided into three cycles. **Fig. 8** depicts the three design cycles with the respective activities within each cycle. While the activities of cycle one and two are already completed, the third cycle is highlighted as the current cycle reported in this paper.

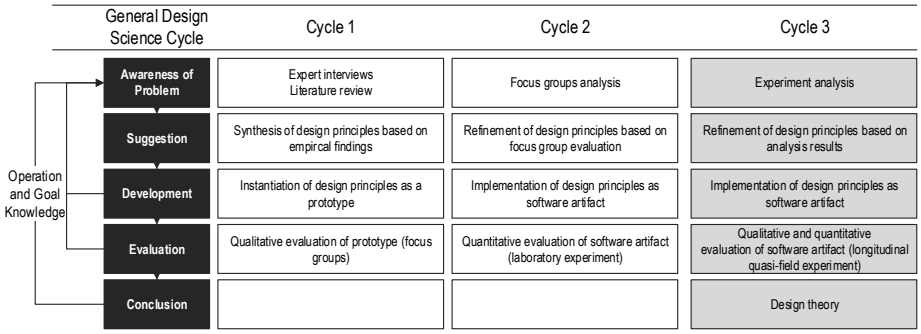


Fig. 8. DSR project's design cycles

In the **first cycle**, we analyzed the current situation in our case company with respect to the execution of document-related processes [10]. The conducted expert interviews revealed that the employees have difficulties in executing processes according to their definitions as well as suffer from a lack of understanding the underlying process models. In particular, one of the interviewees requested some *"...guidance, claiming the system which needs to be used in a particular business process step"* [10, p. 497]. Such guidance should aim to support the users in their process execution. Building on an extensive literature review on guidance in IS research [11], we propose the concept of process guidance to support users' in increasing their process model understanding,process execution effectiveness as well as efficiency, and process compliance performance. Thereby, we identified three theory-grounded design principles for PGS identified within existing guidance literature in IS research [7–9]. The design principles have been qualitatively evaluated in a series of expert interviews being employees of the case company [12]. **Table 10** lists the three design principles of PGS.

The **second cycle** mainly aimed at the adaption of the first cycle's results in order to refine the design principles. For the evaluation of the design principles, we realized a PGS prototype by identifying design decisions being appropriate to fulfill the design principles. Therefore, we again intensively studied existing literature. Since the evaluation is conducted as a laboratory experiment with 92 undergraduate and 28 graduate students from a German public university, we adapted the context of the prototype to the

ticketing process of our case company. To apply the concept of process guidance in a quasi-real case situation, we developed simplified versions of the applications used within the case company's ticketing process for the experiment. In order to prepare the students, the experiment participants received an introduction session to the company's ticketing process by an employee of the case company before the experiment. Within the experiment, the participants had to execute eight processes. Thereby, some of the participants received guidance, while others did not. In total, the laboratory experiment revealed that in particular novices can benefit from additional explanations since they have only little process knowledge. Providing additional explanations supports novices to understand the process model and increase their process execution effectiveness and efficiency. In addition, the visualization (DP2) of process guidance can exploit its highest potential when being combined with the provision of explanations (DP3).

Table 10. Design Principles of Process Guidance Systems

DP1	PGS should provide user-requested, predefined and suggestive process guidance based on the monitoring and the analysis of the user's business process context
DP2	PGS should visualize the process models as lean and precise in the users' working environment.
DP3	PGS should provide detailed information about the process model as well as the process tasks and required resources to the user.

While the design principles have been evaluated in cycle one qualitatively by expert interviews and in cycle two quantitatively as a laboratory experiment, **cycle three** targets the evaluation in a real-world setting as a quasi-field experiment. Since the main goal of this article is to report our planned research activities in order to evaluate the concept of process guidance in a longitudinal field study, the remainder of the paper describes the PGS implementation in our case company and the ongoing evaluation.

3 The Design Cycle Three Artefact: ITSM ProcessGuide

For implementing the PGS in our case company, we cooperated with its Information Technology Service Management (ITSM) team. The ITSM team follows the ITIL framework to structure their offered IT services. In total, there are four different types of tickets defined by the ITSM team: Service Request, Incident, Non-Standard Demand, and Request for Change. For each ticket type there is a dedicated ticketing process and all of the processes are implemented in a ticketing application. Basically, all users are affected by these ticketing processes in order to request IT services. Users from the business side are only requesting services being the starting point of the ticketing processes. Users of the IT departments are executing the processes in order to fulfill the requested services. Although the ticketing processes are completely specified by the ITSM team and there exists a tool to support the execution of the ticketing processes, there are open issues. The ITSM team reports a lack of users' understanding of the ticketing processes and difficulties in the execution of these processes. Thus, we agreed to develop a PGS to support these ticketing processes.

In a first workshop with the ITSM team, the first author presented the process guidance concept, the three design principles and the existing PGS prototype realized in cycle one and two. The ITSM team presented their ticketing processes and the ticketing tool. The four ticketing processes are specified in detail by the case company including all mandatory and optional process steps. There are two different clients available for the ticketing tool, a rich client and a web client. The rich client is primarily used in the European sites of the case company and the web client is currently rolled out in the US sites of the case company. In future, all sites should use the web client of the tool.

After the clarification of the context, we developed specifications for the implementation of the PGS by discussing each design principle. In order to implement **DP1**, we decided to add a button into the ticketing tool which opens the PGS and passes the current users' process context. The current process context is determined by the type of ticket and the current state of the ticket. These information are then used to visualize the process guidance to the user (**DP2**). In order to keep the process guidance lean and precise for the given complex ticketing processes, we decided to provide only the next process steps for the current process state to the user. Each process state includes various mandatory and optional steps. For all the steps, the PGS provides detailed information in the form of explanations on how to execute the particular process step (**DP3**). The explanations can be expanded and collapsed in order to prevent information overload of the users. Within the explanations, the ITSM team can describe how to execute the specific process action and also provide links to other applications or websites. Considering the two different client versions, we decided to implement the PGS as a web-based application. This application can be opened in both versions of the client in the form of a browser window which is included in the users' work environment (**DP2**).

After implementing the first version, we presented and discussed the PGS in a second workshop with the ITSM team. **Fig. 9** depicts a screenshot of the resulting PGS (foreground) with the rich client of the ticketing tool (background). Based on the discussion within the workshop, we added a simplified and aggregated process model diagram to the PGS. Furthermore, we improved the layout and look and feel of the developed system. We named the resulting application ITSM ProcessGuide. In addition to the process guidance features of the ITSM ProcessGuide, we also added functionalities required for the evaluation of the system. Each time the ITSM ProcessGuide is used, it logs the following information: anonymized user name, current ticket type and state, expanding of the process steps, and if the user is clicking on one of the provided links. We also added a feedback functionality for the user. Randomly, the tool invites the user to provide feedback (highlighted as "Evaluation" in **Fig. 9**). If the user clicks on the link, the user is asked to answer questions addressing the three design principles.

For the maintenance of ITSM ProcessGuide, we developed a web-based backend to the PGS. In this backend, the ITSM team can maintain the process states, steps and explanations. Another use case of ITSM ProcessGuide is the easy and quick possibility to communicate changes of the ticketing processes. The ITSM team can easily change the explanations of the process steps in the backend and announce the changes to the employees. Then the users can see the changes when using the ITSM ProcessGuide.

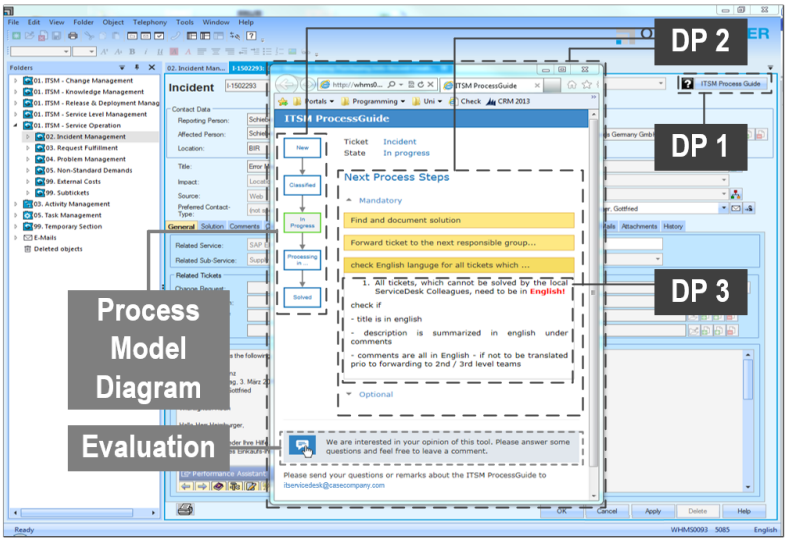


Fig. 9. ITSM ProcessGuide with highlighted Design Principles

4 Evaluation Methodology

Due to the complexity of the processes and the real-world environment, it is not feasible to measure the execution of each process instance of every user. Such an evaluation requires a controlled environment such as in a laboratory experiment. We already evaluated the effects of PGS in a controlled laboratory experiment. In order to evaluate the effects of the ITSM ProcessGuide in a real-world setting, we therefore decided to follow a multi-method approach.

First, adapting the framework on explanation use by Dhaliwal and Benbasat [5] we developed a survey. In a longitudinal study we intend to invite approximately 300 IT users of the case company to complete the survey at two points of time: immediately before and three months after the ITSM ProcessGuide introduction. In order to introduce the ITSM ProcessGuide to the case company's IT users the ITSM team distributed descriptions and a video explaining how to use the ITSM ProcessGuide. At the moment, the first survey is running. We decided to conduct a longitudinal survey approach to evaluate the validity and sustainability of our design principles. Moreover, we assess the effects of process guidance on users' process model understanding, perceptions, process execution effectiveness as well as efficiency, and their process compliance performance. As a side effect, we also evaluate the proposed model by Dhaliwal and Benbasat [5] for the process guidance context in a real-world environment.

Second, in addition to the survey-based evaluation we collect direct user feedback about the usefulness of our design principles for PGS. We translated the design principle descriptions into questions about their usefulness and the user is asked to rate them on a 7-point Likert scale. As previously explained, the possibility to provide feedback is provided automatically and randomly by the system and all users can provide their feedback

multiple times. In doing so, we intend to extract the users' perceptions about the usefulness of the design principles.

As the **third** evaluation approach we decided to conduct focus group workshops with the IT users of the case company. Within these workshops we will discuss and evaluate the ITSM ProcessGuide based on the feedback from the workshop participant. We have decided to add this qualitative approach in order to increase the validity of the overall evaluation and to get more detailed feedback.

For all the evaluations the data are stored anonymously. Due to the system is logging the usage data we have the possibility to not only gather self-reported data, but also real usage data. In doing so, we are able to increase the validity and reliability of our first and second evaluation approach. Moreover, since nearly half of the IT users are novices with respect to the ticketing processes (employees of the US sites) and the other half are already familiar with the ticketing processes (employees of the European sites), we also will have the possibility of a within group analysis. This will enable us to evaluate the effects of process guidance on novice and expert users.

5 Conclusion

This paper reports on our ongoing DSR research project on process guidance and introduces the overall research project and our case company. We already evaluated our design principles in a laboratory experiment with high internal validity. Following the call by Peffers et al. [3], the focus of this paper is the presentation of the planned evaluation of the design principles in a real-world environment. Building on theory-grounded design principles we implemented a PGS named ITSM ProcessGuide for the case company's ticketing process. Using the ITSM ProcessGuide we will evaluate the process guidance concept in a longitudinal field study by applying a multi-method approach. In doing so, we contribute to research and practice. First, we apply the existing framework by Dhaliwal and Benbasat [5] in a real-world environment in the context of process guidance and demonstrate its validity. Second, as we intend to develop a design theory for PGS, we need to evaluate our design principles. Thus, this real-world evaluation will increase the external validity of the design theory. Consequently, our design principles will result in a new design theory for PGS. Third, our research can serve as an example for other researchers on how to apply the DSR methodology in cooperation with an industry partner. The ITSM ProcessGuide is also implemented in order to solve the case company's challenges regarding the ticketing processes. Fourth, the ITSM ProcessGuide can inspire other companies to develop their own PGS to support their users in executing processes. We are aware that our research has some limitations. First of all, the real-world evaluation itself comes with several possible issues. The complex environment cannot not be fully controlled by the researcher. Another possible limitation is the selected context of the ticketing process. We decided for this context due to the complexity of the processes and the involvement of multiple users within the processes instances. However, future research should apply the concept of process guidance in different contexts in order to show the intended effects. As next steps, we will complete respectively execute the first and second survey and conduct the focus group workshops in order to evaluate our design principles of PGS and assess the effects of PGS on user's process

compliance performance. Subsequently, we plan to summarize the findings of all DSR cycles in a first version of a design theory for PGS.

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Design Principles for an Enterprise Systems Chartering Method

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Abstract. Our research follows a design science approach to develop a method that supports the initialization of ES implementation projects – the chartering phase. This project phase is highly relevant for implementation success, but is understudied in IS research. In this paper, we derive design principles for a chartering method based on a systematic review of ES implementation literature and semi-structured expert interviews. Our analysis identifies differences in the importance of certain success factors depending on the system type. The proposed design principles are built on these factors and are linked to chartering key activities. We specifically consider system-type-specific chartering aspects for process-centric Business Intelligence & Analytics (BI&A) systems, which are an emerging class of systems at the intersection of BI&A and business process management. In summary, this paper proposes design principles for a chartering method – considering specifics of process-centric BI&A.

Keywords: Enterprise System Implementation; Chartering Phase; Critical Success Factors; Process-Centric BI&A; Design Science

1 Introduction

Early project activities are highly relevant for enterprise system (ES) implementations – not necessarily leading to success but likely to failure in case of gaps. The initial phase before the official start and funding of an ES project is commonly called *chartering phase* where organizations spend considerable effort. In the chartering phase, decisions are made whether, why and how to do an ES implementation – including objectives, scope, budget, and resources [1]. The term chartering is coined by the ES Experience Cycle process theory of Markus and Tanis [1]. This framework adds the chartering phase to the process theory of Soh and Markus [2] that explains ES business value as a series of three linked models representing the three subsequent phases after chartering: the project phase, the shakedown/use phase, and the onward & upward phase. The result of each phase is an entry point for the next and the ES success might vary depending on the phase in which it is measured. While Markus and Tanis [1] are much-cited regarding problems and motivation of ES implementations, their call for more chartering research remains unanswered to a large degree. The reason might lie in the fact that these activities are often done informally and remain internal. External support – including research

– is requested only after official project start. Therefore, our paper seeks to contribute to ES chartering research.

Success factors and success criteria might differ a lot between projects due to different project scope, uniqueness, and complexity [3]. Hence, with respect to ES chartering across the different ES types, there might be common as well as context-specific factors. Current ES implementation literature relates mostly to Enterprise Resource Planning (ERP) [4]. However, the heydays of large ERP implementations are over and therefore we aim to study chartering in a highly relevant and emerging context: Business Intelligence & Analytics (BI&A). While the importance of BI&A is widely accepted, literature lacks rigor BI&A success studies [5]. Thus, we study ES chartering with focus on BI&A and aim to contribute to BI&A success research.

Initially, BI&A concentrated on strategic and tactical decision support based on historical data [6]. Therefore, traditional data analysis and provisioning is not or is only loosely coupled to the process execution and not available for day-to-day decision making. Currently, BI&A moves to overcome these limitations by embedding analytic information into operational business processes within so called *process-centric BI&A* systems [6]. These systems are "an emerging class of analytics that provides visibility into business processes, events, and operations as they are happening" [7] and can be placed at the intersection of BI&A and Business Process Management Systems (BPMS). The importance of integrating state-of-the-art analytics in BPMS is confirmed by analysts such as Gartner [8] and TDWI [7]. These projects have different characteristics than ERP implementations (e.g. differentiation vs. standardization or short increments vs. huge projects), which should be considered in the chartering phase.

The ultimate goal of our research project is to develop an artifact supporting ES chartering. Thus, our research follows a design science research (DSR) approach. DSR aims to solve identified organizational problems by creating and evaluating IT artifacts, which can also be in the form of a method [9]. The chartering method will be based on design principles which we present in this paper. These design principles can be seen as propositions about factors that eventually influence ES success. In summary, our study addresses the following research questions:
Which design principles should guide the creation of an ES chartering method? Which specifics should be considered in such a method for process-centric BI&A projects?

2 Research Methodology

To come to rigorous and relevant results, the DSR methodology introduced by Vaishnavi & Kuechler [10] was applied: The phases (i) awareness of problem and (ii) suggestion of key concepts to address the problems are presented in this research-in-progress paper. The steps (iii) development of a solution design, (iv) solution evaluation, and (v) conclusions are subject for future research.

Our research is done in cooperation with SAP SE, which is one of the largest ES software vendors in the world who recently introduced a new process-centric BI&A solution. Interviews with practitioners in this domain confirmed the need to ease the start of such projects. To create awareness of the problem in the first research phase, we conducted seven semi-structured interviews and a one-day-workshop at the headquarters of

our industry partner (2 product manager, 1 application consultant, and 4 project manager were interviewed). In the second research phase we derived well-grounded design principles based on a systematic review of BI&A and BPMS literature. In addition, studies about ERP – the poster child ES – were considered for identification of generic chartering aspects. In order to ensure a thorough analysis of the literature, the *Grounded Theory Literature-Review Method* was adopted[5]. 82 publications fulfilled our quality criteria. We used the qualitative data analysis software MAXQDA to support the coding process of these publications and the expert interviews.

3 Systematic Literature Review Results

The identified success literature is dominated by research about *critical success factors (CSFs)*, which are important conditions that influence the project success – typically measured against objectives and PM's "iron triangle" (costs, time and quality) [11]. However, it has to be considered that CSF studies often lack theoretical underpinning as well as empirical evidence [12], which we also observed – despite our applied quality criteria. The coding result regarding CSFs is outlined in Table 11. It shows the percentage of publications that support a CSF per context.

Unfortunately, a relatively low number of 7 publications (column C3) explicitly address questions of the early project phase by differentiating CSFs along their importance for the different implementation phases. To the best of our knowledge, we are aware of only one other study [13] focusing exclusively on the chartering phase. Due to the limited literature, we decided to additionally ask our interviewees to assess the CSFs in a five-point Likert scale. The results are listed in column C4 – it indicates how many interviewees "strongly agreed" that a success factor is critical in the chartering phase. This assessment is not representative but it enriches our perspective on the relevance of the identified CSFs. Informed by our literature review and the interviewed experts, we classified seven CSFs in Table 11 as *chartering core CSFs* which are highly important in the initial phase of an ES project.

Further CSFs which are relevant for the project implementation phase might require consideration before project start. In our context we are particularly interested in *process-centric BI&A CSFs* that are more important for the implementation of such systems than for classic ERP: First, *strategic alignment & organizational fit* is more frequently recognized in the analyzed literature as CSF for BPMS or BI&A projects (57%) than for ERP (15%). One reason might be that in the past ERP systems were often adopted for technical (e.g. year 2000) and operational reasons (e.g. cost reduction). On the other hand, BPMS and BI&A projects target to gain business advantages and are more often adopted for strategic reasons [14]. Second, it is not surprising that *data related factors* such as expertise and access to data from heterogeneous sources are more relevant for BI&A. Third, *user involvement & participation* "is particularly important when the requirements for a system are initially unclear, as is the case with many of the decision-support applications" [15]. Fourth, *performance measurement & control* are essential

[5] Literature review procedure description, detailed analysis results, and full reference list are available at https://madata.bib.uni-mannheim.de/id/eprint/127.

capabilities of process-centric BI&A, which consequently should be considered in such projects. Moreover, *integration* and *legacy systems* are more frequently identified as critical in our context. The reason might be that BI&A as well as BPMS do not substitute existing systems like ERP does – instead they use information from legacy systems to make processes more visible and flexible [14]. Finally, the *implementation approach* is important for BPMS and BI&A projects as their regularly changing scope recommends an iterative planning [5].

Table 11. Support of CSFs in Literature and Interviews by Context

CSF			Literature Review			Inter-views
			[C1] ERP Context	[C2] BPMS or BI&A Context	[C3] Char-tering Context	[C4] Charter-ing Context
			N=27	N=28	N=7	N=7
Chartering Core CSFs ((C3>50% OR C4 >50%) AND C3>0)		[CSF 1.1] Top management commit-ment & support	56%	68%	**100%**	**57 %**
		[CSF 1.2] Goals & objectives defini-tion	33%	32%	**71%**	**100 %**
		[CSF 1.3] Project champion	44%	11%	**57%**	**29 %**
		[CSF 1.4] Team composition & skills	63%	61%	**43%**	**57 %**
		[CSF 1.5] Change & culture	63%	57%	**43%**	**57 %**
		[CSF 1.6] Communication, cooperation & collaboration	48%	25%	**29%**	**71 %**
		[CSF 1.7] Scope Management	30%	14%	**14%**	**86 %**
Implementation CSFs	**Process-centric BI&A CSFs** (C1 < C2)	[CSF 2.1] Strategic alignment & organ-izational fit	15%	**57%**	0%	43 %
		[CSF 2.2] Data related factors	30%	**43%**	0%	0 %
		[CSF 2.3] User involvement & partici-pation	15%	**39%**	0%	57 %
		[CSF 2.4] Performance measurement & control	33%	**39%**	0%	0 %
		[CSF 2.5] Integration & alignment of systems	22%	**32%**	0%	14 %
		[CSF 2.6] Technology infrastructure & legacy systems	22%	**29%**	0%	14 %
		[CSF 2.7] Implementation approach	11%	**25%**	14%	29 %
	ERP CSFs (C1 > C2)	[CSF 3.1] PM	**63%**	36%	14%	29 %
		[CSF 3.2] System & process adaption	**59%**	25%	0%	14 %
		[CSF 3.3] Training & education	**48%**	21%	0%	0 %
		[CSF 3.4] Software package selection	**41%**	0%	29%	43 %
		[CSF 3.5] Business plan & vision	**30%**	14%	43%	43 %

Besides project success, post-implementation impacts of ES also largely depend on the system type. ERP systems, for instance, are associated with standardization in regards to industry best practices and cross-organizational process alignment. In contrast, BPMS aims more at process differentiation and flexibility [16]. Additionally, ERP benefits are to a large degree on enterprise level, whereas BI&A benefits are distributed and depend on "local entrepreneurial managerial actions" [17]. Therefore it is essential that a vision is established from business side rather than from IS.

4 Discussion of Design Principles for a Chartering Method

In this section, we derive design principles for an ES chartering method based on our literature review. The identified design principles are mapped against the aforementioned CSFs and clustered along chartering key activities (Table 12). Specific design principles for our context of process-centric BI&A are highlighted in Table 12. The analyzed publications recognize different chartering activities, which we aggregated by using the terminology from the PMBOK [18]. We excluded the activity software package selection as our interviews indicated that chartering is regularly done under the constraints of pre-selected software. The often used term business case is intentionally avoided due to its ambiguity – reaching from simple cost-benefit calculations to almost all chartering activities.

Table 12. Design Principles (DPs with grey background are particularly important for process-centric BI&A and not equally important for ES in general)

Chartering Activity	*Design Principle (DP)*		*Related CSFs*
Purpose and Objectives Definition	[DP1] Alignment with Strategy and Business Processes	A chartering method shall … … enable the project sponsor to define objectives that are linked to organizational strategy as well as business processes.	1.1, 1.3, 2.1
	[DP2] Measurement of Success	… enable the project sponsor to measure implementation success as well as system success.	1.1, 1.3, 2.4
	[DP3] Top Management Involvement	… enable the project sponsor to involve top management and ensure their support for the implementation project.	1.1, 1.2, 1.3
High-level Requirements Specification	[DP4]End-user Involvement	… involve process participants with appropriate means to understand the business process and discover decision support requirements (such as real-time information needs and process KPIs).	1.6, 1.7, 2.3
	[DP5] Integration Requirements	… create transparency about the complexity of the required integration in terms of data types, sources, volume, and quality.	1.7, 2.2, 2.5, 2.6
Resource & Milestone Planning	[DP6] Iterative Approach	… plan resources & milestones according to an iterative implementation approach.	2.7
	[DP7] PM Methodologies & Tools	… support widely adopted PM methodologies and corresponding PM tools.	2.7, 3.1
High-level Risk Determination	[DP8] Risk Mitigation	… identify and mitigate risks coming from deficiencies in CSFs (such as team composition & skills as well as change & culture), deficiencies in success dimensions (such as system, information and service quality), and external events and conditions (such as competition and economic changes).	1.4, 1.5

4.1 Purpose and Objectives Definition

Goals & objectives definition (CSF 1.1) as well as top management commitment & support (CSF 1.2) are identified as most important CSFs for the chartering phase by our literature review and our interviews. As process-centric BI&A is of strategic importance, the strategic alignment & organizational fit (CSF 2.1) of the project objectives with the organization's strategy, vision and business needs is also critical for the success of such projects [14]. In addition to defining clear goals and objectives, measures should be put

into place to monitor project and system success. Regarding success measures in process-centric BI&A projects one interviewee stated firmly "the project objective is usually to improve a very specific KPI … where snapshots can be compared before, while and after the project". Hence, objectives of BI&A initiatives should be business-driven, which favors top management initiation and continuous support [15].

In addition, our systematic literature shows that the appointment of a project champion (CSF 1.3) is a highly important CSF for project chartering. Unfortunately, definitions of the project champion role vary and it is not clearly stated who assumes it. Traditional PM literature on the other hand does not mention this role, but stresses the importance of the project sponsor for chartering [18]. However, the notions of project champion and sponsor show a lot of commonalities and can be defined generally as the person promoting the ES project, obtaining the resources, overcoming resistance, and involving stakeholders [19]. In practice, the chartering documentation might be delegated to a project manager even though it is issued under the authority of the sponsor [18]. Consequently, design principles DP1 to DP3 (Table 12) are derived for the chartering activity purpose and objectives definition.

4.2 High-Level Requirements Specification

Confirmed by our interviews, a sound scope management (CSF 1.7) is essential at the beginning of project. Based on the defined objectives a high-level requirements specification should be created including details of the business process [14]. In this regard, one interviewee claimed that "one thing you can really do wrong is to have too many or too high stakeholder expectations". ES literature identifies misunderstanding and changing requirements as one of the biggest project challenges [20]. A commonly proposed mitigation is early user involvement & participation (CSF 2.3), which has been recognized in our literature analysis as particularly important for process-centric BI&A. The primary purpose of any kind of BI&A system is the integration of data 'silos' to improve decisions and actions based on analytics [5]. Accordingly, our literature review identified data related factors (CSF 2.2) and integration & alignment of systems (CSF 2.5) as critical for the non-functional requirements specification of process-centric BI&A systems. These technical requirements are affected by the increasing complexity of business process regarding involved data types (e.g. unstructured), data sources (e.g. external), data volume, and data quality [21]. Therefore, we propose design principles DP4 and DP5 (Table 12).

4.3 Resource & Milestone Planning

ES implementations require considerable resources such as funding of hardware, software and human capital, which are typically scarce in such projects and require top management commitment. Resource requirements need to be determined and secured early in the project, because the inability to do so may doom project efforts. However, regularly changing scope recommends following an iterative implementation approach (CSF 2.7) for milestone planning [5]. This is underpinned by our interviews, were multiple experts recommended to start with providing visibility into one business process before approaching the next. Furthermore, a chartering method should be aligned with the well-

established PM approaches PMBOK [18] and PRINCE2 [22], which according to our interviews are also intensively used in the context of process-centric BI&A. Thus, we suggest design principles DP6 and DP7.

4.4 High-Level Risk Determination

Risks are uncertainties that might have effects on one or more objectives [18]. The analyzed literature examines risks largely with the aim to categorize risk factors. Additionally, success of the IT use as well as external events and conditions have to be taken in consideration to achieve project objectives [1, 2]. Therefore, we propose design principle DP8 (Table 12).

5 Conclusion

The research presented in this article outlines the current state of our work on the design of an ES chartering method. To that end, we derived eight design principles from insights we gathered through a systematic literature review enriched by expert interviews. Our analysis identified differences in the importance of certain factors between process-centric BI&A and ERP. Accordingly, some design principles are particularly important for process-centric BI&A (DP1, DP4, DP5, DP6), while others do not relate to specific context aspects and are more generally relevant for chartering of ES projects (DP2, DP3, DP7, DP8).

This paper is subject to specific limitations: First, the limited amount of BPMS related literature might bias BPMS related findings. Second, insights from the expert interviews are not representative and have to be handled carefully due to the limited number of interviews. Moreover, the process-centric BI&A projects discussed with interviewees involved only one particular software vendor. Despite the mentioned shortcomings, we perceive the presented work as valuable for both, research and practice. Our literature analysis, especially the identified CSFs and the derived design principles, extends the existing body of knowledge about ES chartering as well as about BI&A success. The derived design principles are propositions regarding project and system success. Accordingly, our insights can guide practitioners during the charting phase of an ES project.

In future research, we will leverage the outlined design principles to create a chartering method including tool support and corresponding templates. In cooperation with our industry partner we plan to evaluate and refine the artifact within multiple projects – focusing on process-centric BI&A projects.

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Ontological Representation of Design Science Research Publications

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A search result provided by existing digital library and web search systems typically comprises only a prioritised list of possible publications or web pages that meet the search criteria, possibly with excerpts and possibly with search terms highlighted. The research in progress reported in this poster contributes to a larger research effort to provide a readable summary of search results that synthesise relevant publications or web pages to provide results that meet four C's: *comprehensive*, *concise*, *coherent*, and *correct*, as a more useful alternative to un-synthesised result lists. The scope of this research is limited to searching for and synthesising Design Science Research (DSR) publications that present the results of DSR, as an example problem domain.

This article describes the design of a formal ontology called the DSR Document Core Ontology, or DSRDCO, which provides a conceptualisation of the semantic content of DSR publications. DSRDCO is designed to enable automatic reasoning with DSR publications to provide single or multiple document summaries that fulfil the four Cs above. Figure 1 depicts only a portion of DSRDCO, including only the most important core DSR concepts and omitting (for example) a DSR article's thesis, significance claims, and argumentation. Besides the graphic representation in figure 1, DSRDCO is also implemented in OWL DL to support automated reasoning.

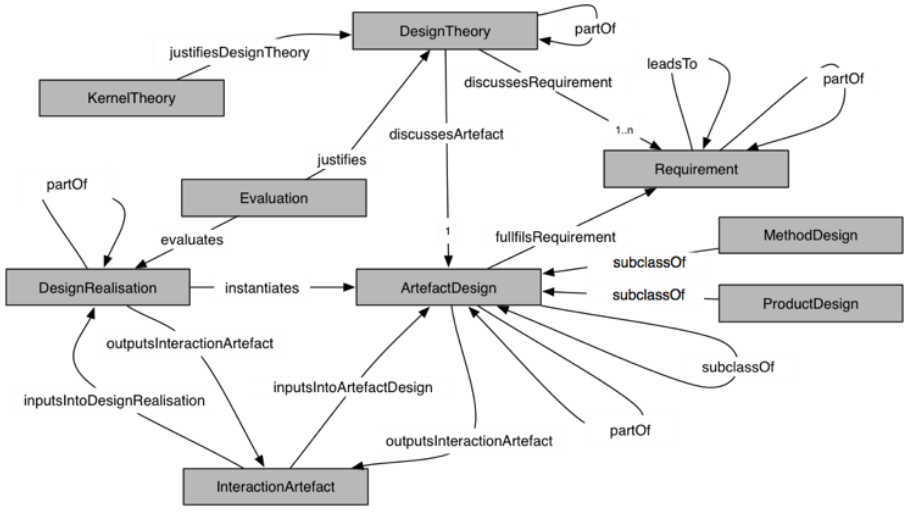


Fig. 10. Core Concepts of DSR in DSRDCO

DSRDCO conceptualises several aspects of DSR. As shown in figure 1, a design theory consists of one artefact design (or meta-design) that fulfils a particular set of requirements (or meta-requirements). An artefact design may contain component artefact designs and a requirement may contain sub-requirements. An evaluation justifies a design theory by evaluating a specific design realisation (instantiation) against its requirements. A design realisation must instantiate any components or other assertions that have been made concerning its corresponding artefact design.

Figure 1 omits other important semantic content components of a DSR article (or any scientific article) – e.g. its thesis, significance claims, and argumentation. The thesis or main claim of a DSR paper is usually that the focal artefact (meta-)design fulfils some (meta-)requirements (i.e. that a design theory is true). Significance claims includes theoretical and practical significance claims. The thesis and significance claims should be justified or supported by further claims and by providing evidence that the artefact design (when instantiated) fulfils the requirements through an evaluation argument (which is shown in figure 1). Other support includes an argument in which the artefact design is based on an earlier, established artefact design. Each support is itself a claim, which can be supported (or argued against).

One potential way in which instantiations of DSRDCO can be transformed into synthesised paper summaries or search result summaries is through plain text generated based on cloze sentences, which are filled in with values from the DSRDCO instantiation. An example of such a cloze sentence is given below.

```
The artefact design named ____ (Noun Phrase for <Arte-
factDesign>) is designed to fulfil the requirement/s ____
(VerbPhrase enumeration for <Requirement> (CARD >= 1))
```

A filled in example summary based on the above cloze sentence is given below.

```
The artefact design named "Annota" is designed to fulfil
the requirements "annotate and organise scientific publica-
tions on the Web" and "share publications with colleagues".
```

The data needed to produce the above example could be represented by instantiations of the following ontological relations (shown as triples) to represent part of figure 1.

```
<DesignTheory> <discussesArtefactDesign> <ArtefactDesign>
<ArtefactDesign> <fulfils> <Requirement>
<DesignTheory> <discussesRequirement> <Requirement>
```

Thus far in this research in progress, the feasibility of DSRDCO to produce synthesised summaries has been demonstrated by instantiating it manually into OWL DL for three DSR articles and by producing natural language summaries as above. Further, more rigorous evaluation is needed to demonstrate the hypothesised utility. Also remaining to be done in this research in progress is to ensure that the proposed ontology supports a shared understanding. The concepts this ontology is comprised of are used by many proponents of DSR and will be further evaluated in an expert evaluation. Ultimately, DSRDCO must also be integrated into the larger system envisioned.

Achieving continuous professional development in higher education

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Abstract. Traditional higher education technology emphasizes knowledge transmission. In contrast, the Community platform presented in this paper follows a social approach that interleaves knowledge delivery with social and professional skills development, engaging with others, and personal growth. In this paper, we apply learning and complex adaptive systems theory to motivate and justify a continuous professional development model that improves higher education outcomes such as placement. The paper follows action design research (ADR) as the research method to propose and evaluate design principles.

Keywords: Action design research (ADR), complex adaptive systems (CAS), higher education

Introduction

Information technology (IT) use in higher education tends to focus on automating and scaling traditional isolated process such as video taping a lecture. This hierarchical, sequential, and siloed process originated from when universities constructed large lecture halls and organized education into packaged blocks of courses in the last century. Higher education can be more than just a factory that applies standardized procedures to create identical goods. Delors et al. [1, p. 37], asserted that "formal education systems tend to emphasize the acquisition of knowledge to the detriment of other types of learning; but it is vital now to conceive education in a more encompassing fashion." IT can play a much more transformative role in higher education rather than just achieve efficiency.

In this paper, we apply a lifelong learning model as a guiding theory and complex adaptive systems as a design philosophy to instantiate technological artifacts that improve the quality of higher education, specifically the 'professional development' of students.

Complex Adaptive Systems

Complex Adaptive Systems (CAS) theory can shed new light into the interaction among the agents beyond the traditional hierarchical views of higher education. CAS is "composed of interacting agents described in terms of rules. The agents adapt by changing their rules as experience accumulates" [2, p. 10]. CAS can go inside the seemingly

highly hierarchical outer shell of higher education and analyze a more nuanced reality to leverage the peer-to-peer under-structure instead of focusing only on the traditional one-to-many over-structure. The uses and consequences of IT "are often enacted through self-orchestrated interactions among users, technologies, and institutional properties rather than dictated by organizational policies or managerial intentions." ([3] p. 505).

Design

The CAS model provides the conceptual and architectural instantiation of the Community platform. The platform is based on WordPress, an open source content management system, and BuddyPress, a social plug-in that adds member profiles, avatars, friending, groups, and private messaging. The platform includes a customized look and feel relevant to higher education, custom developed plugins (e.g., gradebook, leaderboards, e-portfolio wire, e-portfolio search, e-portfolio badges), templates (for course and e-portfolio creation), and tutorials. All content including courses, members, and the individual sites of each member including their profiles, e-portfolios, and activities are open and accessible over the Internet. All members are content generators and aggregators while white pages (profiles), internal messaging, site wide activity "wires", chat, and commenting support interaction and discovery.

All student, faculty, and staff member create and maintain their online brand through an "e-portfolio" site. The open content promotes conversations and sharing. The site-wide activity feed on the front page (similar to the Facebook news feed) fuels additional interaction. In the feed, all sites get equal "billing" including student managed sites. Members update their profiles to indicate their interests as well as job status, and the changes are pushed to the community, while instructors' use commenting, rating, and voting to sustain interaction. As of January 2015, the platform has hosted more than 7300+ members, 5900+ sites, 1200+ e-portfolios, 17,000+ posts, 48,000+ comments, and 300+ courses. The four key design principles of the platform are open, individual control, discovery, and aggregation.

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A support system for mentors of novice entrepreneurs

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Abstract. In this study we present online software to rapidly assess the impact of mentoring techniques on a novice entrepreneur. We have built a prototype that collects data from team members in less than five minutes and that automatically returns a diagnostic analysis to the mentor. Between 2012 and 2015 we have tested three versions of our prototype with longitudinal analyses of teams attending startup weekend competitions, to confirm that our prototype supports mentors with few and yet relevant information. The results of our studies open several avenues of research regarding rapid diagnostic of project teams, whereas, from a practical point of view, our prototype entirely done with Google Docs can be easily used by anyone interested in entrepreneurship education.

Keywords: Entrepreneurship education, effectuation, mentoring, decision support, design science

Problem statement. *Entrepreneurship education* provides individuals with the ability to recognize commercial opportunities and the insight, self-esteem, knowledge and skills to act on them [1], whereas *mentoring* can be defined as the establishment of a supportive relationship to a novice entrepreneur (mentee), thanks to the support of an experienced entrepreneur (mentor), allowing it to develop as a person [2]. To incorporate mentors in practical program increases the capabilities of novice entrepreneurs [3] and, once the novice entrepreneur acquires entrepreneurial experience, he/she should shift from a *causal logic* (from "business idea" to "necessary means") towards an *effectual logic* (from "available means" to "business idea") [4]. Nonetheless, there are no existing recommendations to design a tool to rapidly assess the impact of mentoring techniques, by measuring the change of dominant logic used by mentee. Therefore, our research question is: *how can we design an artifact to rapidly assess the impacts of mentoring techniques on novice entrepreneur?*

Theoretical model. We have developed a theoretical model to represent the change over time of three constructs to measure the common ground in a team [5]: joint objectives (JO), joint resources (JR) and joint commitment (JC). Our three constructs are operationalized by eight variables, which are measured by five-point Likert scales. Accordingly, JO is associated to (JO1) design and functionality of product/service; (JO2) distinctive image from competitors; (JO3) clearly defined market segment. JR is measured by (JR1) available time, (JR2) team competences and (JR3) useful contacts in their network. Finally, JC is measured by (JC1) goodwill trust and (JC2) competence trust.

Description of the prototype. Our prototype is composed by a Google Form to collect data and one Google Sheet with three tabs (participants' answers, group common ground and group coach's common group), that supports three dynamic graphs:

1. *Path analysis for the team*. Novice entrepreneurs are known to proceed in a different way than a team with expert entrepreneurs.
2. *Team members' opinion analysis for the coach*. The second graph represents the score of each team member and it is used by the coach to perform diagnostics on the team dynamics.
3. *Team-coach alignment of perceptions for the supervisor*. The third graph shows the coach's position to induce the mentoring technique used.

In each dynamic graph, the X axis of the first graph represents the average of team members' JO at time t, the Y axis represents the average of team members' JR at time t, whereas the bubble size represents the average of team members' JC.

Testing the prototype. Between 2012 and 2015 we tested our prototype at startup weekends (startupweekend.org), where teams create startup ideas in 54 hours. Starting from Saturday morning until Sunday afternoon, we have collected survey data from randomized participants and coaches after each coach intervention. Friday night we collected the opinions of the coaches and the crowd (pretest), whereas Sunday afternoon we assisted to the discussion among jury members (posttest). Accordingly, our preliminary results show that:

1. *Causal and effectual logics have different paths in graph 1*. Novice entrepreneurs work to increase JO first and then increase JR, whereas expert entrepreneurs advance in the opposite way.
2. *Team Joint Commitment (JC) increases by intervening on Joint Objectives (JO) and Joint Resources (JR) in graph 2*. Statistical analysis of collected data suggests that a coach can focus on JO and JR, leaving aside JC.
3. *Perceptions of successful coaches and teams in graph 3 converge over time*. Team-coach perceptions can be used as a predictor of team performance. Coaches appear to be reliable risk detectors and teams that do not take that into account eventually end up having coordination surprises, which lead to poor performance.

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IS Capability Assessment - The MIND Canvas

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Introduction

With the increasing ubiquity and growing pervasiveness of Information Systems (IS) in todays' organisations, one of the capabilities of essential value to an organisation is its IS/IT (henceforth IS) capability. However, despite this increasing importance of the IS capability, research has barely focused on providing a measure for assessing the IT capability of an organization. In overview, IS capability has contributed significantly in understanding how information technology remains a valuable component of any modern day firm (Bharadwaj 2000, Santhanam and Hartono 2003). While these prior research focus in itself is of value in establishing the importance of IS capability, this current study posits that this research area is attaining maturity and it is about time we extend this stream to provide a measure for assessing and evaluating the IS capability that defines an organization. To borrow a quote from Peter Drucker - *"if it can be measured; it can be improved".*

Research on the IS/IT Capability construct has been a valuable lens in unveiling the importance of IT in a firms performance along with its contribution to a firms competitive advantage. Based on a design science research approach, this research is aimed at providing a qualitative measure for assessing the current status of an organisation's IS/IT capability in relation to its strategic objectives.

Building on existing classifications of IS capability in prior research, this study advances the MIND framework. The MIND is derived from a grounding of these IS capability classifications in prior literature (Baiyere et al. 2014) into four dimension – IS Management **[M]**, IS Infrastructure **[I]**, IS Networking/Sourcing **[N]** and IS-Business Development **[D]** Capabilities. This framework is consolidated into an IS capability assessment artefact (fig 1) with adaptation of existing measurement approaches from prior research –Balanced Score Card (BSC) and SWOT analysis.

Following the identified IS capability assessment gap in literature, this study's specific objective is: *How do we assess the IS capability of an organisation?*

DSR Research Method/Process

The research process to be adopted for the study would be the Design Science Research Methodology (DSRM) framework developed by Peffers et al (2007) which aligns with the guidelines by Hevner et al. (2004) (Gregor and Hevner 2013).

- *Problem motivation* – The need to assess the IS Capability of an organisation.

- *Define the objectives for a solution* – to provide an overview of an organisation's IS capability reflecting its current status relative to the organisation's goals.
- *Design and Development* – The study is grounded in prior research on IS Capability and leverages established assessment approaches such as the BSC and SWOT
- *Demonstration and Evaluation* – The planned evaluation approach is outlined.
- *Communication* – The audience for the study are researchers and practitioners.

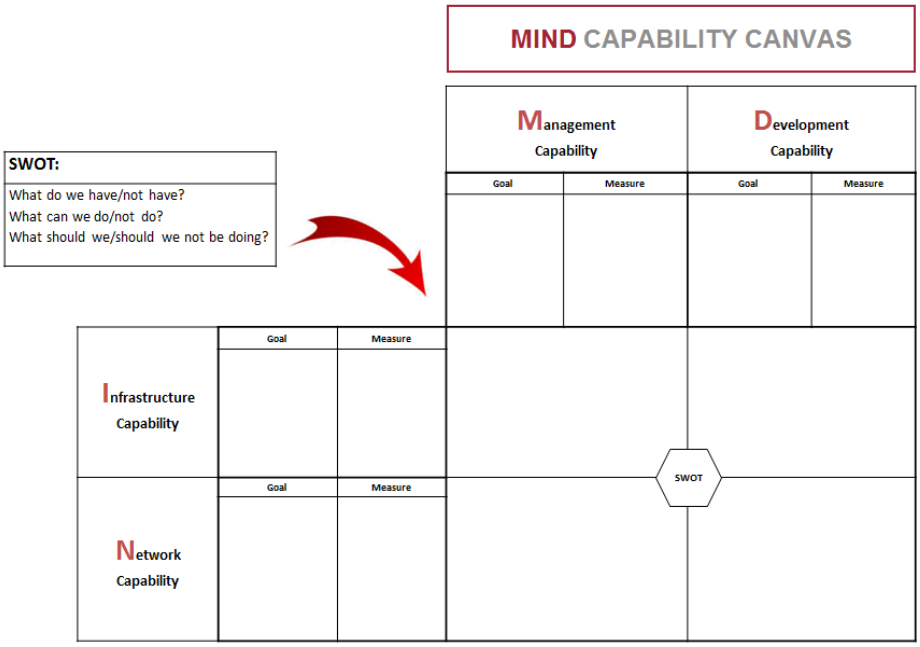


Fig. 11. Design Artifact – The MIND Capability Canvas.

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Designing and Evaluating an Interactive Assessment Instrument to Improve the Process for Mobile Service Application Innovation

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Mobile service applications are essential in both business and avocation. Although valuable, the adoption of new mobile services has been much slower than expected, [1-3, 10]. This may be due to poor decision making in the process for mobile service innovation, as a result of a lack of structure and transparent activities [3-5]. An un-structured and 'fuzzy' process can result in poorly defined mobile concepts and consequently poorly designed mobile services. This research proposes an interactive assessment instrument to address these challenges. Specifically, the instrument is used to help define and evaluate mobile service concepts in the innovation process. Due to its prescriptive and practical suitability, we follow the DSRM proposed by [6] to design and evaluate the instrument. To find a solution to the aforementioned challenges an analysis of relevant literature resulted in the three step process model proposed by [7] being incorporated as the kernel theory to assist with the design and development of the assessment instrument and involved the following: Contextualization: structuring the elements of the decision situation into a "logical framework". This was achieved using qualitative content analysis, focus groups and analytical hierarchy process, to select the factors for inclusion in the instrument [7,11-12]. Quantification: involves making the decision elements calculable. All factors selected for inclusion in the instrument (from the last phase) were then structured on scales, (ranging from 0-100%) in an excel sheet. These scales where then used to categorize and quantify the adoption information, [7, 11-12]. Calculation: involves applying calculative and statistics techniques to calculate rational decisions. The quantified adoption information is visualized in a 3D Graph [11]. A number of functions were applied to the instrument so that the graph will adjust depending on the defined and categorized concept. This information can be used to inform decision makers when evaluating their concept. Once developed the assessment instrument went through an iterative phase of refinement and evaluation. Firstly a number of workshops were held where the assessment instrument was demonstrated to industry experts and then refined based on their opinions. Once refined, the evaluation involved multiple comparative (qualitative) case studies where the assessment instrument was implemented in the innovation process of three real-world organizations, and its impact examined. These include two small private organizations and one large public organization. Multiple sources of evidence were gathered from these studies including: documentation, interviews, observation, field notes and artefact print-out data. This data was then analyzed following a hybrid inductive-deductive thematic analysis approach [8]. Themes traced in the process suc-

ceeding artefact implementation include: Transparency: organized and inclusive approach to understanding and generating mobile concepts and evaluating creative alternatives. Information Exchange: Facilitates interpersonal communication. Cognitive Simplification: Facilitates understanding - simplification of the decision situation (e.g. concept definition and evaluation). Performativity: Rational choice theory mobilised in practice. A further cross-case analysis of case study data is currently being undertaken. The results of the evaluation to date provide valuable insight for the knowledgebase in terms of decision making in the process for mobile service application innovation. Along with this, a significant achievement is the incorporation of the instrument in practice, thus providing strong evidence of industry relevance of the research outcome [9].

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An Overview of Online-Research in Information Systems

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Abstract. As the Internet has changed communication, commerce, and the distribution of information, so it is changing Information Systems Research (ISR). The goal of this paper is to put the topic of application and reliability of online research into the focus of ISR by exploring the extension of online research methods (ORM) into its popular publication outlets. 513 articles from high ranked ISR publication outlets from the last decade have been analyzed using online content analysis. The findings show that in ISR online research methods are applied despite the missing discussion on the validity of the theories and methods that were defined offline within the new environment and the associated challenges.

Keywords: Research Methods, Internet Research, Online Content Analysis, ISR:

Introduction and Research Method

The goal of this ongoing research is to contribute to the development of ISR towards a reference discipline [1] by identifying the status quo and thus the potential for more robust methodological support in application of ORM. We analyzed online articles from top-ranked ISR journals and conferences such as: Management Information Systems Quarterly (MISQ), Information Systems Research (ISR), Journal of Management Information Systems (JMIS), Information Systems Journal (ISJ) and based on [2] following conferences: AMICS, ICIS, ECIS, DESRIST and CONISAR, in order to identify publications explicitly using ORM. After screening of overall 1769 articles from selected journals and 10442 articles from conferences from the years 2004-2014 we identified 513 publications that qualified for the analysis. We analyzed the articles following aspects: ISR theory used, topic of research, ISR paradigm and ORM used. The procedure for the literature review was adopted from [3]. Considered methods were based on the overview by [4] and enriched with Internet-related terms. Whilst not exhaustive, this selection still represents the essence of the methodologies of ISR.

Findings

The findings show that the use of ORM in ISR has steadily grown in the time span of the analysis and that ORM were predominantly used to explore web-related research topics such as social networks, trust and online communities. The most frequently used theory is the Theory Acceptance Model [5].

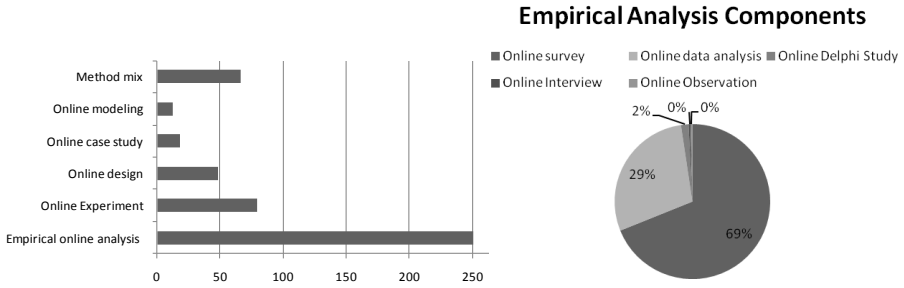


Fig. 12. a) ORM used in ISR in number of articles b) EOA components

Figure 1a shows that the most frequently applied ORM is the empirical online analysis (EOA) followed by online experiment. The decomposition of EOA in figure 1b shows that online survey is most popular method followed by online data analysis. Design science uses ORM more often to evaluate the artifact rather than to construct the artifact online.

Discussion

The descriptive study shows that ORM are adopted by ISR mostly in the context of behavioral research topics or for data collection. Also, ISR has transferred the offline research techniques online without the discussion on how the new environment can affect the research findings or whether the research theory used is applicable to the novel environment. Insights from the study are part of the research intended to develop criteria for a guideline for online ISR to support the researchers in their choice of methods.

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