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par

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Храбрите изгарят, за да има светлина.

The flame of the brave is our light.

На моята майка, Сийка Костова, моята сестра, Анна Костова, и моя баща,
Христо Костов, които ме научиха какво е стойност.
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Abstract

In this thesis, we present a theory of value for the design and analysis of service ecosystems. The theory is based on general systems thinking. The concept of a system is used for relating knowledge from different disciplines (such as software engineering, requirements engineering, conceptual modeling, economics, service-oriented computing, and philosophy) to the domain of service ecosystems. The proposed definition of value is an input or an output that helps a system to construct and to maintain an identity for an observer. This definition is used to design and analyze service ecosystems through the prism of the value that systems find in participating in service ecosystems. The theory is constructed on the two following ideas: (i) the reflections, resulting from a collaboration with industry partners, on the role of the concept of value in the design and analysis of an information system for integration in an organization and (ii) on a review of the state of value definitions and theories in the academic context.

The use of multiple methodologies for system design and analysis, which we observe in service ecosystem design, introduces another question: How do we connect different system representations? To this end, this work contributes a set of heuristics for the reconciliation of methodologies. Instead of asking the question of "How can we align and connect all knowledge from one methodology to the other?", the reconciliation heuristics are based on the assumption that this is neither necessary, nor possible. Accepting that the reconciliation is a continuous process and guiding it, with the help of the heuristics, is a technique for relating, converging, and enabling the independent existence of the knowledge to be modeled via different methodologies.

We conclude the thesis with our current inquiries about the application of the value and reconciliation principles in the domains of services and privacy. We propose definitions for both services and privacy and offer a future research agenda for the further research and practical development of the theory of value.

Key words: value, theory, service ecosystems, general systems thinking, principles, heuristics, interpretivism, service, privacy

Résumé

Cette thèse présente une théorie de la valeur pour la conception et l'analyse des écosystèmes de services. Cette théorie est basée sur la pensée systémique générale. Le concept de système est utilisé pour relier les connaissances de différentes disciplines (telles que le génie logiciel, l'ingénierie des exigences, la modélisation conceptuelle, l'économie, l'informatique orientée services, la philosophie) au domaine des écosystèmes de services. La définition proposée de la valeur est une entrée ou une sortie qui aide un système à construire et à maintenir une identité. Cette définition est utilisée pour concevoir et analyser les écosystèmes de services à travers le prisme de ce que les systèmes de valeur trouvent en participant aux écosystèmes de services. La théorie est construite à partir de réflexions issues d'une collaboration avec des partenaires industriels sur le rôle du concept de valeur dans la conception et l'analyse d'un système d'information destiné à être intégré dans une organisation et d'un examen de l'état des définitions et des théories de la valeur dans le contexte universitaire.

L'utilisation de multiples méthodologies pour la conception et l'analyse de systèmes, que nous avons vue dans la conception d'écosystèmes de services, introduit une autre question : Comment connecter les différentes représentations du système ? À cette fin, ce travail contribue à un ensemble d'heuristiques pour la réconciliation des méthodologies. Au lieu d'examiner la question de savoir comment aligner et connecter toutes les connaissances d'une méthodologie à l'autre, les heuristiques de réconciliation sont basées sur l'hypothèse que cela n'est ni nécessaire, ni possible. Accepter que la réconciliation est un processus continu et le guider à l'aide de l'heuristique est une technique pour relier, converger et permettre l'existence indépendante de la connaissance modélisée par différentes méthodologies.

La thèse se termine par nos recherches actuelles sur l'application des principes de valeur et de réconciliation dans les domaines des services et de la vie privée. Nous proposons des définitions pour les services et la vie privée et offrons un programme de recherche futur pour la recherche et le développement pratique de la théorie de la valeur.

Mots clefs : valeur, théorie, écosystèmes de services, pensée systémique générale, principes, heuristique, interprétativisme, service, protection de la vie privée

Резюме

В тази дисертация представяме теория на стойността за дизайн и анализ на екосистеми за услуги. Теорията се основава на принципите на системния подход и на теорията на системите. Понятието за система се използва за пренасяне на знания от различни дисциплини (като софтуерно инженерство, управление на изискванията, концептуално моделиране, икономика, архитектури за изчисления на услуги и философия) в областта на екосистемите за услуги. Предложената дефиниция за стойност е вход или изход, който помага на системата да изгради и поддържа идентичност за наблюдател. Тази дефиниция се използва за проектиране и анализиране на екосистеми за услуги през призмата на стойността, която системите намират при участието си в екосистемите за услуги. Теорията е изградена върху следните две идеи: (i) разсъжденията, произтичащи от сътрудничество с партньори от индустрията, относно ролята на понятието за стойност при интеграция на информационна система в организации и (ii) обзор на дефиниции и теории за стойност в академичните среди.

Използването на множество методи при проектиране и анализ на екосистеми за услуги поставя също така и следния въпрос: Как да свържем различни представяния и модели на системата? За тази цел, с дисертацията допринасяме и набор от евристики за съгласуване на методи. Вместо да целим да обединим един метод с друг, с евристичния метод на съгласуване допускаме, че това не е нито необходимо, нито възможно. Съгласуването на методи при изграждането на екосистеми за услуги е непрекъснат процес и насочването му с помощта на евристики ни помага да свържем знанията и данните, които се моделират от различните методи.

Като заключение, в дисертацията включваме текущите проекти за прилагането на теорията на стойността и евристиките за съгласуване на методи в областите на услугите и поверителността. Предлагаме дефиниции както за услуга, така и за поверителност и предлагаме бъдеща изследователска програма за по-нататъшно доразвиване и практическо използване на теорията на стойността.

Ключови думи: стойност, теория, екосистеми за услуги, системен подход, принципи, евристика, интерпретативност, услуга, поверителност

Contents

List of Figures

1 Introduction

Today's societal and business landscape resembles a system of many actors who interact in ways that transcend organizational and geographic boundaries, traditional market roles, and academic silos. This conceptualization of organizations, which goes beyond the producer-consumer market structure, is defined as a service ecosystem. From a theoretical point of view, a service ecosystem is "a relatively self-contained, self-adjusting system of resource-integrating actors connected by shared institutional arrangements and mutual value creation through service exchange" [Vargo and Lusch, 2016]. From a practice point of view, ITIL, a framework of good practices, defines services as "the main way that organizations create value for themselves and their customers." [ITIL, 2019]. Therefore, services are the vehicle for encapsulating, creating, and exchanging value.

Value is at the heart of services and service ecosystems, as both the academic and the industry best-practices definitions illustrate. There are definitions of value in the service science field [Vargo et al., 2008, 2017], economics and marketing. Current value theories and definitions are based on the dichotomy between producers and consumers and viewed in light of value creators and value consumers. Extant value theories could be broadly divided in two: (1) Value-in-exchange, defined from the point of view of the producer, and (2) value-in-use, which depends on the consumer's subjective perception. This bifurcated view becomes insufficient, as the roles of the actors in service ecosystems go beyond producers and consumers. Value in these systems is mutual and co-created. The structural differences of service ecosystems then lead to the question about what value is. Recent studies have recognized that value is a system-level construct [Vargo et al., 2017].

In this thesis, we propose a theory and a corresponding definition of value with the help of general systems thinking [Weinberg, 1975], a meta-discipline whose subject matter is the derivation of the principles for systems in general [Bertalanffy, 1950]. We define value as an input or an output that helps observers construct and maintain an identity of a system. Service ecosystems are systems. As such, they are interconnected and value is the glue that holds them together. In the service exchanges, the service ecosystems are able to find value in order to maintain an identity.

1.1 Contributions and Organization of the Thesis

The central piece of this thesis – the theory of value – is the outcome of a multi-year inquiry into various domains, through the lens of systems thinking and experiential learning. Rather than embarking on the journey to first define value, the process of formulating the theory followed a learning approach: The research result is a combination of deliberate reflections and abstractions of systemic principles based on real experiences and on noticing emerging patterns. Hence, the final doctoral project presented here could be seen as an "emergent sense making" strategy [Mintzberg et al., 1998]. Emergent sense-making is a cross between the emergence of patterns that we recognize from past experiences applied deliberately in the future and the pure sense-making view of Weick [1979] who argues that all understanding is based on looking backwards and on reflection.

The organization of the thesis is depicted in Figure 1.1. In Chapters 2 and 3, we develop an approach for structuring the thesis with (1) our principle-pattern-practice (PPP) structure and (2) the experiential learning steps – experience, reflection, generalization, application – adapted by Kolb [1984]. Then, our main contributions are (1) the exploration of a pattern used in practice in Chapter 4, (2) the principle of value (encapsulated in our theory of value in Chapter 5), and (3) the principles for reconciliation (explained in Chapter 6). Lastly, we propose an application of the value principle in services and privacy (Chapter 7). Chapters 3, 4, and 6 are based on previously published papers ([Kostova and Wegmann, 2018; Kostova et al., 2019a, 2020]). Chapter 5 is based on a working paper. Chapter 7 is partially based on a work-in-progress paper. The material from the original articles is altered in places for readability and to present more context in relation to the other chapters and the overall thesis. First, there is an introduction that relates the chapter to the overall thesis and the PPP structure and the experiential learning process. Then, these chapters present the main material of the articles. The summary of the contributions in the chapters is as follows:

Chapter 2 presents the literature background, used in the remainder of the thesis, on systems thinking and interpretivism. Next, in Chapter 3 we present the PPP structure. As stated by Banathy and Jenlink [2003], systems thinking without praxis is of little use. The philosophical foundations of connecting disciplines requires operational methods to uphold its validity and to acquire knowledge about general systemic principles. Our research method consists of a conceptualization (PPP) and a process (the experiential learning process). We show the use of PPP in the classroom to teach how to connect engineering knowledge with business-oriented concepts. PPP connects practice and theory by helping us explore the space around value and design methods: With the help of PPP, we structure the rest of the thesis. The material on PPP in this chapter originates from the following paper:

- Blagovesta Kostova and Alain Wegmann. Service-oriented business design for IT students. In *IEEE Frontiers in Education Conference, FIE*, 2018

Chapter 4 shows the use of a pattern in practice. The pattern is a service modeling canvas based on SEAM, the systemic modeling method developed in our research group [Wegmann, 2003]. The practice is our participation in a collaborative project, between our research group

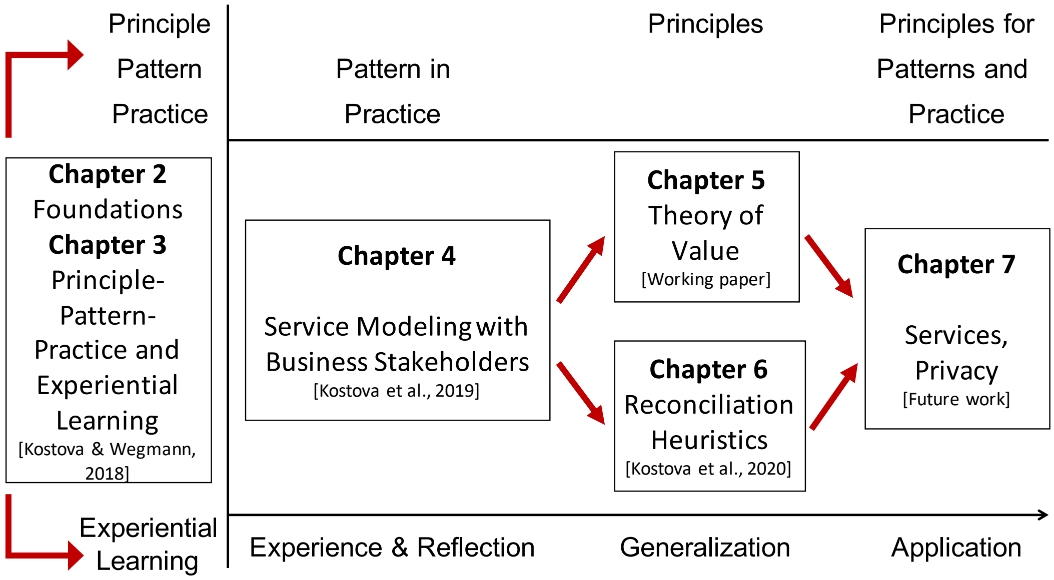

Figure 1.1 – Organization of the Thesis and Contributions

and a consultancy enterprise, for integrating a customer-relationship management (CRM) system in a large financial institution. This experience marks the first step of the experiential learning cycle. In addition to describing how to conduct workshops centered around services for low-code information systems, we conclude that the concept of value is of importance. As foreseen by service science, value is at the core of services. The lessons learnt from the project are to recommend discussing value that customers receive from using a service (value as in benefit or value-in-use) and how to organize the service provider internally to deliver that value. The chapter is based on the following paper:

- Blagovesta Kostova, Lucien Etzlinger, David Derrier, Gil Regev, and Alain Wegmann. Requirements elicitation with a service canvas for packaged enterprise systems. In *IEEE International Requirements Engineering Conference, RE*, 2019a

In Chapter 5, we further explore the notion of value in the literature and propose a theory of value for service ecosystems. The value definition we propose is that value is an output or an input that helps an observer to preserve or to construct an identity for a system. In order to co-create value, every system would have to exist on its own in order for the service ecosystem to hold together. We look at identity as the outer expression of a system's actions. Identity is in the eye of the observer: For a system's observers to be able to recognize it as as a previously identified system, a system that behaves in a certain way is expected to behave in alignment with its given identity. Value is an input or an output that helps the systems take actions that are congruent with its (desired) identity. This chapter is based on the following working paper:

- Blagovesta Kostova, Jaap Gordijn, Alain Wegmann, and Gil Regev. A theory of value for service ecosystems, 2022

After our experience and reflections about the state of practice of value modeling in industry and subsequent to proposing a theory of value that is independent of a modeling pattern, we conclude that using multiple modeling methodologies, together in a system design process, is to be expected. In Chapter 6, we propose heuristics that could be used to reconcile such methodologies. These heuristics belong to the principle category of PPP: they could be used regardless of the modeling patterns that they reconcile. Using different models (and methods) brings inevitable inconsistency, and this needs to be reconciled in order for an agreement to occur. To contribute to the multiple ways of modeling, we propose a set of heuristics that guide the process of reconciliation. This chapter is based on the following paper:

- Blagovesta Kostova, Irina Rychkova, Andrey Naumenko, Gil Regev, and Alain Wegmann. Systems-thinking heuristics for the reconciliation of methodologies for design and analysis for information systems engineering. In *International Conference on Research Challenges in Information Science, RCIS*, 2020

The principles that we have proposed in the previous two chapters could be applied in other domains. In Chapter 7, we show the last step in our experiential learning process; this is the application of these principles to two research areas, services and privacy. We propose definitions for a service and for privacy, both are based on value and reconciliation. The concepts of privacy and services have been widely addressed in the literature. We further discuss how these definitions relate to the existing body of knowledge in the domains and what the implications of the new definitions are.

Service science is closely related to systems thinking and a foundational discipline upon which our modeling method was built. The service-dominant logic heralds and advocates a shift in the focus from the producer to the customer [Vargo and Lusch, 2011]. The definition of value that is closest to our proposed definition comes from the service science world: "We define value simply in terms of an improvement in system well-being and we can measure value in terms of a system's adaptiveness or ability to fit in its environment" [Vargo et al., 2008]. Yet, even this definition is still limited to the improvement of a certain quality, in this case, the well-being of a system, without a discussion about what well-being is. We propose our definition of a service: an exchange between actors, which facilitates desired outcomes by redistributing value and risk.

Privacy and security have become increasingly relevant with regulations and laws that have introduced constraints in the technical fields in recent years. The concepts of privacy and security are becoming central to system design and vice versa: Systems thinking could be useful for the contextualization and definition of these concepts, as they have outgrown their original disciplines. The application of systems thinking to privacy and security is an open area for exploration, and here we apply the value and reconciliation principles to privacy. We propose a working definition of privacy based on our value principle: Privacy is that which the observer defines as an acceptable input and output in order to construct and maintain an identity for a system.

In Chapter 8, we summarize the findings of the thesis and reflect on possible future research avenues.

2 Foundations

In this chapter, we present the theoretical foundations upon which the thesis lies. We use general systems thinking and interpretivism to define new principles for system design. These two domains enable us to explore and show the complexities of different points of view that are an indispensable part of the real world for which system designers create systems. Observers create conceptualizations that we call *systems*. Making these systems explicit through models enables system designers to understand and communicate the view points of the different observers in order to reach consensus. Here, we give an overview of general systems thinking, interpretivism, and our methodology, SEAM, for the modeling of systems.

2.1 General Systems Thinking

Bertalanffy, a pioneer in the systems-thinking field, observed that isomorphic laws emerge from different scientific disciplines [Bertalanffy, 1950]. These similarities lead to the conclusions that "*general system laws* [...] apply to any system of a certain type, irrespective of the particular properties of the system or the elements involved" [Bertalanffy, 1950]. General systems thinking (GST) is an inter-discipline that connects other disciplines through general principles [Weinberg, 1975].

Weinberg [1975] defines GST as an approach to thinking about problems when they fall outside of the traditional boundaries of research disciplines, as they are sometimes used before disciplinary research and sometimes bypassing and integrating them. GST is a way to conduct transdisciplinary research by borrowing knowledge that is produced in one discipline and using it in other disciplines. The lore of GST is that each discipline creates its own explanations of phenomena that are similar and are sometimes identical to those defined in other disciplines by a different vocabulary. Hence, GST identifies the common traits found in other disciplines so that these explanations can be moved across these disciplines. To be able to do so, GST uses the concept of a system to transfer knowledge between disciplines and distills principles that are valid for any and all systems.

2.1.1 Hard vs Soft Systems-Thinking

We distinguish between two streams of GST: (1) hard and (2) soft systems-thinking [Checkland, 1981]. Hard systems-thinking assumes that systems exist in the world independently of who is there to observe it. Whereas, soft systems-thinking (SST) is a way of inquiring into problematical situations, a way of structuring the world by conceptualizing systems to help us organize (in effect, decide on the relationships between entities that we see and the conditionality between them) the messy real world observations. The systemic inquiry in SSS is a system of learning for the observer. The observer learns how to structure what they see. For hard systems-thinking the systems exist independently of the observer. The observer is there to "spy" on and to engineer them [Checkland and Poulter, 2010].

In this thesis, we adhere to SST and develop further ideas about how to conduct systems practice, given the assumption of SST.

2.1.2 System

To quote Von Bertalanffy [1968], the subject matter of the general systems research is "the formulation and derivation of those principles which are valid for 'systems' in general." A system, put simply, is a description of anything we see in the world. To be able to transfer knowledge from, say, biology to marketing, we say that a cell is a system as a much as a consumer is a system. We can then transfer knowledge created by biologists about cells to and from consumers, thereby helping marketing experts to talk with biologists.

The term system is a conceptualization for what we observe. A system is a conceptualization held and created (implicitly or explicitly) by an observer. The system is a set of interrelated elements. The elements and the relationships, as well as the identity of the system, are all relative to and dependent on the observer. This means that to identify a system, we, as an observer, "recognize" a set of elements, interpret the relationships between them, and distinguish between the system and its environment. We use the following definitions adapted from [Regev and Wegmann, 2005a].

Definition 1 (System)**.** A system is a set of interrelated elements as defined by an observer.

Definition 2 (Environment)**.** The environment (of a system) is all of the systems that are not elements of the system of interest or the system of interest itself for an observer.

Definition 3 (Identity)**.** An identity of a system is a set of elements and relationships between them and the environment that an observer uses to distinguish between a system and its environment.

The term system is widely used: When we speak of systems, we can refer to biological systems, information systems, service systems, socio-technical systems, enterprise systems, sociopolitical system, economic system, ecosystem, etc. The terms for these different systems have been specialized because they are useful and used by researchers and/or people in a particular domain. We make use of the system concept as a way to cross the disciplinary boundaries and to bring knowledge from one research area to another. This approach is the signature of general systems thinking.

Research disciplines that are related to information and communication technologies but also management and marketing use specialized system-based definitions. The topic of the thesis uses the concept of a system from the GST point of view to draw conclusions that are valid to systems in general. With this, our findings are transferable to the other research domains by a mapping between the definitions of a certain type of system and a system as defined by us.

For example, Moore [1996] defines an ecosystem as “a collection of companies that work cooperatively and competitively to satisfy customer needs.” Mapping it to the system definition gives us the following interpretation: The elements of the system are companies, the identity of the systems is defined by the actions taken to satisfy customer needs. The relationships between the companies (systems) are cooperation and competition.

The specialized system definition that we adopt to name the type of systems we design is service ecosystems. Vargo and Lusch [2016] defines it as “a relatively self-contained, self-adjusting system of resource-integrating actors connected by shared institutional arrangements and mutual value creation through service exchange.” We use a definition closely related to the systems definition.

Definition 4 (Service ecosystem)**.** A service ecosystem is a system whose elements are actors who exchange services.

2.2 Interpretivism

Interpretivism is a paradigm that regards meaning as an emergent property of the relationship between an observer and their reality [Checkland and Holwell, 1998; Maturana and Varela, 1981]. Systems are a conceptualization (an interpretation/understanding) made by an observer on the basis of what the observer sees in the part of the observed reality called the universe of discourse (UoD) [Boman et al., 1997]. We reserve the term *entity* for what the observer sees in the UoD. We use the term *system* to refer to the conceptualization the observer makes of this entity. Thus, a system is a point of view [Weinberg, 1975]. This point of view emerges from the relationship between the observer and the entity in the UoD. This explains why, for different observers, the same observed phenomena can result in different systems, indeed different interpretations of reality [Regev and Wegmann, 2005b; Weinberg, 1975]. There is a dependency between the conceptualization that an observer has and their perception of the UoD. This dependency means that the commitment the observer holds prompts them to look for the elements and relationships that they can recognize with their conceptualization [Olivé, 2007].

The use of interpretive methods in the IS research domain is usually used and discussed in juxtaposition to the positivism paradigm with its core belief in an objective, observer-independent reality [Checkland and Holwell, 1998; Walsham, 1995]. The relationship of the observer with "a reality" helps interpretivists avoid the trap of solipsism, where every observer has their own reality with no connection with other observers [Maturana and Varela, 1981].

The shared *reality* between observers helps them to create a shared meaning, a social construction. According to Weick [1990], in a socially constructed world, the conceptualizations we hold ("the map") create the reality we see ("the territory"). Hence, co-constructing their conceptualizations makes sense to a group of people who share a similar experience.

2.2.1 Requisite Variety

Given the presence of multiple points of view for describing any given situation, their use could be to paint a rich picture of the situation under observation and to see the multitude of models as "devices (intellectual devices) which are a source of good questions to ask about the real situation, enabling it to be explored richly." [Checkland and Poulter, 2010] Flowing from this is also the possibility to accumulate a requisite variety of models. The principle of requisite variety was coined by Ashby based on Shannon's tenth theorem [Ashby, 1958]: The solution space for a problem has to be at least as rich as the problem space. This means that, in order to be able to deal with the complexity of system design problems, designers need to gather the multiple points of view and to have a varied tool-set for modeling the system.

A consequence of the interpretivistic and the requisite-variety principles is that there is a need to accommodate different points of view of the system(s) under observation. As Checkland and Poulter [2010] state "these purposeful activity models can never be descriptions of (part of) the real world. Each of them expresses one way of looking at and thinking about the real situation, and there will be multiple possibilities."

2.2.2 Limitations to Interpretive Research

Just as any other dichotomy, the division between positivism and interpretivism is a simplification. In this section, we reflect on interpretive research. This section is based on parts of our reflections from the following paper: Blagovesta Kostova, Irina Rychkova, Andrey Naumenko, Gil Regev, and Alain Wegmann. Systems-thinking heuristics for the reconciliation of methodologies for design and analysis for information systems engineering. In *International Conference on Research Challenges in Information Science, RCIS*, 2020.

Positivist research creates objective, generalizable knowledge (e.g., laws of physics) that describes the physical world, is absolute, and can be reused independently from the context. Nevertheless, researchers in natural sciences recognize that they operate under a certain set of assumptions that have to be updated because of our indirect and observer-dependent way of observing reality. Einstein [1931] reflects that "The belief in an external world independent of the observing subject lies at the foundation of all natural science. [...] sense-perceptions only [indirectly] inform us about this external world, or physical reality [...] Consequently our conceptions of physical reality can never be final. We must always be ready to change these conceptions, i.e., the axiomatic basis of physics, in order to do justice to the facts of observation in the most complete way that is logically possible." The axiomatic basis or a set of assumptions could be seen as a scientific paradigm [Kuhn, 2012].

In another words, when the majority of a scientific community operates under the same set of assumptions and this knowledge becomes tacit, or invisible, similar to observer-independent laws of physics, then, there is a certain status quo. Communities undergo periods of revolutions when they explore the limits of their axiomatic assumptions. Hence, positivism and interpretivism are not two mutually exclusive categories of research [Weber, 2004]. Rather, interpretivism is explicit about the central role of the observer in creating knowledge, and positivists are aware of the limitations of the knowledge they create but do not discuss the observer as a vital part of the research results.

In this thesis, we propose new GST principles that are based on the interpretivistic research paradigm. In other words, they are a product of our interpretation of our own experiences. We reflect on the limitations of the interpretivistic research paradigm and pose the question, "Is the validity of our findings, in general, an oxymoron ?" [Onwuegbuzie and Leech, 2007].

Reusability of our Findings

We argue that the whole idea of research results, in the domains of system design, as being general (or context-independent) should be taken with caution. Once the results are presented as general, the researchers, who rely on the results or implement them in the context of their particular socio-technical system, can be absolved of any responsibility. Interpretivism, in contrast, makes the researchers and their view an integrated part of the research and its findings. Consequently, it is the responsibility of a researcher to choose and to reuse all or part of our heuristics in their context. Therefore, our findings are reusable but not absolutely or objectively, as they are subjectively reusable.

Generalizability and Reliability of our Findings

It could be argued that, if responsibility is in researcher's hands, then what about the reliability or generalizability of the results they produce? The results would be inevitably biased. According to the positivist research paradigm, the researcher is independent from the research; they provide objective observations (or measurements) that guarantee the objectiveness of results. Any researcher, by reproducing the same experiment, should obtain the same results. This implies reliability. According to the interpretivistic methods, the researcher is a social actor, a part of a socio-technical system they study, and it is through their observations that the system to be studied emerges and its identity is created. However, the observations are obviously biased. We argue that the socio-technical system is a product of the biases of its actors. They are not a threat rather a part of the system's identity, hence they have to be explicitly taken into consideration [Weber, 2003].

A possible contradiction that could be found is between our interpretivistic approach and the very nature of systems thinking. Interpretivism shies away from generalizability, whereas systems thinking is an inter-discipline that connects other disciplines through general principles [Weinberg, 1975]. However, any GST principles (or heuristics) are a subject of interpretation and contextualization. Hence, this interpretation is integral to constructing a systems thinking body of knowledge, that can be applied throughout.

Validity of our Findings

In positive research, the created knowledge is said to be absolute and can be validated (or invalidated) analytically (by deduction) or through experiments, with the use of falsifiable hypothesis. In qualitative interpretive research, the validity of knowledge can be demonstrated only within a given *frame of reference* [Cho and Trent, 2006]. This frame of reference labeled by some transactional validity defines "research as an interactive process between the researcher, the researched, and the collected data that is aimed at achieving a relatively higher level of accuracy and the consensus by means of revisiting facts, feelings, experiences, and values or beliefs collected and interpreted" [Cho and Trent, 2006]. Once the frame of reference changes, the knowledge can be invalidated. In the positivist paradigm, such a frame of reference is taken for granted by researchers as "something everyone agrees upon", hence it is often omitted (implicit). This creates an illusion of an absolute or objective validity. In interpretivism, the frame of reference, the context or the socio-technical system, is a part of the research, a variable of the equation; hence, it cannot be omitted, as we cannot claim that "everyone shares it". Interpretivism leaves a researcher no choice but to explicitly mention their frame of reference (and to identify a community that shares this frame of reference). Only within this frame of reference and for this community will the produced knowledge be valid.

For some researchers, our findings are potentially valid, but not "absolutely"; they are valid only within a given frame of reference. In the grand scheme of research pursuits, studies such as ours are natural precursors to a potentially better understanding of the field. After the accumulation of a critical mass of knowledge in the domain of systems design, these studies can be re-used in practice [Le Goues et al., 2018; Weick, 1989]. Any academic pursuit that investigates a new or under-studied phenomenon goes through stages of understanding: from chaos to heuristics to algorithms [Martin, 2009].

2.3 Systems-Thinking Methodologies

As noted by Baxter and Sommerville [2011], SST offers a seemingly miraculous way to solve problems by describing the situation. The systemic inquiry is a process of learning [Checkland and Poulter, 2010]. By continuously inquiring into the situation, with the help of models (that represent the systems viewed with each worldview/point of view), modelers learn about the conflicts between the viewpoints and about the situation. Moreover, this continuous process enables a co-evolution of common sense-making, as the conceptualization of the observed reality is communicated between observers.

The situations that result in human affairs could be considered problematical [Checkland and Poulter, 2010]. Considering the different points of view and accommodating them, up to a point where people can live with the newly described situation, is at the heart of SST. Applying SST is a never-ending process of learning that can bring about change – a change that is both desirable and feasible – by inquiring into the situation [Checkland and Poulter, 2010]. By bringing change, the situation becomes a new one altogether. Thus, the learning process continues.

The concrete application of SST requires a methodology that, rather than a method or technique, is flexible and adaptable to the uniqueness of human situations [Checkland and Poulter, 2010]. "A methodology, as the word indicates, is a logos of method; that is to say it is a set of ongoing principles which can be adapted for use in a way which suits the specific nature of each situation in which it is used. [...] provides a set of principles which can be both adopted and adapted for use in any real situation in which people are intent on taking action to improve it." [Checkland and Poulter, 2010]. SST Methodologies are a concrete implementation of the systems-thinking philosophy [Banathy and Jenlink, 2003].

2.3.1 The Modeling Process

Models and modeling are an important part of SST methodologies. We use the conceptual-modeling literature to understand the process better and to tie it to interpretivism. Figure 2.1 depicts the process of modeling. Modelers observe a portion of the "reality" called a universe of discourse (UoD) [Boman et al., 1997]. In the UoD, there are, between them, entities and relationships that the modeler/observer perceives. The observer holds mental models, or conceptualizations, regarding the observed phenomena. These mental models are not precise, correct, or scalable [Norman, 1983]. Modeling is a process of abstraction; it could be seen as a back-and-forth 'translation' between observation, conceptualization, and explicit models.

Models are used to unify perspectives, as they are explicitly observable artifacts [Bézivin, 2005], unlike the implicit mental models that people hold in their minds. Nevertheless, not all models are the same, as they differ greatly, based on their given purpose for modeling. Kühne [2018] defines two categories of styles of modeling (or modes of modeling), namely, exploratory and constructive modeling. The exploratory modeling mode is employed when modelers, with their goal being to understand, describe a system in an open world. In such situations, ontologies are appropriate models (less formal representations). The constructive modeling mode is employed when modelers design a system, their goal is to build the system under a closed-world assumption. Conceptual models are appropriate for capturing the formal descriptions of the system.

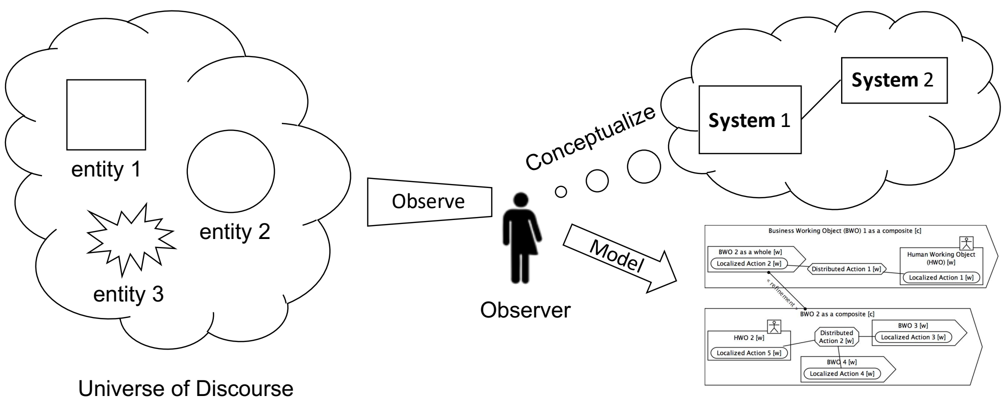

Figure 2.1 – Modeling Process

Model Representation

For modeling systems, an important part of a SST methodology is the model representations, either graphical or textual. As shown by Larkin and Simon [1987] and consequently by Mayer and Gallini [1990], a diagram is worth many or a thousand words. They found that the textual models are verbose but require less familiarity with a modeling convention/standard [Larkin and Simon, 1987].

Textual models are cumbersome to maintain and design. They are prone to errors and discrepancies because there are no rules between elements. Textual models cannot scale or be trivially transformed into executable models, unless we use an executable domain-specific language. The upfront investment of learning a modeling methodology is compensated over time as, later, the reading of models is similar to taking shortcuts because the signs are known well. The textual models are in order when making explicit, less familiar, or newly formed conceptualizations. And ontology-based graphical models are in order when the modeled phenomena is better understood. We use both graphical formalized models and textual descriptions in the thesis.

2.3.2 SEAM

In this thesis, we use the SEAM [Wegmann, 2003] SST methodology. SEAM helps system designers represent the value exchange and configuration through the modeling metaphor of services between systems. SEAM was built on foundations that include general systems thinking, philosophy, service science, software engineering, and enterprise architecture. SEAM is a family of methods that includes different types of models, viz. behavioral, motivational, and informational. In the remainder of the thesis, we use the behavioral service models, the service canvas, and the SAR model. Hence, we present here these models.

Behavioral Service Models

The behavioral models capture a service system's actors and the relationships between them. A behavioral model contains working objects (either business- or human-working objects) and relationships between them. The models are hierarchical: a working object as a whole (noted with "[w]") hides its implementation details from other working objects. With the refinement relationship between working objects, we relate and refine working objects as a whole to the working object as a composite (noted with "[c]"), and we "see" how the service system is organized. Service-system refinement means that a working object as a whole is an abstraction of a working object as a composite; and vice-versa, a working object as a composite is a refinement for a working object as a whole.

The *business element* represents a service-providing value network. The business element can be seen as a black box or as a white box. If the business element is shown as a black box, the only other element it contains is a *service* (and its *properties*). A *service* is an interface for the value that an element provides, where the external elements cannot see how the *service* is implemented internally. For a modeler to depict how the internal organization of

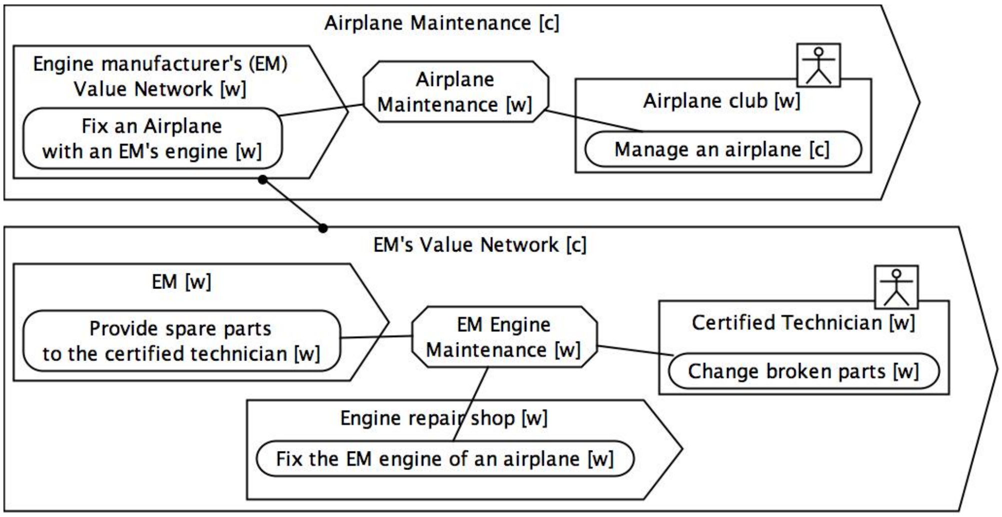

Figure 2.2 – Example of A Behavioral Service Model

a *service* is done (i.e., the transition from black box to white box), the *business element* can be refined through a *refinement* relationship. When the *business element* is shown as a white box, the model includes elements that comprise the value network that delivers the service: for example, business elements and human elements. These other elements participate with their *services*, through an *exchange* relation to the service *process*.

Figure 2.2 depicts an example of the SEAM behavioral service model that shows a service system called *airplane maintenance*. There are two actors: a business working-object named *engine manufacturer's (EM) value network* and a human working-object named *airplane club*. The process in which they interact is the *airplane maintenance* process. The *engine workshop* provides the service *fix an airplane with an EM's engine*. The service model includes the details about who is a part of the value network that delivers the service *fix an airplane with an EM's engine*. The model is refined with the service system as a composite of the *EM's value network*. The composite service system includes *EM*, a *certified technician*, and an *engine repair shop*. The value network disregards organizational boundaries and includes, based on the service they provide, all actors who collaborate in a service process.

A Service Canvas and a Supplier-Adopter-Relationship Model

The service canvas we use here is based on the SEAM behavioral model and is used together with the supplier-adopter-relationship (SAR) model. Our service canvas consists of nine elements, specifically, a supplier, the supplier's partners, an adopter, the adopter's influencers, a main competitor, regulators, components provided by the supplier and their partners, features of the service that the supplier gives to their adopter, and benefits that the adopter and their influencers will receive by using the service. The main benefits of the canvas are that it simplifies the original service models to a form understandable without prior tutoring. Figure 2.3 shows the relationship between the service canvas, the SEAM behavioral models, and the SAR model. Based on the notion of a value network, some elements in the canvas are implicitly logically connected, but the canvas shows only the blocks without relationships. The supplier and the partners, as well as the adopter and the influencers, represent different

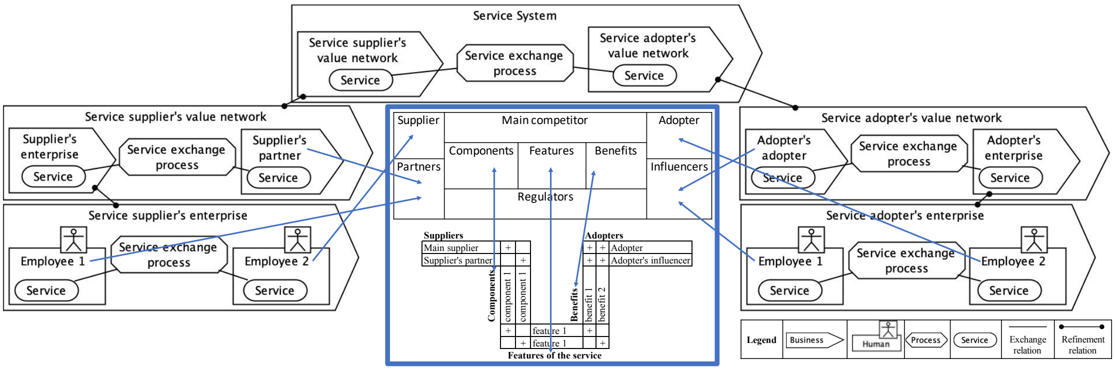

Figure 2.3 – Relationships between the SEAM behavioral models, the service canvas, and the supplier-adopter relationship model.

value networks, based on the hierarchical representation from the SEAM behavioral model. We could depict the different entities at different levels, as well as show the regulators and the main competitors in the behavioral models. For the sake of readability, we omitted these details from the models shown.

The SAR model details the service-exchange relationship between an adopter and a provider of a service. The service provided by the supplier is modeled by its features that stem from components provided by the supplier's value network (either the supplier or any of their partners). And these features provide a benefit to the service adopter's value network (either the adopter or any of their influencers). The SAR maps to additional annotations in the behavioral model, cf. [Wegmann et al., 2007].

Figure 2.4 depicts how to relate canvases hierarchically. The logic follows the hierarchical decomposition of the SEAM behavioral model. These relationships include the following steps: (1) a component from the first level as it becomes the service that is modeled in the second level, (2) the first-level supplier is an adopter in the second level service, (3) the adopter of the business service becomes an influencer, (4) one of the first-level partners becomes the supplier of the second-level service, (5) the other partners might become influencers but not necessarily, and (6) the features of the first-level canvas relate to the benefits for the second-level adopters.

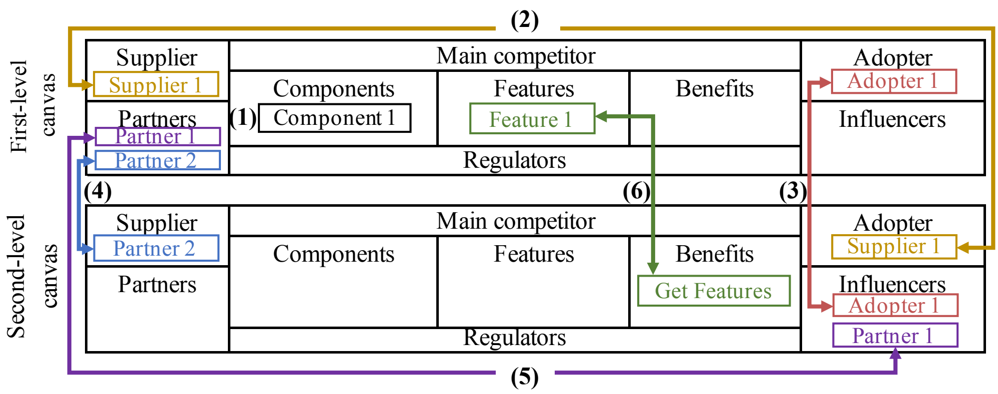

Figure 2.4 – Relationship between a first-level canvas and a second-level canvas.

3 The Principle-Pattern-Practice Structure for Soft Systems Thinking

In this chapter, we propose the principle-pattern-practice (PPP) structure for SST. With the PPP structure, to fuel the creation of new general principles, we are able to integrate principles from outside and inside SST. This is done by operationalizing the principles through modeling patterns (in many cases modeling with SEAM, but not only) and applying these patterns to concrete examples in practice.

This chapter is based on the following paper: Blagovesta Kostova and Alain Wegmann. Service-oriented business design for IT students. In *IEEE Frontiers in Education Conference, FIE*, 2018.

3.1 Introduction

We devise a meta-principle for explaining and teaching SST, with the concepts of principle, pattern, and practice (PPP). The PPP enables us to structure the contributions presented in this thesis. We developed the PPP as a set of concrete teachable heuristics in order to introduce our students to SST and to show them how to apply abstract SST in practice. We see principles, patterns, and practice as heuristics for dividing our knowledge into different levels of abstraction and scopes of applicability (from most generic to most concrete). It is by going back and forth between these three levels that we teach future system designers to reuse their thinking style in different contexts. We categorize these heuristics accordingly. We define the terms as follows:

- A principle is a generalized rule that applies in many contexts. The example principles in this chapter come from SST and business theory.
- A pattern is a regular form or sequence discernible in the way in which something occurs. Thus, a pattern is a sign of order from seemingly unconnected elements. For us, the pattern is SEAM, a concrete systems method.
- A practice is the actual application or use of knowledge.

Our research project is a design science research (DSR) project that follows the Information Systems Research Framework [Hevner et al., 2004]. The result of our DSR project is an artifact that answers both a practical and a research question. The results in this chapter are based on the course that we gave during the 2016/2017 academic year. The DSR artifact is a description of a teaching approach that answers explicitly the research questions. In the categorization of Gregor [2006], the contribution to the knowledge base is an analysis and a description of an approach for teaching service science, with the help of SST and various business theories.

We validated our interpretations through two surveys, during the semester with all students, and through semi-structured interviews, after the end of the course with a small set of students. The purpose of the first survey was to understand the expectations and background of the students in the classroom. The purpose of the second survey was to test our hypothesis about how well our teaching method worked.

With the students from the current class, we also co-constructed the course for students of the following year. At the end of the semester, the students reviewed what they learned on the subject matter and the teaching staff reviewed what we learned about the teaching approach. We then "traded" and reflected upon possible improvements.

Our main findings are as follows:

- It is easier for students to apply abstract theories (business concepts and SST) in order to analyze new situations, but only after many repetitions of the same systemic method.
- The human factor in the course — the professor and the guest lecturers — influence the motivation of the students to take the course.
- The closer the context is to the students' experiences, the easier it is for them to understand it.

This chapter has the following structure. In Section 3.2, we describe the research methodology. In Section 3.3, we describe our teaching approach towards service-oriented business design. In Section 3.4, we present our findings from our surveys with students. In Section 3.5, we discuss open questions. In Section 3.6, we present related work. We conclude and give directions for future work on the topic in Section 3.7.

3.2 Research Methodology for Investigating the Principle-Pattern-Practice Structure

We use the Information-Systems Research Framework [Hevner et al., 2004] to organize our research (see Figure 3.1). The relevance of our research comes from the observation that the business environment has an increasing need for IT engineers with professional skills [Shuman et al., 2005]. The research rigor stems from the knowledge base and the systematic application of theories and evaluation methods from the it. Our goal is to solve a practical problem and to contribute to the knowledge base with the help of an artifact: a service-oriented teaching approach to explaining business concepts to IT students, who are future system designers.

The DSR framework has a two-fold purpose. First, we answer a concrete practical question that comes from the application domain. Our practical question is, How can we teach IT students service-oriented concepts so they can relate to their previous computer-science experience in understanding a business environment? Second, we address a research question, about

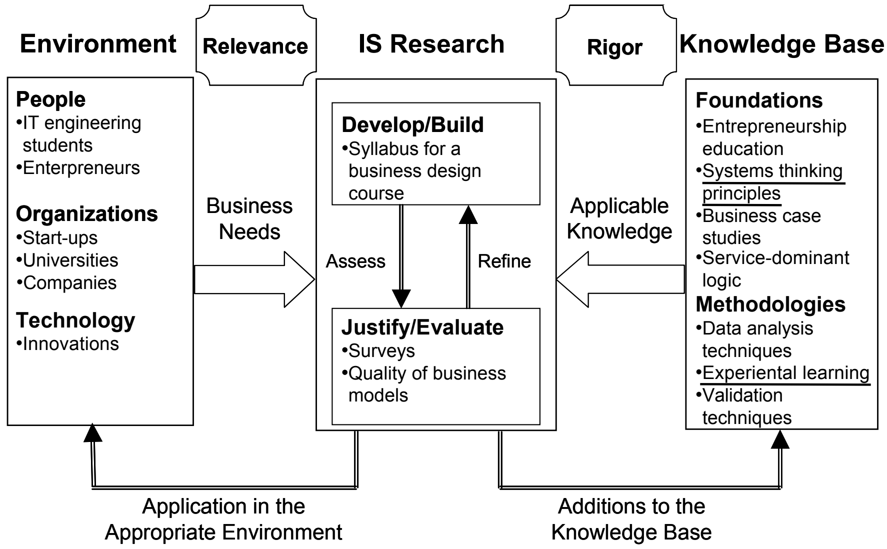

Figure 3.1 – Design Science Research Project Based on Hevner et al. [2004].

how to teach abstract service-science principles to IT students and potentially engineering students. Our artifact is an explanation on how to teach service-oriented business design both systematically (in an ordered manner) and systemically (based on SST). With our artifact, we contribute a theory of analysis and description [Gregor, 2006] to the service-science educational literature.

The practical environment for our project is an elective course for the business design of IT services in the School of Computer and Communication Sciences at École Polytechnique Fédéral de Lausanne (EPFL) for master students. Our environment involves people (IT students, entrepreneurs, teaching staff) and organizations (universities, companies, startups). The chapter is based on our observations from the 2016/2017 academic year. 26 students attended the class. The duration of the course is 14 weeks in the spring semester (of a two-semester academic year). In addition to the teaching staff, there were six guest lecturers: four presented their own companies, one presented sales heuristics for helping customers discover the right service (based on [Mattson, 2009]), and one led a creativity session "Lego Serious Play", where students used Lego metaphors to model their projects.

We draw our theoretical assumptions for creating the artifact from SST, service science, marketing, experiential learning, embodied cognition, and educational theories. To evaluate the artifact, we use a selection of qualitative evaluation methods: surveys and interviews [Patton, 1990].

We conducted two surveys — one in the fourth week and one in the last week of the class. 26 students responded to the first survey and 22 responded to the second. After the end of the class, we interviewed three students on their overall impression, motivation, acquired skills and knowledge, and the future evolution of the class.

3.3 Service-Oriented Design with Principles, Patterns, Practice

We use principles from three fields: SST, service science, and marketing (see Figure 3.2). We use SEAM [Wegmann, 2003] as a modeling pattern. Lastly, we use different examples and cases as practice to apply the principles through the modeling pattern.

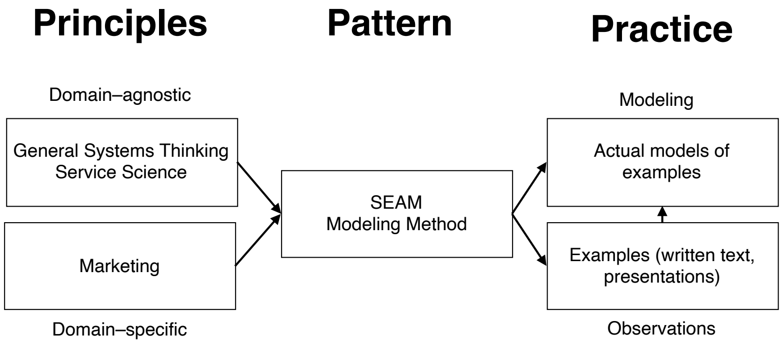

Figure 3.2 – Service-oriented teaching approach.

3.3.1 Principles, Patterns, Practice

Principles

Service science is an interdisciplinary discipline, similar to and partially based on SST, in its views of reality in connected systems. The focus of service science is on analyzing the business environment. Originally, the underlying logic of service science, the service-dominant logic as an alternative to product-dominant logic, emerged from marketing.

Our running examples are based on the two following principles: (1) moving the company's perspective, which entails shifting the strategy of the company to focus on the customers instead of on the product [Levitt, 1960], and (2) changing the marketing strategy of a company, which entails a non-trivial change in a company's value network configuration [Ahlstrand et al., 2001] (the counter argument to the first heuristic).

These heuristics are abstract as they are generalized to apply in many situations: a principle applies to many contexts. We believe that SST and service science are useful to IT and engineering students because these principles provide a framework for investigating business cases, real-world settings and, ultimately, for helping students analyzing and understanding their roles and opportunities in their professional lives after university. For this purpose, we present these principles on a lower abstraction level to students so they can relate to the principles and embody their knowledge as tacit.

Patterns

To help students understand the SST and service-science principles, we use a systemic modeling method called SEAM [Wegmann, 2003]. We used two types of SEAM models in the classroom - a canvas and a supplier-adopter relationship (SAR) model [Wegmann et al., 2007]. The two models are complementary. The canvas, called a service system model, shows the service and the different actors, e.g., partners, competitors, influencers. The SAR model focuses on the relationship between a service supplier and a service adopter. The service has features that correspond to the adopters' benefits on one side, and the features are provided by components provided by the suppliers and their partners.

Practice

The practice in our approach is the application of acquired knowledge and first-hand experience that students have in different contexts. We apply the pattern (the two SEAM models) to various cases in order to analyze and to model them, and we connect the experience through reflection and generalization to the principles. The practice level is the most concrete one, where students instead of the teacher are the driving force.

The practice is based on observations that students make during the exercises – either guest lecturers' presentations, or their own group projects. The observations of the real world tie to the epistemological foundations of our method, where students have to observe how they create their assumptions.

3.3.2 The Experiential Learning Process

We use experiential learning as a process for our content delivery [Kolb, 1984]. Kolb's experiential learning cycle has four steps - concrete experience, reflection, generalization, repetition. According to the corresponding step from Kolb's cycle, we schedule the content of the course from the three different categories (principles, patterns, practice).

- Experience: observe and experience different contexts. During the semester, we present to the students the examples from the different papers, three case studies on Amazon that we composed, the businesses presented by guest lectures, and a group project.
- Reflection: use SEAM models and heuristics to structure (model and explain) the observed universe of discourse in a service-oriented way.
- Generalization: systemic principles, service-dominant theories.
- Repetition or another experience.

We take under consideration two additional factors in designing the course: the theory of embodied cognition and spaced repetition.

Barsalou [2010] shows that cognition is an inseparable part of the brain's modal parts for perception, i.e., verbal, motion, vision. Furthermore, in a constructivism view, the learner and the educator are both facilitators in the knowledge creation process [Aqda et al., 2011]. The cognitive distance to a subject is important for developing confidence (by applying a known cognitive schema) and creativity (by exploring unknown territories and creating new cognitive schemas) [Nooteboom, 2000; Nooteboom et al., 2007]. To evaluate how students felt about the cases, we look further into the cognitive distance between the students mental maps and their perceptions.

The second theory we use is about spaced repetition as a means to achieve automaticity (or repetition priming) [Logan, 1990]. We consider three major characteristics:

- The more times a stimulus has been encountered, the faster an individual reacts to it. We repeat as often as every week the same activity (service-oriented modeling) with different case studies.
- The benefit of repetition is still dependent on an individual's traits.
- The associations between the stimuli and the contextual interpretations influence the benefit of repetition. As we follow an experiential learning cycle, we reflect on the experiences after each activity, hence, we create these associations.

Example – Marketing Principles through the Service Science Lens

To illustrate our teaching approach, we use an example of how we use the heuristics from the marketing literature [Ahlstrand et al., 2001; Levitt, 1960], together with a service-oriented toolkit. Levitt questions the product-oriented approach of companies and calls for a change to a customer-orientated mindset [Levitt, 1960]. This deceptively simple change of perspective leads a chain of cultural and organizational changes [Ahlstrand et al., 2001]. The word "product" has a connotation of an item to sell; with such a sales-centered point of view, a company "speaks" the language of manufacturing and production (quotas and sales forecasts) and not the language of customers (values, benefits, needs, use).

Our modeling methodology includes the SAR model, with analysis of corresponding components provided by a service supplier, the features of the service, and with benefits for a service adopter. Figure 3.3 depicts the product-oriented example of the railroad industry from Levitt's paper [Levitt, 1960]. In this model, we see that the main service offering of the service providers includes the infrastructure for the railroad – stations, rails, trains. The service adopter is a passenger on a train, and the reason for traveling remains unknown. The only motivation that the service provider considers is that the passenger wants to go from Station A to Station B. The partners of the railroad company (or in service science terms, the value network that provides value to the service adopter through a service collaboratively) includes

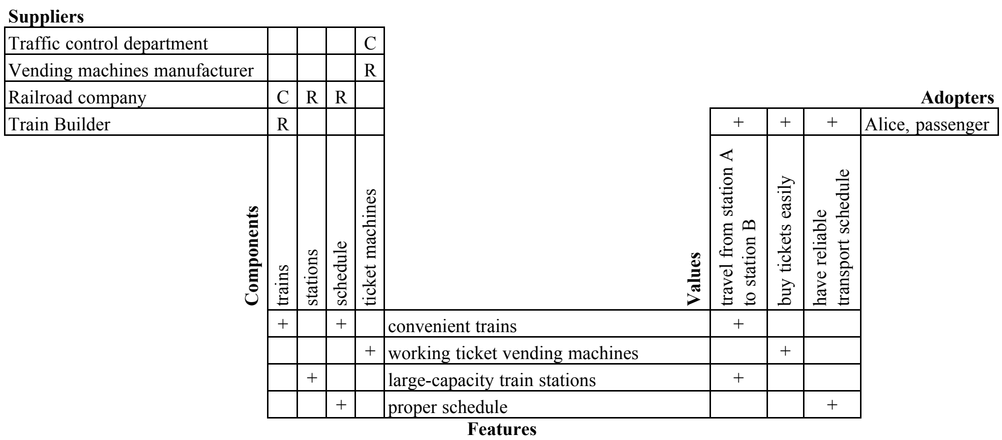

Figure 3.3 – Product-oriented SAR model of the railroad business.

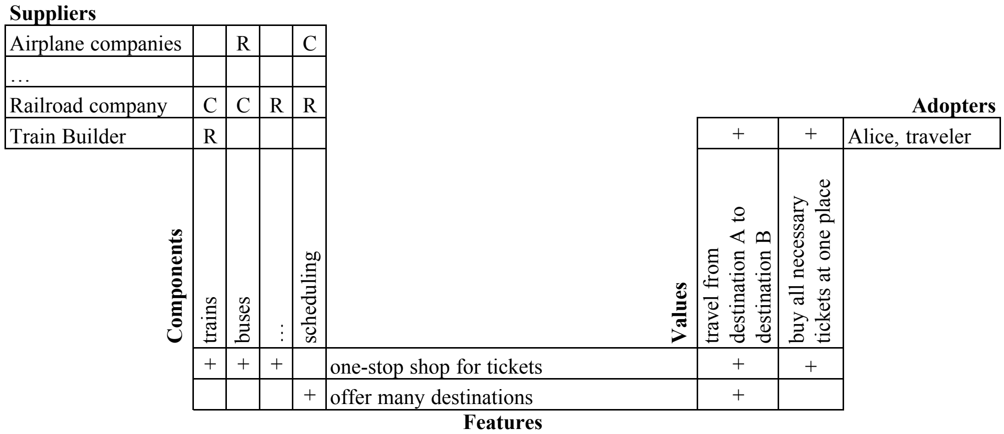

Figure 3.4 – Customer-oriented SAR model of the railroad business.

the state, the ticket vending machine manufacturer, the traffic control department, etc. We see how their alliances, as in this model, differ considerably from the value network necessary for shifting from a product-oriented to a customer-oriented perspective.

Figure 3.4 depicts the second model, or the customer-oriented service system. In this model, the service adopter is a traveler. The modeling process starts with understanding the benefits of traveling from Destination A to Destination B. The scope of this transit expands because traveling from Station A to Station B is a part of a larger journey. The full package needs to include other means of transportation, i.e., airplanes, buses, taxis. The features of the service are a direct response to the benefits for travelers.

Students begin by analyzing the value network of the supplier and, only afterwards, they model and conceptualize who will benefit and how from the service. The example shows primarily the stark difference between conceptualizing what is already assumed to be known (a railroad company provides trains and stations) and asking questions to obtain new information ("Why would a person travel to a station?")

Ahlstrand et al. [2001] questions the change in perspective from a product-oriented company to a customer-oriented company and the necessary capabilities for facilitating the change. The corresponding business heuristic is based on a principle in systems thinking: the regulatory principle that every system tries to preserve its state (homeostasis); and to do so, the system opposes any change that can bring its inner state to inconsistency.

In the SAR model, we observe the differences in the value networks for the two situations. Using these models, we analyze the required change: is it only slightly different or is the change significant? If the change is major, a company might have to explore a territory that is beyond its competence and capabilities. We relate this change to the epistemological bases of knowledge: If a company has no observation over a certain portion of reality, it can have little to no conceptualization of this reality. Hence, it would be nearly impossible for it to even perceive the possibility of change, much less to actually make the change.

3.4 Results from Applying Principles-Patterns-Practice in Context

Here we present the evaluation of PPP based on two surveys.

3.4.1 First Survey

We conducted the first survey during the fourth week (out of fifteen weeks). All students participated in the survey (26 in total). The main goal was to collect opinions on the expectations, background, and motivation of the students who took the course (results in Figure 3.5.

At the beginning, most students decided to take the course because they wanted basic business knowledge. However, at the time of the survey (fourth week), the desire for basic business knowledge decreased. The main reasons the students continued with the course were the presence of guest speakers, and both the professor's interesting background and his passion for the subject.

After the fourth week, the number of students who have an interest in learning something new is the same. This gives us grounds to believe that the students expect that there will continue to be something new to learn from the course. We find it intriguing that at the beginning of the class no student indicated that they wanted to pursue a project or an internship in the domain of business design. In their fourth week, however, nine students said they were interested in doing this.

In addition, we asked students to give their opinion on their preferred learning activities. The activities most liked were analyzing case studies to understand business concepts in context and working in a group to develop their own ideas. The most disliked activities were theoretical lectures and presentations in front of the class.

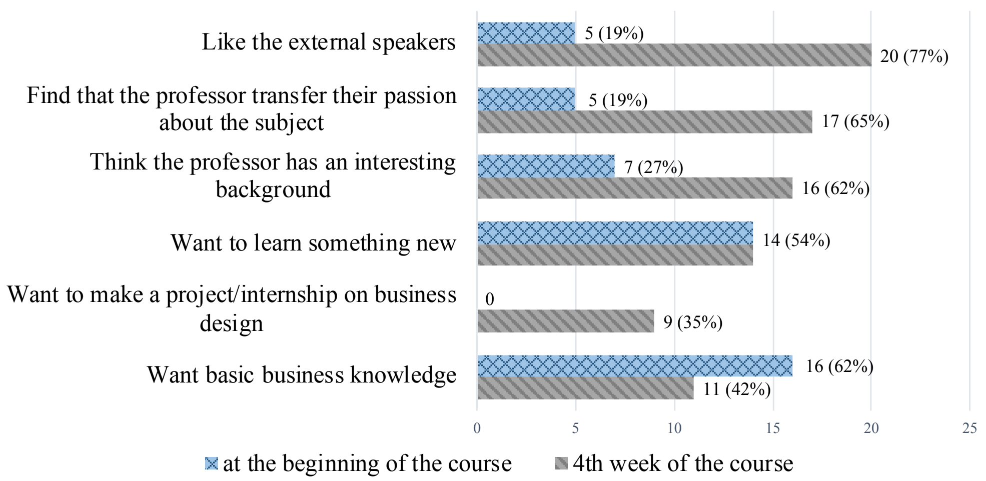

Figure 3.5 – Motivation and expectations of students

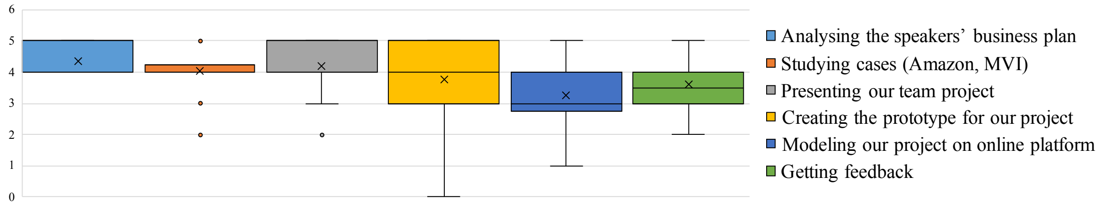

Figure 3.6 – Activities that students liked during the course

3.4.2 Second Survey

We conducted the second survey during the last lecture of the course (fourteenth week). 22 students participated in this survey. We asked them questions in categories: on the activities they liked (see Figure 3.6) and what knowledge they felt they had acquired (see Figure 3.7). All questions follow this scale: 1 = Strongly disagree, 2 = Disagree, 3 = Neither agree, nor disagree, 4 = Agree, 5 = Strongly agree.

The activities most liked were the experiential activities: the three top activities are analyzing the speakers' business plans (mean = 4.4), studying the practical cases (mean = 4.0), and working on their own project (presenting with mean = 4.2 and prototyping = 4.0). The activities students disliked were modeling their assignments in the online platform (mean = 3.3), which support our modeling exercises, and receiving feedback on their models (mean = 3.6).

The next set of questions probed what students believed they had learned and understood from the course (see Figure 3.7). For a start, students gave the highest value to the difference between product-oriented (or goods-dominant) and service-dominant logic (mean = 4.5). The other take-away from the course was the thinking model that students would reuse (mean = 4.1). Students understood the relationship between different parts of the course, e.g., examples, case studies, the group project, papers, etc. (mean =4.1). Students had difficulties understanding the idea of principles, patterns, and practice (mean = 3.2), relating concepts from the course to the read business papers (mean = 3.4), and launching a startup (mean = 3.4).

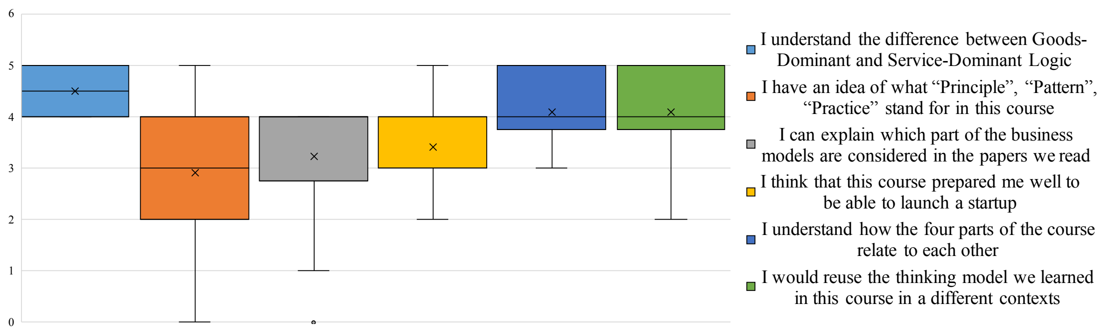

Figure 3.7 – Knowledge that students believed they acquired

3.5 Discussion

3.5.1 Principles, Patterns, and Practice as a Way to Connect Different Fields

The results from our second survey report that students could not understand what we meant by principles, patterns, and practice. From this, we learned that we have to explicitly explain our teaching approach to the community and to our students. The idea of PPP is based on our previous courses in which we did not present these ideas to the students, rather we expected to build the knowledge and understanding with them. We acknowledge the limitations of the constructivist teaching style. We decided to guide the students of next year's classes towards the meta-principles.

Nevertheless, students acquired knowledge about how to relate different fields, and they adopted the mindset of the service-dominant logic, which was our goal. Due to their answers on the exam, we believe they have embodied service-oriented thinking.

3.5.2 Emotional Proximity

We also observe that the emotional proximity to the context influences the engagement of the students; the closer the context is, the easier it is for students to immerse themselves in the details. Third, a great part of the outcome for engineering students in these non-engineering classes depends on their tolerance of uncertainty.

It is only by practicing that we can acquire or perfect a skill. Many people are uncomfortable experimenting with something they are not familiar with, this phenomenon is not exclusive to students. But as our students are in our classroom to learn something new, we try to make them experience unfamiliar settings that put them outside of their comfort zone. Students practice analyzing the environment by, for example, writing down explicitly their assumptions, talking to people to collect information, working in a team, handling interpersonal relationships, and presenting in front of a public. Even unwillingly, they can acquire feedback form the environment and construct mental models.

We, as humans, have cognitive maps that help us deal with complexity [Eden, 1992]. We observe in the classroom that students prefer exercises with cases closer to their personal context. For example, a bed manufacturer (with a business background) presented their company to the class. He put a strong emphasis on the difference between typical beds and his smart beds (with sensors in the beds, data analytics, mobile applications). The students preferred, however, the presentation by an ex-IT student who started a burger company with friends, without any technology behind the burger business. The burger company has a venue on campus. After the presentations, the students modeled the businesses, while the speakers were available to answer questions. Even if we account for the difference in personality and presentation style, our survey shows that students prefer to work on cases in which they can imagine being a part of (such as the burger company).

Indeed, one of the preferred presentations was the one given by a student from the same master's program. The speaker started a company with a friend and worked on it in addition to their studies. Students can imagine themselves running a small company, in addition to their studies, more easily than imagining themselves being the CEO of a company such as Amazon.

3.5.3 Uncertainty

We observe a certain correlation between how much students benefit from the course and their tolerance towards uncertainty. Most of the frustration in the life of an entrepreneur comes not from risk but from uncertainty [Bhide, 2003]. Tolerance for uncertainty is hard to cultivate in a classroom environment but this is possible. The classwork in our course is of such nature that there are no absolute correct answers. We encourage students to explore the cases by asking questions and imagining situations. With this approach, the teachers are not able to say that a model is (in)correct. The students have to explain their reasoning and support it with evidence. Our goal is to help students become confident in their own knowledge. All this stems from the constructivism view of the learner as an active participant in the knowledge creation process.

3.5.4 The Pitfall: "If the only instrument you have is a hammer, all problems are nails"

SST is not a panacea for solving problems. It is a way to look at the world and see connections between scattered pieces and to give meaning to what we see. We emphasize, however, the need to understand the subjectivity of service science and SST. Models are dependent on the observer/modeler and their subjective interpretation of the world, their goals, and their experience. Moreover, service-oriented and product-oriented mindsets can complement each other in a beneficial way. In the business and academic settings, every successful project needs both depth and breadth. Service-dominant and product-dominant logic can contribute to these different parts.

3.5.5 Course Co-creation with Students

Students felt they had an effect on the course's content and its structure because we collected feedback from them, discussed our interpretations, and communicated the changes that stemmed from this process. This technique is nothing new in the world of business, where companies use co-creation techniques to stimulate the customers' long-term loyalty. Our initial idea was to use the surveys as an instrument to understand our students and to devise a course that fits their needs and expectations. But the added benefit was that students became involved in the course and felt ownership.

3.6 Previous and Related Work

The content for existing service-oriented courses can be broadly categorized in three types: (1) introductory course to service science, (2) service management, and (3) service engineering [Wei et al., 2010]. Our course combines these three content types. We include service strategy, service design, and service operations in the term service management [Glushko, 2008]. We also explain the meaning of these services in terms of logical reasoning (to analyze motivations), behavioral semantics, and refinement theories (to analyze service structure). Non-computer-science students can take our courses but computer-science students will relate more to the "underlying" theory of services.

This chapter is the full result of a previously published short paper [Kostova et al., 2017]. There, we presented our assumptions on how to relate principles, patterns, and practice, what content to choose based on the emotional distance to students, how to conduct the research project, and how to deliver the course based on experiential learning.

We apply this teaching approach in a second course, called Enterprise and Service-Oriented Architecture, delivered by our research group. We have previously shown the benefits of experiential learning [Regev et al., 2009] and the role of ethnographic methods in the classroom [Regev et al., 2015].

3.7 Conclusion

In this chapter, we have presented our teaching approach towards service design with the PPP structure. PPP helps students, who are future system designers, to understand and apply in practice SST. Our approach is based on the notions of principle, pattern, and practice. We have described these three levels of abstraction. We have presented the results from two surveys we conducted with our students during the spring semester of the 2016/2017 academic year. Our main findings are that students understand and adopt the service-oriented mindset after taking the course, and that the human factor (lecturers, teaching staff, and the professor) is important for students to relate to the new knowledge, and to be able to embody it.

4 [Pattern in Practice] Service Modeling with Business Stakeholders

This chapter is an account from a concrete experience that we had, therefore,it is the first of the steps in the experiential learning cycle. Here, we show the use of a pattern in practice. The pattern is the service modeling canvas based on SEAM. The practice is our participation in a collaborative project, between our research group and a consultancy enterprise, for integrating a CRM system in a large financial institution. The concept of value was already present in the service canvas, as it models benefits or values for service adopters. During and after the experience, we inquired further into a more specific definition of *value* and into what, in practice, modeling value could bring. These reflections are the second step of the experiential learning cycle. We formalized our reflections in the following paper, where the chapter originates: Blagovesta Kostova, Lucien Etzlinger, David Derrier, Gil Regev, and Alain Wegmann. Requirements elicitation with a service canvas for packaged enterprise systems. In *IEEE International Requirements Engineering Conference, RE*, 2019a.

4.1 Introduction

We present the results of a tripartite project between research and business, in the context of a technology-transfer relationship. The parties of this collaboration were our research group from EPFL and two industry partners: a customer relationship management (CRM) systems integrator, called Nexell, and their customer, a multinational financial institution that we call AFI. Nexell offers integration consulting services to their clients for CRM systems based on Salesforce.com. The goal of the collaboration was to produce the early requirements for a CRM integration project conducted by Nexell for AFI.

AFI has several thousands of employees, in more than forty locations worldwide. The CRM integration project consisted of fourteen requirements-elicitation workshops, in which around forty people participated. During the workshops, we employed SEAM, the service-oriented enterprise-architecture method developed at LAMS [Wegmann, 2003].

A CRM integration project is a typical example of the implementation of modern enterprise information systems, in which organizations choose customizable, general-purpose systems (e.g., Salesforce.com, SAP) instead of developing the software from scratch [Melgarejo, 2012]. These organizations seek the services of specialized CRM integrators in order to tailor the

CRM system to the organizations' specific needs. CRM integrators must understand what the business requirements are by identifying the expressed – and hidden – expectations that triggered the client's decision to initiate a CRM integration project. CRM integrators typically use the following process:

1. Analyze the business environment of their clients ("as-is" analysis)
2. Propose a configuration of the CRM system that will fit the organization's needs ("to-be" proposal)
3. Define the intermediary steps of the transition between the current and the future state ("gap" analysis)
4. Setup, configure, and customize the CRM and train key users while providing ongoing support

The problem that we identify and address in this chapter is based on our observations that, over the years, the customers of CRM integrators are increasingly reluctant to pay for the first three steps of the project. From our experience, this is due to the fact that customers usually know their business well and believe that what they want is what they need. This leads customers to consider the elicitation of CRM requirements as a pre-sales cost that CRM integrators should cover. The integrators face a challenge in convincing customers to even elicit their requirements. They must either show the value of the elicitation phase or find ways to reduce the time and cost of these steps. Nexell found that SEAM helped them on both accounts. The involvement of LAMS in this project was centered around the following practical question: *"How do we elicit realistic CRM requirements that fit the client's needs quickly and at a low cost?"* In this chapter, we provide a detailed account of our collaborative project and our findings from it.

We learned many lessons from this experience. One observation is that even if a client is unwilling, in the beginning, to elicit their requirements, CRM integrators can convince them, but only if (1) the required time is short, (2) the cost is low, and (3) the risk:benefit rationale is convincing. We found that people at every organizational level were willing to share information when the conversation was framed around how they work to deliver value to their customers. We offered practical guidelines on how to organize workshops around the service canvas. We also reasoned about the combination of techniques (i.e., workshops, interviews, and discussions) that,in our case, yielded enough results. We show, here, how we used a service canvas to aggregate results from multiple workshops, in order to tailor the integration of a CRM.

The structure of the chapter is the following. We present related work in Section 4.2. We explain the service canvas and the workshops that we used in the industry project in Section 4.3. In Section 4.4, we describe how we collected the data. In Section 4.5, we present the CRM project, the way we elicited the requirements and the outcome. In Section 4.6, we present lessons learned from the CRM integration project and reflections regarding the canvas and the workshops. We discuss threats to validity in Section 4.7. We conclude in Section 4.8, with open questions and the practical problems that remain.

4.2 Related Work on Requirements-Elicitation Techniques

4.2.1 State of the Art

Requirements elicitation is a process of activities, such as understanding the domain, identifying the sources of requirements, analyzing the stakeholders, selecting tools and techniques, and eliciting the requirements [Zowghi and Coulin, 2005]. For each activity, there are many requirements-elicitation techniques mentioned in the RE literature: for example, introspection, interviews, group work, joint-application development, prototyping, protocol analysis, domain analysis, questionnaires, group work, ethnography, apprenticing, task analysis, brainstorming, prototyping, goal-based approaches, scenarios, and viewpoints (cf. [Zowghi and Coulin, 2005], [Goguen and Linde, 1993]). Selecting a technique for each activity is difficult and the mappings are based on literature surveys [Zowghi and Coulin, 2005] or on expert advice [Hickey and Davis, 2003].

Requirements engineers can choose to use a modeling method to guide the requirements-elicitation process and to capture the knowledge they obtain from their fieldwork. Some of the best-known examples of such methods in the RE community are the goal-oriented approach i*, for early-phase requirements engineering [Yu, 1997], and the value-based method e^3value [Gordijn and Akkermans, 2003b]. There are studies in the literature that report on case studies (cf. [Horkoff et al., 2018],[Kort and Gordijn, 2008]) conducted mostly by researchers specialized in the methods rather than by practitioners.

However, these requirements-engineering approaches and, in particular, requirements elicitation, are mostly tailored towards classic software development projects. Customizable packaged systems with plug-and-play components (often called commercial-off-the-shelf or packaged enterprise systems) undergo different requirements engineering, implementation, and integration processes [Lucas Jr et al., 1988]. Enterprise systems are information systems that support core business processes: for instance, CRM and enterprise-resource planning [Seddon et al., 2010]. There are studies on the differences in requirements evolution for packaged enterprise systems [Schneider et al., 2018], on the specifics in adopting and maintaining such systems [Light, 2001], and on comparisons between the process of traditional system-development and packaged system-development [Sawyer, 2000] among many others.

4.2.2 State of Practice

There are 50 techniques in the toolkit for business analysts listed in BABOK [IIBA, 2015]. Different techniques are recommended for different activities: for example, the elicitation activity entails preparation for the elicitation with 12 different techniques, conducting the elicitation with 18 different techniques (workshops is one of them), confirmation of the elicitation results with 4 different techniques (workshops is one of them), and communication of the results with 3 techniques. However, BABOK gives only generic advice on how to use these 50 techniques. Choosing a technique, or a combination of techniques, and learning how to use it depends on the constraints of each project, the culture of the company, and the experience of the business analyst.

We argue that, based on the fifty years of combined industry experience of the co-authors in requirements engineering and business analysis, most early-phase efforts for requirements elicitation in industry are ad-hoc and rarely, if ever follow a formalized method. Enterprises often rely on techniques that, such as interviews, questionnaires, and workshops, are sometimes centered around a conceptual framework, for example, the customer journey for understanding business processes [Lemon and Verhoef, 2016], personas [Cooper et al., 2007], mind maps for brainstorming and ideation, and affinity maps for prioritizing and aggregating results. For high-level business requirements, industry players are also familiar with and occasionally use the business model canvas [Osterwalder and Pigneur, 2010].

4.3 Requirements-Elicitation Workshops with a Service Canvas

In this section, we explain the principles we follow for designing workshops, such as those we conducted in our experience.

The objectives of the workshops are to bring people together and to structure their perspectives around the CRM and the way they work on a service canvas. The basic guidelines that we follow, when designing the workshops in our case study, are as follows:

Planning Guideline 1: Understand the organizational chart.

The first place to look in order to decide who to invite and how many workshops to plan is the organizational chart. If the company is a small or medium enterprise, there might not be many stakeholders hence only a few workshops will suffice. If the company resembles AFI, the workshops should capture different geographies, business units, and hierarchical levels.

Planning Guideline 2: Split management from operations.

The two levels have different objectives. The alignment between the two levels does not come from bringing people to the same workshops but from the structured findings that result from the workshop. The management level has strategic objectives and different requirements for the CRM, e.g., monitoring key performance indicators and daily activities. The operational level works directly with the CRM and interacts with the system, for their daily activities. These goals can compete or conflict with each other. Hence, a workshop for each of the levels clarifies the expectations of the two groups of CRM stakeholders and ensures further alignment and consistency.

Planning Guideline 3. Gather a small representative sample with knowledge and experience in the process.

Our experience shows that there is no need to have more than eight people in a workshop. At the management level, one or two participants might be from the operational level; yet, there should be more upper-level managers than other participants, in order for them to provide feedback from the point of view of their group. However, at the operational level there is no need for managers from the upper levels but only a direct manager who knows the daily activities and the needs of their teams.

Execution Guideline 1: Start the conversation about the value customers and their influencers (often, their own customers) expect from the service exchange.

The main focus of the workshops is on the services the company provides to their customer and how a CRM can support their business process. The service canvas brings the customer to the forefront: How do they benefit from using the services, why do they choose these services, and who influences them?

Execution Guideline 2: End the conversation with agreeing upon *how* to deliver the value that the adopter and their influencers expect.

The discussion in the workshops should lead to an understanding of what the internal structure of the company's value network should be in order to meet the customer's expectations. Focusing the attention on how to deliver what the customer wants helps the participants to learn how to work to deliver that value.

4.3.1 From a Canvas to Requirements

The service canvas enables the transition from a canvas to a list of requirements for the IT system. First, the structure of the canvas captures both the reasons a service adopter would use a service and the features that service needs to provide to satisfy the adopter. Knowing the features of the service, the service provider(s) can enlist the requirements (both functional and non-functional) that would deliver the desired features. The service components are the primary construct for capturing the requirements for the system. The priority of the requirements is determined by: (1) the benefit the delivery of this component would bring to the service adopter, (2) the ease in delivering the components, and (3) the dependencies between the components. This cost-benefit and dependency analysis can be captured with labels, and the requirements list can be sorted based on this prioritization technique. Second, the level of granularity of the components has to be similar; for instance, for a packaged system, the components of the service map and the configurable modules of the system.

4.3.2 Supporting Tools

The use of the canvas is facilitated by a web-based tool. The tool helps workshop facilitators to structure and to document the requirements gathered during workshops. The collaborative online tool also helps multinational organizations to work together because there is no need for all workshop participants to be physically present. Thus, more stakeholders, who have valuable input and are from different countries, can attend the workshops. Computer-aided service design accelerates both the canvas creation and modification for the users and the consequent review of the gathered requirements with other stakeholders. The first-level canvas is used to create the skeleton of the second-level canvas, based on the refinement shown in Figure 2.4 in Chapter 2.

4.4 Data Collection and Analysis

The method we used to study the business environment is action research [Avison et al., 1999]. Action research differs from other research strategies by being an active-participation research method. More concretely, our study is based on participant observation because the researchers have a double role: (1) an active participant and (2) a researcher observer. I were a part of the Nexell's team and also observed how the workshop participants and Nexell's team interacted during the workshops. Participant observation is an ethnographic approach for collecting data, by participating in the daily life of a social group. Participant observation lies on a continuum between a pure participant and pure observation [Gold, 1958]. The direct involvement and the active role of a researcher in the process preserve the authenticity of the data, as the researcher better understands the context in which the artifacts (notes, e-mails, etc). came into existence. Field notes are a written representation of the day-to-day observations of the events and people; these notes can be studied at a later stage [Emerson et al., 2001].

We consider the data collection and analysis to be an integral part of our experience because we apply an academic method in the industry. Here, to provide the context of the experience, we also describe our roles. I participated in the requirements-elicitation phase of the CRM integration project for AFI and is a part of the research group. Lucien Etzlinger and David Derrier were a part of Nexell's team, during the CRM integration project.

Data Collection. I collected data (notes, service-oriented canvases, documents, e-mails) by participating in the requirements-elicitation phase and by closely collaborating with the second and the third author to clarify, analyze, and to follow the entire CRM project development. AFI was aware that I was from academia and that Nexell collaborated with a research group to use a service method in the requirements-elicitation phase.

At the end of the workshops at each location, the project team communicated the results of the workshops to the local AFI executive manager by presenting a succinct description of the situation and by asking about their own goals. These discussions served to elicit the expectations of the managers and to understand the key success factors for them. At the end of the requirements-elicitation workshops, the second and the third authors, together with the AFI project manager, aggregated all fourteen canvases. Our data sources also include all canvases, notes, e-mails, and shared documents.

During these meetings, the first author took notes. She wrote down what happened in the room, without analyzing the situation on the spot. During the workshops and the interviews, she wrote context-dependent information: the names of everyone present in the room, the place, and the kind of questions and/or answers exchanged. She observed the group dynamics and the way participants came to a consensus. She also took part in informal conversations between the Nexell and AFI representatives.

Data Analysis. At the end of every workshop, the collected data were analyzed by first sharing observations between all members of the Nexell team. At the end of each day, the Nexell team discussed the results with their general manager. After the requirements-elicitation phase, the first author used her notes to analyze the canvases that were created: How detailed were they? Was there coherency in the canvases between business units? With the help of these data, we analyzed the results of the service canvas and the workshops. Later, all of the authors discussed the requirements-elicitation methods and the lessons learned from the experience. The Nexell team also communicated to AFI their impressions and experience from the requirements-elicitation phase.

4.5 Application in a Large-Scale CRM Project

4.5.1 Presentation of the Company and the CRM Project

The AFI organization was established approximately a decade ago. Its main activity is financial services, including asset management, corporate finances, individual finances, company incorporation, legal and fiduciary services, and investments. AFI has thousands of employees in more than forty countries. The company's growth strategy was based on external growth, with an average of four new acquisitions per year for ten years. The acquisitions were not accompanied by a change in the business processes for integrating the newcomers. This strategy led to dissimilar operations across AFI.

AFI's organizational chart is depicted in Figure 4.1. The highest is top management. Below the top management, there are regional managers who oversee the company's activities within a region (e.g., Europe, Asia, the USA). Each business unit has one worldwide manager, multiple regional managers, and many business developers (matrix organization). There are four

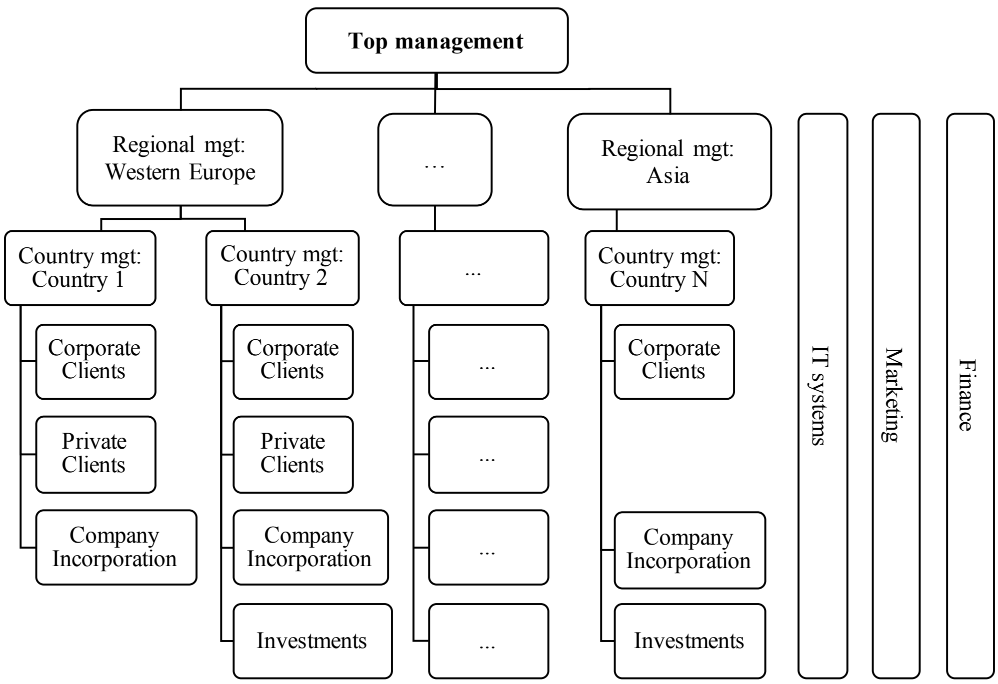

Figure 4.1 – AFI's organizational chart

business units: private clients, corporate clients, company incorporation, and investments. Not all countries have all four units. The business developers within the business units are the end-users of the CRM system. Marketing, finance, and IT systems are the three cross-organizational departments.

The Problems

The problem AFI faced and decided to solve by adopting a CRM system was the lack of coherent customer-information and the impossibility of tracking revenues, costs, lifetime values, and referrals. For example, an international customer might interact with the business unit *corporate clients* from country 1 and with business unit *corporate clients* from country 2. These units would not be able to share client information. They would have to rely on the client to share it. The same applied to clients who interacted with different business units that were in the same country. A CRM system would enable information sharing of AFI's customers, between the business units from the different regions and among the business units. This would reduce costs by avoiding duplicated efforts (e.g., legal services), by providing more precise estimations on customer acquisition/retention costs and customer lifetime values. It would possibly increase sales by cross-selling (selling different services) and up-selling (increasing the purchases of existing customers).

AFI previously attempted, twice, to integrate a CRM, but they were unsuccessful. From our observations, AFI had limited knowledge of what went wrong with the previous two projects[I]. AFI explained the failures to be due to the fact that CRM integration projects were regional projects that were started, due to company acquisitions and to a CRM system that was already in place, when they bought the companies.

The Project Settings

AFI planned two phases for the CRM integration project: (1) a request for proposal (RFP) to select an integrator and (2) the CRM integration. AFI did not dedicate time for eliciting the CRM requirements. The requirements for the CRM were collected via an e-mail to the managers of the business units. AFI provided the spreadsheet as an input to the companies who submitted RFPs. Any elicitation of the requirements had to be quick and effective.

During the RFP phase, AFI asked five potential integrators for their proposals for a CRM integration proposal, cost estimates, and a delivery time. Two integrators included in their proposals a requirements-elicitation phase. This prompted AFI to dedicate time for eliciting requirements, but they still severely limited the time because their understanding was that the requirements for the CRM were clear. The overall CRM project was then divided into three phases: (1) an RFP, (2) a requirements-elicitation phase, where the selected integrator identified the main features of the CRM, which features should be included, and where it developed a full project proposal, including a road map for implementation, cost estimates,

[I] AFI's CRM project manager had joined AFI a few months before the start of the project and had not been involved in the previous CRM integration attempts. In fact, the CRM integration was their first AFI project.

and a delivery time, and (3) the CRM integration. Nexell faced the challenge of understanding the business environment of AFI: within a limited time frame (two months), with limited exposure to business stakeholders and CRM users (because people were not available on short notice), and within a tight budget. Nexell won the requirements phase but had to compete again for the implementation phase, which they also won.

Ultimately, AFI agreed to separate the CRM integration project into multiple phases because of the favorable risk:benefit analysis. First, the requirements elicitation phase was self-contained and short (two months), compared to the overall project time-span (two years); and the cost of the phase was approximately fifteen times less than the most modest cost-estimation of the entire integration. AFI could choose another CRM integrator for the final integration phase, as the output of the requirements-elicitation phase was generic and another vendor could use it as an input. However, AFI mitigated the risk of choosing an unknown integrator for the entire project. Second, Nexell needed to understand AFI and their business process in order to be able to prepare a proposal that was not over- or under-estimated in terms of business and technical issues, time, and costs. Without careful elicitation of the requirements, Nexell faced the possibility of inaccurate 'to-be' analysis and a high chance of the CRM specification not fitting the needs of AFI. As a result, the requirements elicitation phase mitigated the risk for Nexell as well.

During the requirements-elicitation phase, Nexell used workshops based on the service canvas, defined the key success factors for the CRM project (according to the different stakeholders), understood the environment, and estimated costs and delivery time. Nexell had to find the CRM features from a representative sample across the countries they were established in and had to aggregate them into one model. We planned the workshops, based on the organizational chart and the participants' availability. The Amsterdam and the Hong Kong offices were chosen by AFI. Then, Nexell aligned the aggregated business units' requirements into an overall AFI's service model. From the aggregated service model, Nexell developed the CRM specification and the project proposal. AFI accepted the project proposal.

4.5.2 The Workshops for AFI

We considered two levels from which to choose participants for the workshops: (1) the level in which the AFI's business developers interacted with AFI's customer and used the CRM to support the interaction, and (2) the level in which Nexell provided the CRM system as a service to the AFI's business developers as the CRM users. The workshops were facilitated by the third author.

We conducted fourteen workshops in total: four workshops with business unit managers (management or first-level workshops), eight with business developers (CRM or second-level workshops), and two workshops with the marketing and the finance departments. We created a canvas for each workshop, resulting in fourteen canvases. The number of workshops reflects the organizational chart of AFI and the access we had to AFI's employees. There needed to be at least two workshops (management and CRM) for each of the four business units, or a minimum of eight workshops. We held the CRM workshops with participants from two geographical regions in order to capture the differences and similarities of the operational process between regions. The remaining workshops were with the cross-organizational departments who would be direct users of the CRM system, namely, marketing and finance.

At first, we conducted workshops with the management level of a business unit in each country. These workshops showed the expectations of the management towards the business units' performance and the role of the CRM as a tool for achieving these expectations. For the next step, we did workshops with the operational level of the same business unit. In these CRM-level workshops, we focused on gathering the requirements on the specifics of the work process and the expectations for the CRM capabilities. The CRM-level workshops were driven by the features that Salesforce.com can deliver, e.g., e-mail integration, and accounts. The modular structure of Salesforce.com allowed Nexell to derive – from the benefits for the business developers (e.g., "save time") and the features of the CRM – the specific components of the Salesforce.com platform. We also discussed the information systems in place, with representatives from the IT systems unit. We collected feedback from interviews with two regional managers from Amsterdam and Hong Kong. After all the workshops, Nexell's team, together with AFI's project manager, analyzed all fourteen canvases and merged them into one single canvas that contains the set of features for the CRM system.

Workshops at the Management Level

In the management-level workshops, we invited people from the top management and the regional managers, as they could articulate the services that the company provided to their customers. We conducted four management-level workshops: one for each business unit of AFI. For example, at a management-level workshop for the company incorporation (CI) business unit, we would fill a canvas such as Figure 4.2. The service provided by CI to its clients was to create one or several companies for them (mostly done for international expansion). The discussions at the workshop started with questions about who the customer of CI was. During the workshop, the facilitator asked participants to use the name of a real customer. The facilitator filled the customer's name, called Bob here, and their company. Our assumption, based on the work of Barsalou on grounded cognition [Barsalou, 2008], is that using a real customer's name helps participants relate to their experience and feel involved because the context is closer to them.

<table>
<tr><td>Supplier
Alice, AFI's biz developer</td><td colspan="3">Main competitor
SomeFinCorp, a financial company</td><td>Adopter
Bob, AFI's customer</td></tr>
<tr><td rowspan="2">Partners
• Nexell
• Salesforce
• Chris, Alice's manager</td><td>Components
• Catalog of services
• CRM platform
• In-house expertise</td><td>Features
• Global network
• Flexible pricing
• Local expertise</td><td>Benefits
• Comply with local laws
• Save on licenses
• Expand internationally</td><td rowspan="2">Influencers
Bob's client</td></tr>
<tr><td colspan="3">Regulators
Local authorities</td></tr>
</table>

Figure 4.2 – The company incorporation management-level service canvas.

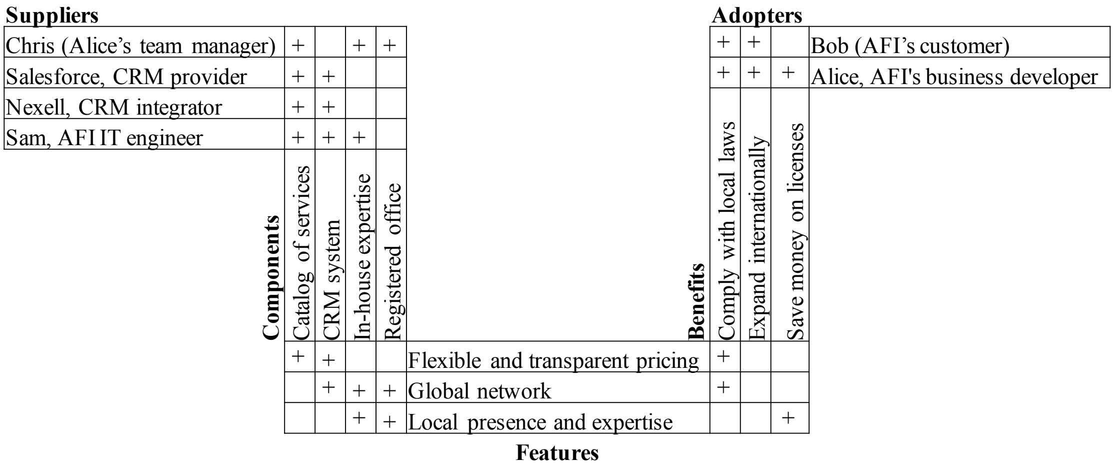

Figure 4.3 – A Supplier adopter relationship (SAR) model for the management-level workshop of the Company Incorporation business unit.

Bob represented an intermediary company, who would offer a package of international company expansion services to their own clients. Bob's company would use the services of AFI's CI to incorporate the company but would turn to other vendors, for example, for legal services. The workshop participants had to refer to the business process of Bob's company to decide upon some influencers. Often they were the clients of Bob.

The next step was for participants to identify the benefits (for Bob), for instance, of complying with local laws or of expanding internationally. The facilitator asked participants to think of who could influence Bob. The benefits for Bob and their influencers connected to the features of the service that AFI provided. One or more components were "responsible" for delivering each service feature. The components were provided either by the supplier of the service, e.g., Alice, a business developer from CI, or by a partner. The partners of the supplier could be either internal to the organization (e.g., Chris, Alice's team manager), or external (e.g., Nexell). We captured the relationship between the different canvas elements in a SAR in the online tool (Figure 4.3). The management-level workshops showed the managers' perceptions of the services that AFI delivered to their clients. In these service canvases, Nexell is a partner of the business developer. The service canvas describes the CRM system in the context in which it will be used.

Workshops at the CRM Level

Next, we conducted CRM-level workshops with the business developers, the CRM system users, and their immediate team managers. In these workshops, we elicited requirements for the CRM system, based on the day-to-day work activities and on how the CRM system would accommodate these. We conducted eight CRM-level workshops in total, or two workshops for each of the four business units of AFI. For CRM-level workshop, we started with the decomposition from the management-level canvas.

Figure 4.4 depicts an example canvas of CI's service organization captured during a CRM-

<table>
<tr><td>Supplier
Nexell</td><td colspan="3">Main competitor
e-mails and document sharing</td><td>Adopter
Alice, AFI's biz developer</td></tr>
<tr><td rowspan="2">Partners
Salesforce</td><td>Components
• Salesforce parts (i.e., Accounts, Contacts, Leads)</td><td>Features
• Customer profiling
• Leads management
• Pipeline management</td><td>Benefits
• Info in one place
• Save time while building proposals</td><td rowspan="2">Influencers
• Bob, AFI's customer
• Chris, Alice's manager</td></tr>
<tr><td colspan="3">Regulators
Local authorities</td></tr>
</table>

Figure 4.4 – The company incorporation CRM-level service canvas.

level workshop. The online tool automatically pre-fill the CRM-level canvas based on the relationships described in Chapter 2. In these workshops, Nexell is the service supplier and the CRM system is the service. The service adopter is Alice because the end CRM system user is Alice. We model the CRM system (which was a component in the first-level canvas) to be a service that Nexell provides to Alice. The influencers of Alice can be actors from the business-level partners, the adopter of Alice's service, or other external actors not captured in the management-level workshop. The benefits of using the CRM system for the CI business developers were primarily to have various automation tasks that the CRM's features could execute and to save time by using a centralized data repository.

The most important features of the CRM system were identified to be customer profiling, lead management, and pipeline management. Nexell's team was responsible for populating the components of the service offering. These components need to correspond to the features that the end-user of the CRM system needs. The components come directly from the configurable Salesforce's components. The facilitator filled these components independently after the workshops.

Workshops with the Cross-Organizational Units (Marketing, Finance, IT Systems)

We conducted service-canvas workshops with two additional business units, marketing and finance, without dividing them into two-level workshops. The two units operated across the organization and globally supported the operations of the four main business units. Both units had to use the CRM system. The marketing unit generated customer leads and needed to input them in the CRM system. For the marketing unit, it was important to track the return on their campaigns and events (by tracking generated leads at each campaign and conversion rates of leads into paying customers). The finance unit was mainly concerned with the key performance indicators (i.e., a contract has been paid, not only signed). The finance unit's use of the CRM system was mainly for the purposes of auditing and control.

With the IT systems unit, we conducted two free-style workshops (not counted in the total of fourteen workshops) to review the canvases from the CRM-level workshops and to gather information about the various systems that the CRM system would need to integrate with. We chose this format because this unit was not a direct user of the CRM but was a partner of Nexell in integrating the CRM system in AFI. For this reason, we decided to ask about the current systems in place, those that all other participants used. The IT unit was cross-business-unit and each regional office had one.

4.5.3 Canvas Aggregation and Project Proposal

After the workshop phase was completed, Nexell's team had to prepare a project proposal. The end result was that AFI chose Nexell to integrate the CRM system and accepted the project proposal. The project proposal was based on all fourteen canvases but in an aggregated form. The project proposal included a road map for continuously integrating CRM components and a detailed analysis of the AFI environments with a justification for each of the components being included, for a plan for the training of the users, and for other miscellaneous details on the Salesforce.com capabilities.

We conducted a two-day work session with the project manager of AFI to merge the canvases. The strategy to aggregate the canvases was to start from the common items at each business unit and to look separately into the two levels. The structure of the service canvas made it possible to work with similar requirements. First, we merged the canvases from the duplicated CRM-level workshops of each unit. We created an expanded canvas with all the service components listed in both CRM-level canvases. Then, we added in the aggregated canvas all features and removed the most similar ones. Subsequently, we combined the benefits for the user, and from those, we kept all except obvious duplicates. In the CRM-level canvases, the components of the service were mostly Salesforce.com components. One of the few exceptions was the custom-data adapter that Nexell had to develop to populate the CRM with historical records. The standardized components architecture helped us create a single CRM-level canvas per business unit. We used the same schema for merging the CRM-level canvases, from different business units. The resulting aggregated canvas had 30 components, 27 features, and 16 benefits. We loosely followed the aggregation schema for the management-level canvases. From these, we extracted mainly the opportunities and the risks that AFI would be able to address.

Using the aggregated canvas, we created a project proposal that included a detailed analysis of the strategic vision and a road map for integrating the CRM system. The road map included a monthly delivery plan for each of the 30 components from the aggregated canvas with the dependencies between components. For example, the CRM component 'activity tracking' had to be delivered before 'e-mail sync', hence they were scheduled two months apart. For each component, we also included two labels: business value and complexity; we coded them with values *very low, low, medium, high, very high*. The business-,value label indicated the number of times the component was listed in the original canvases (which indicated the benefits that the component would deliver to the CRM user via the SAR model). The complexity label indicated the technical or organizational complexity for integrating the components, as identified from the requirements elicitation phase and the experience of Nexell's team. This points-based system enabled us to plan for a balanced integration of components that would yield benefits from the beginning. For example, the component 'multi-currency' had a very high-business value and a very low-complexity, hence it was scheduled for month one. The project proposal was accepted by AFI, and Nexell followed with little deviation the road map during the integration phase (which is now over).

4.6 Reflections and Lessons Learned

4.6.1 Requirements engineering, and requirements elicitation in particular, are not a given in industry projects.

Companies assume that they already know what they want from a system. In our case, AFI had collected requirements via an e-mail, and three of the five initial bidders agreed to proceed with the integration, based only on the list of features collected via the e-mail. Dedicating time and resources to elicit requirements might seem unnecessary and wasteful to enterprises. Requirements-aware practitioners often need to advocate for conducting requirements elicitation, and requirements engineering altogether and for dedicating time and resources to formalize, structure, and manage the requirements-elicitation process. It is a non-trivial question, for both academia and industry: How do we show the value of RE up-front when the return on the investment might be visible only later on?

Yet, it is still possible to convince your customers to conduct requirements elicitation. What you need to propose in return is fast and reasonable specifications, at low cost and from the requirements-elicitation phase. This is not a single phase and continues throughout the entire project. However, in an unknown environment with many stakeholders, not conducting a feasibility study and not planning a realistic project delivery in a dedicated phase is risky in most cases. Nexell convinced AFI to split the CRM integration into two parts and to dedicate time for eliciting requirements. The requirements-elicitation phase lasted two months, compared to two years for the entire project. It cost fifteen times less than the entire project's budget. The cost-benefit ratio was favorable because it helped AFI to mitigate the risk of choosing, for the entire project, a supplier they did not know. With the integration phase over, we have seen that the requirements produced during the requirements-elicitation phase and the road map were followed closely.

Throughout the requirements-elicitation phase, we sought feedback from the project manager and other top managers about how they felt about the process. At the beginning, most of AFI's managers were not enthusiastic about this phase. They perceived the workshops as a waste of time. They already believed they had all the requirements for the CRM in a spreadsheet created from a company-wide e-mail in which all managers expressed their needs. After going through the workshops, the managers' attitudes were much more positive. They saw that there were discrepancies between the regions and business units, and that the initially collected requirements did not capture these differences. By sifting out the CRM requirements at this early stage, the project was more likely to succeed. Top-management recognized that the method was delivering results, in terms of aligning people's expectations of the CRM, and was getting them on board with the change of the operational process that the CRM would require.

4.6.2 Any workshop might have worked, but a focused workshop works better.

We are convinced that other types of workshops might have resulted in a similar outcome. Gathering people in a room to talk to each other about their expectations, needs, and pains is a well-known recipe for creating a shared view. However, an unfocused approach is unlikely to yield quick results for specifying a CRM project under heavy availability constraints. The service canvas and the two-tiered structure enabled us to accelerate the process by engaging a representative sample of people in the requirements-elicitation phase and to remove heterogeneous forms of expressing requirements. Speed and cost are critical for such projects. Consequently, the results should be known as soon as possible. During the requirements elicitation, we still had to combine the workshops with other techniques, mostly interviews. We used the service canvas and the two-tiered workshops as the main elicitation technique and validated and complemented our findings with the other techniques.

4.6.3 The service paradigm helps people externalize their needs by explaining how they work through the prism of the value they provide to their clients.

The notion of 'the service to provide to clients' shifts the conversation from explicit needs ("I need this") to implicit needs ("This is how I work and the CRM system has to support me"). Employees might not be comfortable or able to express their needs explicitly or in front of managers. With the two-tiered structure of the workshops and the service canvas, the topic of the conversation was about how to deliver value to customers. This service-dominant view of the business enabled employees to voice their needs by describing how they worked. A CRM is foremost a service-oriented strategy that a company adopts. As such, it highlights the services that the company needs to deliver [Payne et al., 2008].

The canvas structure and the conversation during the workshops employed the service-dominant logic: We shifted the focus from AFI's business developer's day-to-day activities to the value AFI provided to its customers. This external focus (the reason the work is being done) helped the participants to create an imaginary "to-be" environment to support their day-to-day activities, with the help of a CRM system. Our experience was that most of the workshops' participants actively collaborated and contributed openly to fill the canvases.

This requirement elicitation process is the implementation of Zave and Jackson's second recommendation to describe the organization without and with the system [Zave and Jackson, 1997]. The presence of the canvas focused the discussion during the workshops on the environment of the CRM system and made it possible for the requirements to be defined. The workshop's participants had a different visibility of the AFI processes, and their accounts provided a more complete description of the business process. For example, at a CRM-level workshop, a business developer shared the process of obtaining clients' records: e-mailing and calling clients on the phone. A representative from the IT unit knew where the records originated from (an IT system). Hence, to speed up the process of record retrieval, Nexell understood that the CRM had to connect to this specific IT system.

The service canvas structure is key for aggregating all requirements. The canvas design and use were a prerequisite for creating a single paramount canvas. The canvas captures by design similarly framed requirements. The predefined structure made it possible to create a single canvas that corresponded to all business units. After all workshops were conducted, they were merged. This allowed Nexell's team to prioritize the CRM features that needed to be delivered first.

4.6.4 Employees and Not Only Management Buy-Ins

A management buy-in is a key success factor for a CRM system [Mendoza et al., 2007; Wilson et al., 2002] and for any enterprise system [Brown et al., 2003] but, alone, is insufficient: an employee buy-in is equally important. Top-tier managers are not essential participants in the workshops, but it is key to align, with the rest of the company, their strategic view(s) for the CRM. The two-tiered workshop structure enabled the two levels, management and operations, to "talk" to each other and to voice their expectations for a CRM that would support both groups' activities. In the management workshops, the managers were in the middle-tier of the organizational chart. They managed the teams of business developers and had to directly interact with the CRM system. For the middle managers, it was important to voice their needs because they were the end-users of the CRM.

For the top managers, who were in charge of regions and the global organization, we employed a different strategy. Instead of inviting them to the workshops, we presented our findings to them and collected their feedback. The regular contact with the top managers also ensured finding additional constraints and resources, such as the budget and the scope of the CRM integration project, the performance indicators that they wanted to monitor from the CRM system, and the additional people who Nexell needed to talk to. The only top-manager who we included in the first management-level workshop was the chief information officer who was the main sponsor of the CRM integration project.

Functional, geographical, and hierarchical misalignments are not an AFI-specific problem but are observable in many companies with the same profile [Frygell et al., 2017]. We addressed this problem with the two-level workshops; they helped to elicit requirements from both perspectives and to align the expectations, which ultimately led to a shared vision about the CRM system and buy-ins from both managers and employees.

4.6.5 Low-code enterprise systems entail process re-design but remove the question of technical feasibility

A CRM integration project is a business process re-design project [Mendoza et al., 2007]. As such, it is tightly coupled with the information technology that a company adopts [Attaran, 2004]. Moreover, an IT system can either support or hinder the adoption of the process re-design [Attaran, 2004]. Packaged systems, such as Salesforce.com, help homogenize heterogeneous business processes in multinational companies. These systems propose a standardized way of working, which is an established good practice in the industry. If the company were to implement a CRM, they would have had to build from scratch the functionality that

Salesforce.com has had for years.

In the case of AFI, the workshops were designed to engage people in the CRM integration project. The conversations at the workshops were centered around expectations and daily activities. The main goal was to get people on board with the new way of working that translates into the adoption of a packaged system. The workshops did not need to revolve around technical requirements because integrating a mature packaged enterprise system removes the uncertainty about technical feasibility.

4.6.6 Requirements elicitation is an iterative process of managing change.

The challenges for a CRM integration project in a multinational company with thousands of employees are not only technical but organizational. As the scope of the project is large, the requirements-elicitation process has to begin with assessing the feasibility of the project, defining the scope, and estimating the time and the costs. Only then can the integrator proceed with eliciting fine-grained technical requirements. Nexell continued refining the technical requirements for the CRM system (e.g., define the API that will populate the Salesforce.com instance with historical data).

The challenge lies in the change that a CRM system introduces. This change has to be managed and, for this reason, it is important to engage key users and to acquire the high management's support [Kotter, 1995]. By managing the change explicitly and from the beginning of the project, we convinced the management and operation units to share their expectations and to commit to the project because they felt they had a stake in it, as they shared with us after the workshops.

4.6.7 Application in Other Contexts

Our method for requirements elicitation could be used for other packaged systems, as well as for bespoke software development, e.g., in digital transformation, enterprise resource planning systems. The CRM integration project is an example of how our method could be used in other projects because it spans the entire business process of an enterprise. Our method builds, between stakeholders, a common understanding about how they work and the goals an IT system should help them achieve. Therefore, it is suitable for requirements elicitation in other contexts.

4.7 Threats to Validity

This is a case study built upon a single project, hence the results from the requirements elicitation method might not be reproducible or we might not be able to apply precisely the same technique in another context. We note that validity is an elusive concept in qualitative research; it can be mediated by diligently documenting how data have been collected, analyzed, and interpreted [Onwuegbuzie and Leech, 2007]. We are not able, based on this case study, to conclusively determine cause-and-effect relationships because we cannot control all the extraneous variables. But, we reflect on the limitations of our work based on [Cook et al., 1979]. For example, regarding threats to conclusion validity, we might have misinterpreted the positive outcome of the project proposal and falsely attributed some of its success to the requirements elicitation that we conducted. We modified our approach, along with the project, and employed not only two-tier workshops but also other techniques so as not to be isolated in one single construct. This is a threat to the validity of our construct; the effects we observed might be a result of the interaction of different techniques or of the interference between the use of the technique and the measurement of its success by a researcher (interaction of testing and treatment). Also, our construct, the service canvas and the workshops, are only one possible way of conducting service-oriented requirements elicitation, against which our data should be compared. Regarding the external validity threats, if we vary the people, the settings of the project, etc., we cannot conclude that such requirements elicitation would produce the same effect. Our other experiences, however, show that the same approach - with some variations - could be used in other projects; this would be an avenue for exploration.

We note that our contribution offers observational evidence from a primary study on how practitioners can use a service-oriented approach for requirements elicitation for packaged systems [Le Goues et al., 2018]. Single case-studies are a necessary building block toward a coherent formalized theory that could be applied broadly. One of the main limitations of single data points, especially in qualitative research, is that they are insufficient for drawing causal relationships. Nonetheless, we deduce that, based on our experience, conducting the workshops (possible cause) led to an accepted CRM integration project proposal and successful integration of the CRM system (effect). The threats to the internal validity are that the workshops were irrelevant and the same would have happened without them, or with a different treatment. We believe this is not the case because we have, as a baseline, the two failed attempts of CRM interactions that were managed differently.

4.8 Conclusion and Future Work

In this chapter, we have presented a method for requirements elicitation based on workshops that were supported by a service canvas. We have described a collaborative project between our research group and two industry partners. We have described two levels of the workshops, management and operational, and how these workshops helped to align stakeholders' expectations. We have also discussed how the service canvases were merged into an aggregated one that served to plan a road map for integrating the CRM. Nexell followed the road map closely. We observed a practical problem that practitioners face: convincing enterprises to even consider conducting requirements elicitation. We believe that the challenge is not specific to the case we presented here but it is an industry-wide phenomenon that requires the attention of both the academic and the industry communities. Next, we investigate the concept of *value*.

5 [Principle] A Theory of Value for Service Ecosystems

After reflecting on our experience, we move to the third step of the experiential learning process: generalization. In this chapter, we present a principle that is a theory of value. The abstract theory is reusable in many contexts and we show how to apply it to service ecosystems and their modeling.

We propose the following definition of value: Value is an output or an input that helps a system preserve or construct its identity for an observer. In order to co-create value, every system has to exist on its own in order for the service ecosystem to hold together. Value is the construct that represents that which runs in and out of systems in order to keep them viable and to keep different systems together. We look at identity as the outer expression of a system's actions. Identity is in the eye of the observer: A system that behaves in one way is expected to behave in alignment with the same behavior that signifies its identity for an observer; and the system must do so in order to be recognizable as the same system. Value is an input or an output that helps a system take actions that are congruent with the identity that an observer desires for the system. The chapter is based on a the following working paper: Blagovesta Kostova, Jaap Gordijn, Alain Wegmann, and Gil Regev. A theory of value for service ecosystems, 2022.

5.1 Why Define Value?

Value is one of the concepts that years ago attained the status of a buzzword in business speak and has been maintained at this level for as long as we can remember. Who has not been the target of the slogan written on glossy advertising paper saying: "Dear valued customer"? Levitt [1960] wrote in his seminal paper "Marketing Myopia" that companies "create value satisfying goods and services that consumers will want to buy." Therefore, the search for value seems to be at the core of the success of commercial companies, as much as it is for other types of organizations for and not for profit.

We find the concept of value used in both practice and in various research areas, among which are management, service science, business modeling, requirements engineering, marketing. For example, in management, Adner [2017] revisits the definition of the term *ecosystem* in light of its relevance to scholarly and applied strategy as "the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize." In service science, the main conceptual construct is defined as a service ecosystem, which is "a relatively self-contained, self-adjusting system of resource-integrating actors connected by shared institutional arrangements and mutual value creation through service exchange" [Vargo and Lusch, 2016]. These new conceptualizations of current organizational models go beyond the two-sided market of consumers and producers; these are systems of actors that hold together due to the value they exchange between each other and with the outside world. Value is at their core.

But what is understood by value? There are many studies on what value is. From the fields of marketing and service science, value is usually viewed as subjective and dependent on the customer [Holbrook, 1999; Vargo et al., 2008]. Value is seen as wealth [Mazzucato, 2018] or as value-in-exchange [Smith, 1776]. Value-based methods for system design in the ICT research domain usually look at market valuation and financial viability [Boehm, 2003; Gordijn and Akkermans, 2003a]. Value in these works subscribes to the dominant interpretation of value as economic value: either value-in-exchange or value-in-use. As a result, value is understood to be tightly coupled and defined by the traditional economic model of the market economy, where consumers and producers interact. In this rational-actors tradition, consumers strive to maximize utility and producers strive to maximize profit. Value is instrumental in informing producers about the consumers' purchasing behavior. Service ecosystems surpass the two-sided market of producers and consumers and the dichotomy between competitors and partners. In a service ecosystem, there is no one with a single role: value is co-created by all actors, consumers become producers and vice versa, and competitors cooperate. All these characteristics of ecosystems require a different interpretation of value, and this interpretation needs to surpass value-in-exchange and value-in-use categories.

We argue that we can study value by asking not only how organizations interact with their environment and what goals they pursue, but more importantly how they hold together (cf. [Regev et al., 2012, 2013b; Vickers, 1956]). Each constituent in a service ecosystem has to exist on its own right, and they need to hold together to be able to operate as a whole. As any other system, a service ecosystem can only deliver value only if it holds together. If the members of the service ecosystem part their own way, the service ecosystem ceases to exist and the value it provides becomes nil. The rational-actor economic theory of utility-maximizing consumers and profit-maximizing producers does not explain how an ecosystem holds together but is a theory based on the goal-seeking organizational model [Checkland and Holwell, 1998].

Let us take the Apple and Android service ecosystems. If utility maximization were the only reason for consumers to remain in the Apple service ecosystem, they would leave it as soon as the Android service ecosystem could provide them with a better solution. With the rate at which smartphones and new operating systems reach the market, it would mean that many consumers would switch from one service ecosystem to another on a monthly basis. This seems absurd and far from our observations. Mostly consumers choose a service ecosystem and remain with it for long periods of time. If you are an iPhone user, you're likely to remain one for many years, despite Android gaining some advantage over iOS at certain times and vice versa. The chances are that the iPhone users will not even look at the developments in

Android hence will avoid being lured into its service ecosystem. There is more than a rational utility maximization in their decisions to remain with a service ecosystem or leave it. But, as we said before, remaining in the service ecosystem produces the value for the consumer who participate. So what is this value that we give or receive from the service ecosystem?

Here, we propose that *value is an input or an output that helps a system to maintain or create an identity for an observer*. In our theory, a system's identity is defined by the actions that the systems takes. Value enables the observers to identify the actions that systems should take in order to ultimately define the systems as who they are. The value that systems receive through their interactions keeps them in the service ecosystems in which they participate. In this chapter, we propose a theory and a corresponding definition of value in Section 5.4. We construct our theory by following the guidelines by [Wieringa, 2014] on theory building (Section 5.2). We present a literature review of the concept of value in Section 5.3. We illustrate the use of the theory with the example of the Dutch electricity market and its transition to a decentralized one (Section 5.5). We discuss our theory and the implications for system design in Section 5.6 and conclude in Section 5.7.

5.2 Research Method

We define value through the lens of SST. We use SST's cornerstone techniques (as described in Chapter 2) of borrowing principles from different disciplines, applying them to the concept of systems in general by making analogies in order to transfer knowledge and to create new principles.

We follow the steps of theory construction that is based on the structure of theories of Wieringa [2014] and the guidelines of Weick [1989] and Whetten [1989]. The theory of value that consists of three elements: (1) a conceptual framework, (2) generalizations, (3) a scope [Wieringa, 2014]. We categorize our theory as a theory for the explanation of value, and more specifically an architectural explanation [Wieringa, 2014].

The **conceptual framework** of the theory consists of *system*, *environment*, *identity*, as these concepts have already been defined in the literature. Then, we propose to connect these concepts with three principles that are the **generalizations** in our theory, and that govern the interactions of systems. We use the following three principles: the second law of thermodynamics, homeostasis, and interpretivism. The generalizations govern the relationships between the concepts and enable us to explain value through the exchanges between systems that follow the fundamental principles. Our work is based on interpretivism, hence we find that making this principle explicit offers its advantages in the application of the theory. Our previous work discussed the second law of thermodynamics in relation to systems, their identity, and to the relationships between the environment of the system and the increasing entropy that systems strive to keep in certain bounds [Regev et al., 2011]. We also already studied and applied the principle of homeostasis to organizations to show how identity maintenance and survival offer a great explanation with regard to business modeling and individual organizations [Regev et al., 2012]. We also link these two principles to explain the relative stability of states of entities in the UoD that corresponds to identities of systems in the observer's conceptualization [Rychkova et al., 2019]. In our current proposal, we bring together all these principles and propose a definition of value for systems governed by these principles. We categorize our theory as a theory for an explanation of value in the *scope* of systems. More specifically, it is an architectural explanation that means that the interactions among components are the mechanism for producing hence for explaining the phenomena [Wieringa, 2014].

To decide on the concepts to include in the *conceptual framework* and the *generalizations* of a theory, there are two heuristics: (1) comprehensiveness and (2) parsimony [Whetten, 1989]. We generated more statements than are now in the theory (for example, 'boundary', 'white-box/black-box views'). These statements were not classified into definitions and principles but only in principles. After multiple iterations, theory structuring, and the removal of all elements that can be stripped out of the list, we arrived at the minimal set of concepts and generalizations that enable us to explain value. The heuristics we used are best described by the artificial selection process that states that theory creation can be achieved by mimicking natural selection steps: first by generating variations then, to remove the unnecessary elements, by using selection rules [Weick, 1989]. The rule to remove the unnecessary is based on Occam's razor principle that states that, all other conditions being equal, we should always choose the simpler explanation [Blumer et al., 1987].

The **scope** of our theory of value is the domain of systems, and specifically service ecosystems. By the virtue of its general nature, the knowledge in the domain of systems could be applied in various disciplines, hence the theory of value is also valid in the domains of, for example, information systems, software engineering, requirements engineering, and service science.

5.3 The Concept of Value in The Literature

We look into the definitions of value in three broad categories: economic-value theories , which could be interpreted as value-in-exchange and value-in-use, and moral values. We forbade the discussion on value as the measurement or quantity attributed to a given thing, such as a value of a variable in calculations. Graeber [2001] presents a thorough analysis of the three different interpretations of value. We use the first two categories to sort out the literature related to system design and the definitions of value used. Table 5.1 summarizes the value definitions in the different fields we surveyed in our literature analysis.

Discussions about value date back to Aristotle's time. More recently, Smith [1776] influenced the development of economic theory by also noticing two meanings for the word value then choosing to focus on value-in-exchange. "The word value, it is to be observed, has two different meanings, and sometimes expresses the utility of some particular object, and sometimes the power of purchasing other goods which the possession of that object conveys. The one may be called "value in use"; the other, "value in exchange." The things which have the greatest value in use have frequently little or no value in exchange; and, on the contrary, those which have the greatest value in exchange have frequently little or no value in use. Nothing is more useful

Table 5.1 – Value definitions from different literature streams

Field	Definition	References
	Value-in-Exchange	
Economics	wealth	[Mazzucato, 2018]
	“the power of purchasing other goods which the possession of that object conveys”	[Smith, 1776]
	Value-in-Use	
Economics	“the utility of some particular object”	[Smith, 1776]
Marketing	“value is thus a benefit experienced by buyers or customers”	[Ramsay, 2005]
	“consumer value is an interactive relativistic preference experience”	[Holbrook, 1999]
Service science	“value is improvement in a system, as determined by the system or by the system’s ability to adapt to an environment”	[Maglio et al., 2009]
ITIL v4	“the perceived benefits, usefulness, and importance of something”	[ITIL, 2019]
	Moral Values	
Public good	“a result of evaluations about how basic needs of individuals, groups and the society as a whole are influenced in relationships involving the public”	[Meynhardt, 2009]
Value-sensitive design	“a value refers to what a person or group of people consider important in life”	[Friedman et al., 2013]

than water: but it will purchase scarce anything; scarce anything can be had in exchange for it. A diamond, on the contrary, has scarce any value in use; but a very great quantity of other goods may frequently be had in exchange for it.”

5.3.1 Value-in-Exchange

The traditional economic theory views value as an exchange value. An exchange value expresses the worth of one product or service for another, e.g., “The value/price of this phone is 300 Euro.” Value-in-exchange usually accounts for the producer’s costs plus a profit margin. The software engineering community also uses the notion of value-in-exchange to estimate the relative usefulness of software components [Boehm, 2003]. The value-in-exchange concept was explored in the requirements engineering field, most notably by the e^3 *value* method and its ontology [Gordijn and Akkermans, 2003a]. The interactions between the elements in the e^3 *value* models are based on the notion of reciprocity, and the value port of each actor who participates in a value transaction has both an input and an output that are required for the model to be consistent. Nevertheless, value in e^3 *value* is not necessarily a monetary value. Even though the modeling method was created on the premise and promise to evaluate the economic viability of electronic service ventures, e^3 *value* models can express subjective value or goods exchanges. Valuation is subjective: for someone who is poor, 100 Euros can make the difference between having a number of meals or not; for a rich person 100 Euros is noise.

5.3.2 Value-in-Use

Value-in-use is the foundation of consumer value interpretations. For example, Holbrook [1999] defines consumer value as “an interactive relativistic preference experience”; this is another way of phrasing value-in-use. The consumer is the one who ultimately extracts the value from the interaction experience. This experience is subjective (or relativistic) to the consumer and is a preference that defines the choices that a consumer makes. The market value of a product/service is defined by what consumers are willing to exchange in order to obtain value for themselves.

Value-in-use is another way to define value in service science [Vargo et al., 2008]. The service-science literature defines value in the interaction among participants in the service exchange, and it places the service adopter inside the value creating network [Spohrer and Kwan, 2009; Vargo and Lusch, 2008]. It is only by participating in a service exchange that a service adopter can receive valuable benefits. The process of ascription of value has been explored in depth (cf. [Guarino et al., 2016; Sales et al., 2017]). These works recognize the subjective nature of value (value is ascribed to experiences and not to objects) and that value is not only subjective but also dependent on the experience of the person who interacts with a value network. Moreover, the subjectiveness of value ascription is attributed, to an extent, to goal dependency or if an object satisfactorily serves us into obtaining a goal. Despite the subjective and experiential nature of value, it is still believed that the ascribed value is affected by the intrinsic properties of the objects that participate in the exchanges.

5.3.3 Public and Moral Value

The theory of public value proposed by [Moore and Khagram, 2004] distinguishes between public and private values. Value for the public is a result of evaluations about how basic needs of individuals, groups, and the society as a whole are influenced in relationships involving the public [Meynhardt, 2009]. Whereas, private value is associated with satisfying individual desires, public value is mostly focused on achieving social outcomes. This theory identifies three main characteristics of public organizations: the public value, the authorizing environment providing legitimacy and support, and the core organizational capabilities required to produce this value. Therefore, public value is considered to be a central element in organizational strategy and managements [Moore and Khagram, 2004].

Researchers have recently looked into other types of values, specifically, human or moral values as principal design constraints for software systems [Ferrario et al., 2016]. The foundation for these values is psychology. Human values are subjective and again related to how important something is. The definition in the human-values literature is as follows: “Values represent our guiding principles influencing our decision-making processes as groups, individuals, and organizations” and also, “values describe what an individual or a group thinks is valuable or important" [Ferrario et al., 2016]. In the same school of thought, we include a value-sensitive design, even though there are subtle differences [Friedman et al., 2008], [van der Hoven and Manders-Huits, 2009] due to the similarity in defining value as "what a person or group of people consider important in life" [Friedman et al., 2008]. The operationalization and wide adoption of the human values theories in software engineering is under question, with the definition of value being the first item in the list of identified problems [Mougouei et al., 2018]. The authors argue the lack of a coherent definition that can reconcile view points and that can show the context in which human values are defined is of upmost importance in order to advance the field. Concerning the same stream of literature, researchers have evaluated the values embedded in top machine-learning publications [Birhane et al., 2021]. In their work, the authors develop a schema for values exhibited by the academic publications that resemble requirements (e.g., performance, accuracy, generalizability). Their work does not define value nor does it use a taxonomy for the values they recognize.

5.3.4 Why a new definition, given all the existing work?

Our research curiosity for the theory was provoked by a dissatisfaction with the definitions we found throughout the many (sub)fields: information systems, software engineering, requirements engineering, conceptual modeling, service science and service management. This spans both research and practice. A fitting example is ITIL, which defines value as [ITIL, 2019] "the perceived benefits, usefulness, and importance of something." This seems like a reasonable definition, as long as we refrain from asking, What exactly is meant by benefits, usefulness and importance? What is this something that is supposed to provide these aspects, and more importantly, by whom and for whom? ITIL 4 complements its definition of value by stating that "Value can be subjective." This gives us a hint about our last question above about for whom the benefit, usefulness and the importance are. Unlike most contemporary conceptualizations of value, which focus entirely on what it brings to customers, ITIL 4 attributes value to stakeholders in general, including [ITIL, 2019] "the customers or consumers of a service, or part of the service provider organization(s)." Missing in this conceptualization are regulators and possible competitors. So, value is for everybody. Can this be true? What does it mean if all stakeholders obtain benefits from a service? Why are there competitions, arguments, disappointments, bickering, etc. if all stakeholders benefit?

To answer these questions, we expanded our literature analysis beyond the IS literature (the result of which we presented in this section) to include areas such as economics, axiology, business modeling, and marketing, which could be considered to be the traditional domains of value theories and definitions. Yet, even after including a broader set of literature, the definitions are either not sufficiently precise or are very specific to the given discipline. And even though value has become a cornerstone in many domains, the concept is often defined, e.g., the benefit or the utility of goods or a service, in terms that do not guide service ecosystem design in general. Hence, we define value for systems.

5.4 A Theory of Value

To understand the notions most often used to define value (i.e., benefit, improvement, usefulness, importance, quality), we go to what it is that exists and what it means to relate to things around us and to ourselves. We will do this, not from a psychological point of view, but from the more general standpoint of perception, physics and physiology. Richet quoted by [Cannon, 1929] describes value in the most explicit and general terms we have yet to find: "The living being is stable. It must be in order not to be destroyed, dissolved or disintegrated by the colossal forces, often adverse, which surround it. By an apparent contradiction it maintains its stability only if it is excitable and capable of modifying itself according to external stimuli and adjusting its response to the stimulation. In a sense it is stable because it is modifiable; the slight instability is the necessary condition for the true stability of the organism." In other words, we need small changes to remain ourselves, to remain stable. *To be stable means that an observer is able to identify an identity.* Think of the change demanded by those who engage in the fight against climate change. Do most people ask for a drastic solution, such as a reduction in world population (a large change), in order to reduce our emissions? Not really. Obviously most people would like to reduce our emissions without reducing the population (a smaller change). We tolerate change only when it improves our "resilience" to it, so that we can still identify ourselves and identify the world around us, hence resilience is in itself a property of stability.

We value stability more than we value change, but we are unable to express this because all that is stable disappears from our perception. We value stability, but are oblivious to it. Whenever something remains stable, we cease to see it. Yet, ironically for our need for stability, change is the most prevalent aspect of our universe, according to our current understanding. Two of the fundamental laws about this universe are the first and second laws of thermodynamics. These laws say that, essentially, change is inevitable and prevalent, that any closed portion of the universe that we care to observe will, over time, be transformed into pure chaos, into a murky soup in which we can observe nothing. In this case, we return with the question of, "Why do we observe anything?" The answer is well outlined by Cannon [1939]: "Organisms composed of material which is characterized by the utmost inconstancy and unsteadiness, have somehow learned the methods of maintaining constancy and keeping steady in the presence of conditions which might reasonably be expected to prove profoundly disturbing."

In alignment with the theory construction process, we present our theory that explains value as the phenomena that holds systems together, the input or output that gives them enough stability to adapt to internal and external changes in order for an observer to identify them in the UoD. First, in our conceptual framework, we use the definitions stated in Chapter 2 of (1) *system*: a set of interrelated elements as defined by an observer (2) *environment (of a system)*: all of the systems that are not elements of the system of interest or the system of interest itself for an observer, and (3) *identity*: a set of elements and relationships between them and the environment that an observer uses to distinguish between a system and its environment.

5.4.1 Principles

Here, we relate the concepts through the following three principles, ergo, the *generalizations* of our theory [Wieringa, 2014]:

Principle 1: Interpretivism

The conceptualization of entities as systems emerges from the relationship between an observer and the universe of discourse (UoD). We use interpretivism as a basis of our theory, presented in detail in Chapter 2.

Principle 2: The Second Law of Thermodynamics

The total entropy of an isolated portion of the universe of discourse increases over time. This law means that, in the end, everything will decay into chaos hence lose its identity if no counter measures are taken. We assume that each observer wants to construct and to maintain their identity (self observation) and the identities of the entities they observe, hence they want to control the increase of entropy. In the case of ecosystems, if two enterprises have their own distinct identities but decide to merge, the previous two recognizable identities could be relinquished in order to construct a new one; but this usually occurs over time and with a conscious management of change in place. Therefore, identities are not permanent but are actively socially co-constructed and ever evolving, even if they seem stable in the moment of observation.

We also postulate that as human beings, we cannot see pure disorder. It follows that the entities we see in the UoD, first and foremost, maintain order for some time. These entities do so by interacting with their environment through inputs and outputs. In our search for an explanation of how we see the world, we chose the second law of thermodynamics due to its fundamental nature. In a world governed by the second law of thermodynamics, we ask how some entities maintain stability. Our intuition is based on an observation made by Cannon [1929] , where organisms maintain steady states, even though they are made of unstable internal elements and are subject to perturbations from their environment [Weinberg, 1975]. The second law of thermodynamics leads us to the subsequent principle that enables us to reason about the openness of systems as a prerequisite for receiving inputs and giving outputs to counter the ever-increasing entropy.

Principle 3: Homeostasis

Entities maintain stable states, which enables an observer to identify them. It is these stable internal states that maintain a living being's identity, hence its survival. Homeostasis, therefore, can be seen as the force that counters the second law of thermodynamics. It is not enough to have only inputs and outputs, they must be continually controlled so that the entropy within and without will not destroy the entity. A system exists in the mind of the observer as a conceptualization, because the entity in the UoD that the observer observes maintains stable states; and vice versa, the observer maintains stable states (memory) between observations.

Consequently, for the observer, it is as if the entity maintains a stable identity that the observer attributes to the system of their conceptualization.

Interpreting, or identifying, systems is a relationship between an observer and their observations in the UoD, yet the second law of thermodynamics brings about constant change (an increase of entropy). Hence, maintaining the interpretation relationship between an observer and their observations is an on-going process of adjustment to "seeing" entities, which are slightly different due to this increase of entropy, as the "same" system when we first conceptualize them. For example, entropy increases for our reader when they read our manuscript because (hopefully) there is newness to the ideas about value, and the observer has to merge and reconcile this with their current conceptualizations. The combination of these three principles leads us to the definition of value.

5.4.2 Value Definition

Definition 5 (Value)**.** Value is an input or an output that helps a system to construct and to maintain a identity for an observer.

We define value to be a product of the interactions between a system and its environment that helps the system to build and/or to maintain an identity for a given observer. Given that the second law of thermodynamics governs isolated systems (that do not interact with other systems), we assume that the only way to maintain stable states that are identifiable is to be a system and to interact with other systems (or with the environment). Hence, value helps a system conserve its internal entropy at a level that enables it to construct an identity for itself and to actively preserve itself as itself. The identity of a system, as given by an observer, goes beyond the primal physiological survival of living systems. The survival of an identity means the maintenance of the perception the observer has of the system. For example, to maintain our identities as researchers, we write (give output to the environment) and review (receive input from the environment) articles because it helps us in the process of giving and building the image of ourselves as a system that self-identifies and is identifiable as researchers.

This notion – of a system's identity and its actions that define this identity – is in line with certain organizational and business-strategy theories. In the words of Weick [1979]: "organizations formulate strategy *after* they implement it, not before. [..] meaning is always imposed after the fact and only after elapsed actions are available for review." For example, Amazon began as a book-selling enterprise, but throughout the years it expanded its actions to selling anything, and now it has the identity, in the eyes of the observers, of an everything shop. We still keep, in our definition space, the possibility of the creation of an identity that is different from the one exhibited by the current actions of the system. This is important in order to accommodate the change of the exhibited behavior by design (Alphabet designed itself) or to react to turbulent/violent change that disintegrates the previous identity. In a socially constructed world, where the identity of a system would be co-constructed by the multiple observers of a system, there needs to be a negotiation space for what a system would value in the future, not only what could retrospectively say about the system's identity.

5.5 Illustrative Example

To illustrate the theory of value, we take the case of the Dutch renewable electricity market, as described in [Kaya et al., 2020]. We first briefly explain this example then analyze the case in terms of the principles we defined in Section 5.4 by using two service modeling methods: e^3 *value* and SEAM. We presented SEAM in Chapter 2. We introduce e^3 *value* in this section.

The Dutch government signed, as many other countries did, the Kyoto CO_2 emission reduction agreements [UNFCCC, 1997]. As a result, the Netherlands has to reduce its CO_2 emissions, and one of the ways to do this is to increase the share of *renewable* energy. There are many renewable energy initiatives, for example, photo-voltaic (PV) cells on the roofs of homes. One of the reasons that homeowners invest in PV-cells is that it is financially attractive. Homeowners received the same amount of money for the energy that they generated as for the energy that they consumed, provided that they, considered over the time period of one year, produce a less or equal amount of energy than that they consume. This is referred to as the 'netting agreement': over the period of one year, the total amount of energy produced is subtracted from the total amount of consumed energy, and the customer pays only for the difference; all under the condition that the amount of energy generated is smaller than the total amount of energy consumed. This arrangement implied that the consumer received the same quota for generated electricity as the price they paid for electricity consumed. This included the fees for transportation, distribution, metering, and taxes.

There was one important caveat for this arrangement. Solar energy has, from an energy-grid perspective, the unpleasant of not being as stable as other sources of energy, in terms of the amount of energy produced. In other words, if the weather conditions change from sunny to cloudy, this immediately affects the total amount of energy produced. The energy grid behaves, however, like a physical system: the total amount of energy produced should at *all times* equal the amount of energy consumed. If more energy is consumed than produced, there is grid instability, hence loads are switched off automatically, by shutting down (partly) the grid. Obviously, this is highly undesirable. To avoid such situations, the energy grid had so-called balance-responsible parties (BRP). These are entities that have to forecast their energy production or consumption for 15 continuous minutes at a time. In the case where the forecast consumption outnumbers the forecast supply, the transmission system operator directs the energy generators to scale up in order to maintain grid stability, or similarly, the operator instructs large consumers to switch off their loads. The parties not responsible for keeping the balance (NBRP) are considered to be predictable and/or negligible, in terms of generation and consumption, hence they do not affect the grid stability. However, due to the huge popularity of the initial netting agreement for private PV-cell owners, these entities could no longer be considered NBRPs. The total amount of PV-cell generated energy is significant, provided that the sun shines, hence it influences the stability of the grid. This means that if the sky suddenly becomes cloudy, the total amount of PV-cell generated electricity decreases significantly and the stability of the grid is in danger. Consequently, large-scale generators were directed to switch on to deliver emergency energy. Such emergency energy is expensive, because it requires generators that are normally switched off hence do not generate revenue.

The costs for this energy power was reflected in the overall energy tariffs that had to be paid by *all* consumers. Indeed, all consumers had to pay for the instability caused by PV-cell owners; this resulted in higher energy fees. and was considered unfair. As a result, the government proposed a change in the energy market structure. Home owners now still pay the normal energy fee (currently about 0.20 Euro per KWh) but receive only about 0.06 Euro per KWh. This is a significant reduction compared to the fee (also 0.20 Euro per KWh) they received under the netting agreement.

The home owners with PV cells were not happy with this change of policy of the Dutch government. This gave rise to different behaviors of the home owners, and one of the initiatives was the creation of so-called Local Energy Communities (LECs). The idea is that homeowners in an electricity-distribution region sell a surplus of energy to other people in their region. As the participants are in the same local region (as seen from an energy distribution grid), this could be done with limited effect on the distribution grid. The price to be charged for generated energy should be higher than the 0.06 Euro per KWh, as proposed by the government for generated PV energy, but should be lower than the 0.20 Euro per KWh that was to be paid if energy is obtained from elsewhere. Moreover, the LECs now behave as BRPs. This means that LECs have to forecast their production and consumption on a 15-minute basis.

5.5.1 Modeling Value in the Example with e^3 *value* and SEAM

In the remainder of this section, we analyze this case by means of the principles that constitute our theory of value and use the definition of value to illustrate the theory. We use two value-modeling methods: (1) e^3 *value* [Gordijn and Akkermans, 2003a], which is the most well-known value based methodology in the information systems domain, and (2) SEAM. We supplement the models with a textual analysis of the principles and of the value definition. These two different ways of perceiving, conceptualizing, and modeling value bring a richness of methods that can be used in the appropriate context. We show the versatility of our theory of value to be used in existing modeling methodologies. The theory of value can be used, in addition to the existing body of knowledge, to provide more explanatory power to the situations under observation and to connect different methods for system design.

The SEAM model in our example is used to provide a high-level perspective of the ecosystem of the energy transition and to make certain assumptions explicit. The e^3 *value* models are used to show the market viability of different configurations based on these assumptions. The theory of value provides a qualitative narrative around the principles in order for system designers to analyze and design a service ecosystem. We first model, using SEAM, the Kyoto protocol [UNFCCC, 1997] and the involvement of the Dutch government and energy sector; the commitment of the Dutch government led to a restructuring of the energy market in order to accommodate the new agreement (to reduce CO_2 emissions). Next, we analyze with e^3 *value* the current situation of the netting agreement. Then, we analyze the proposed change in regulation by the government. Finally, we consider the introduction of LECs. To conclude the example, we offer a meta-analysis of the illustration of the theory and reflect on our choices of models, actors, and interpretations.

5.5.2 The Kyoto protocol, EU, and the Netherlands Ecosystems

The SEAM model shows the “raison d’être” of the Kyoto protocol. In its essence, this international agreement was proposed to initiate a transition from fossil fuels that are overheating the Earth’s climate. Why is climate change a problem? The reason is that it threatens the very existence of the human species. In line with the system’s vocabulary we use, humanity will lose its identity and decay quite quickly if the living conditions on earth become unbearable for humans. Identity maintaining mechanisms (homeostasis) often result in major changes being made to certain parts of the system in order to keep other parts unchanged. The example of the climate change is very fitting. In order to maintain the climate approximately as we had it in, for example, the 1990s, much change is required to our way of producing and using energy hence to our way of life. This is all the more true for developed countries that are the most responsible for the climate change and those that stand to lose the most from it.

The SEAM models use the service ecosystem as a main unit of analysis and focuses on cherry-picked actor who and the services that contribute towards a particular service exchange. The saying “We are what we do” is a fitting metaphor for the SEAM models: an ecosystem that delivers a certain service is an identity relationship between the actors in that ecosystem. Figure 5.1 depicts the ecosystems of the Kyoto protocol and the ecosystems of the EU and the Netherlands. The Kyoto protocol has been amended (the Doha amendment) and succeeded by other agreements (Paris agreement). The amount of reduction of gases, as well as the timeline and participants change, yet the Kyoto agreement is a suitable entry point for our analysis of the Dutch energy market transition of today.

On the first level, the signatories of the protocol are depicted as “a whole” (denoted with `[w]`): They participate in the service exchange to reduce emissions of six gases that are associated with anthropological climate change with the services for reducing their emissions within a certain target, without exposing any of the internals about the delivery of the reduction service. The Kyoto-protocol ecosystem is an identity-changing ecosystem; the participating actors change their actions according to the belief that gas emissions have to be lowered. The EU-15, as a whole, pledges to reduce its CO_2, which is one of the six gases, emissions by 8% [UNFCCC, 1997]. The 15 countries of the EU deliver, as one unit, this service of reduction by distributing the reduction target amongst all its members. The Netherlands, as one of the 15 countries, receives a quota of 6% by negotiating with the other countries and based on the possible internal analysis.

The `EU representatives` on the second level (which shows `EU-15` as “a composite” (denoted with `[c]`)) negotiate among all countries and interface with the Kyoto participants, whereas `the Netherlands` as a whole delivers (as a service) an anticipated reduction of emissions. In `the Netherlands` as a composite, we depict multiple actors who contribute to the discussion of what the transformation could look like. The Netherlands not only participates in the EU-15 and the Kyoto protocol ecosystems but also already provides certain services to its citizens by providing a certain living standard, in a democratic society, and with an open market economy. These existing services are not depicted in the model. With the participation of the `Dutch EU representatives`, the `Dutch government`, an `electricity supplier`, and the

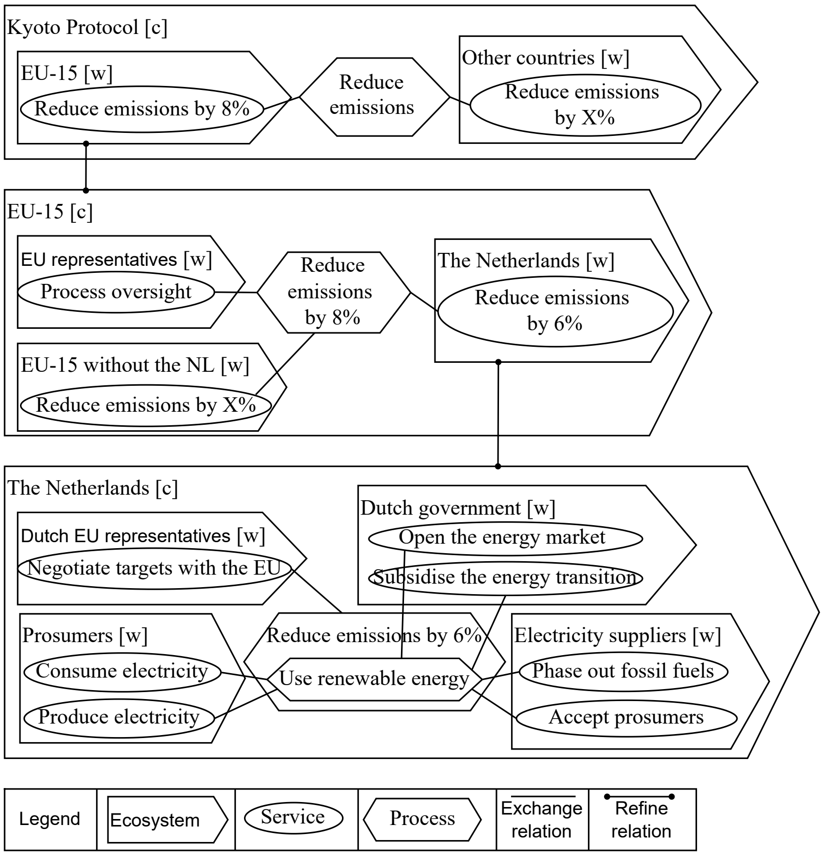

Figure 5.1 – The Kyoto protocol, the EU, and the Dutch government ecosystem

consumers (who become also producers), hence `prosumers`, `the Netherlands` actively co-constructs its identity as a relationship between the different actors in order to accommodate the climate change through responsible living with the other services that it already provides. The Netherlands values services that satisfy this multi-constraint requirement of ensuring that every citizen has access to electricity while reducing its emissions. In the process of *delivering the reductions of gas emissions* of the `Netherlands` as a composite, there is one sub-process that reflects the belief that the *use of renewable energy* is a means to satisfy the aforementioned requirement. The `electricity suppliers` begin accepting `prosumers` in the electricity market and phasing out fossil fuels. The energy-transition strategy requires that homeowners/citizens participate in the generation of electricity. The identity of the homeowners as consumers of electricity changes into consumers and producers. The shift to renewable energy also requires the government to support the process with appropriate (economic) incentives both for prosumers to participate and for the electricity supplier to balance and maintain the grid.

Interpretivism. Figure 5.1 depicts an interpretation of the phenomena that the Kyoto protocol triggers in terms of reactions in the Netherlands. We interpreted the case in light of the theory of value to show the identities of the systems under observation (for example, the Netherlands is a developed country) and to illustrate the new identity that the agreement for reducing gas emissions brings.

Second Law of Thermodynamics. The Netherlands strive to preserve its status as a developed country and as a country that provides a high living standard to its citizens. The new situation of gas-emission reduction targets threatens this identity, unless something else happens – something that would maintain a part of the old identity and morph with the new one. The Dutch EU representatives 'bring' the seemingly external perturbations of the energy transition: without the Kyoto protocol the Netherlands would continue to exist in its stable state. However, the current mode of operation of the Netherlands is at odds with the finite resources of the planet. Without the external change to the identity of the Netherlands (to become a climate-change conscious country), the country would dissipate into an internal chaos.

Homeostasis. The Netherlands, as a system under observation, is more complex than a single identity that we could define. The Netherlands, now, is an evolving concept of what a country is. The energy sector representatives would be more inclined to reject a market-liberalization move as their core business and identity is to produce energy. Yet the Netherlands is composed of many more actors who define its identity and these actors are the ones who insist that gas-emission reductions have to happen. The prosumers adopt a new identity of an environmentally conscious people yet without rejecting their identity of citizens of a developed country. The definition of a developed country changes over time, as the threads to the concept of a developed country are infinite, economic growth clashes with the finite nature of natural resources. Hence, maintaining the identity of a country that is developed means changing the underlying meaning to include a climate-change conscious way of living.

Value. Value, to the Netherlands, is to accommodate its new identity and to change at a rate that does not disintegrate its current identity. Even though it is possible to reduce emissions by not producing any electricity, providing access to electricity to everyone at a fair market price in order to maintain the economic and social life of the country is a part of the Dutch identity. To be environmentally conscious becomes a part of the core identifying variables that, over time, characterize the Netherlands with the help of inputs and outputs that are of value to strengthen that notion. The different solutions (such as PV cells, consumers becoming producers, market liberalization, governmental subsidies, market restructuring) for reconciling the multiple identities – generating energy from renewable sources, participating in an open market for fair economic exchange, and providing access to energy to promote and support the lifestyle and progress of the Netherlands – of the Netherlands are of value.

In the following sections, we elaborate on the energy ecosystem. We analyze the alternative market dynamics and the structure of this mix of consumption and production of electricity. First, we show the initial netting agreement, then, the proposed reduction of the payment for the generated energy and the LECs. Figure 5.1 provides the context for the remainder of the analysis. We do not state in each model that they contribute to CO_2 emission reduction.

For modeling next, we use *e^3 value* [Gordijn and Akkermans, 2003a]. *e^3 value* is the most prominent value-based method in the information-systems and requirements-engineering academic fields. We have previously compared the *e^3 value* and SEAM [Kostova et al., 2019b]. *e^3 value* represented, at first, mostly the economic viability of a venture. The models capture ecosystems (networks of enterprises, based on the definitions of [Moore, 1996] of the actors who exchange value through activities. The definition of value here is based on [Holbrook, 1999]. e^3 *value* models were originally used to capture the environment of information systems but have evolved towards market dynamics, even without an explicit information system.

5.5.3 The Netting Agreement

Figure 5.2 shows, in terms of an e^3 *value* model, the initial market arrangement, namely, the netting agreement. The prosumer is an actor who consumes *and* produces electricity. During the contract period, usually one year, they have a number of customer needs (e.g., 3,000 KwH) for electricity. In order to satisfy their needs for electricity, the prosumer either obtains electricity from the 'produce' activity they perform (actually, the PV cells perform this activity) or obtains electricity from the electricity supplier. The activity 'consume' pays a fee for the generated electricity to the 'produce' activity. As both activities are performed by the same actor, the net-cash effect for the prosumer is zero. We assume that the quantification of the model is made in such a way that all electricity generated by the 'produce' activity is consumed by the 'consume' activity. Any missing power is obtained from the electricity supplier.

Interpretivism. Figure 5.2 depicts the e^3 *value* model of the netting agreement. This model is an interpretation of the case described in [Kaya et al., 2020]. The observers are the authors of the current manuscript. Our observation is centered around the change of fees, the electricity market structure, and the illustration of the theory of value. Hence, the system that we observe and describe here first gives the as-is situation (Figure 5.2) and thought analysis – based on the theory of value – the progression of the to-be situations in Figure 5.3 and a proposal for a future alternative in Figure 5.4.

Second Law of Thermodynamics Observations. If the prosumers continue selling and consuming electricity for 0.20 Euro (in this isolated system under observation), the system would disintegrate because as much as prosumers profit from it, the value for the supplier is negative.

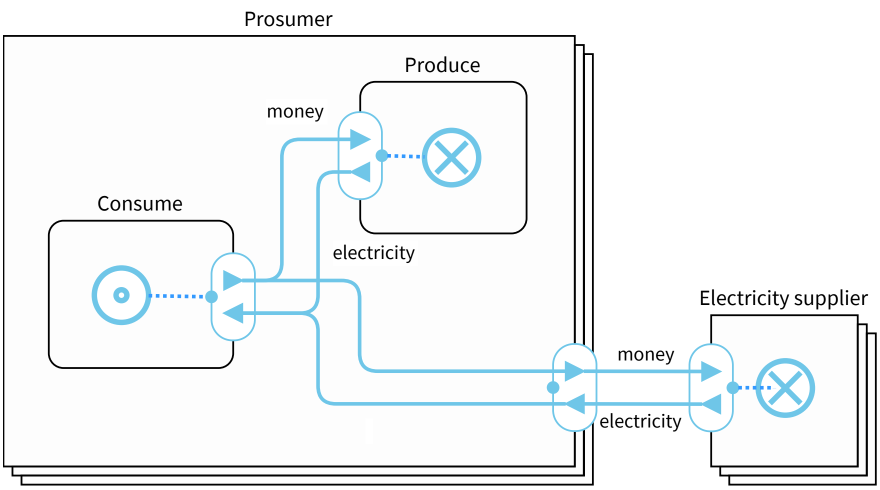

Figure 5.2 – The netting agreement

Any viable system must receive more energy than it provides in order to maintain its internal environment, with a lower entropy than the external environment. Paying prosumers the same amount for the electricity they generate as the amount received from them for the electricity they consume is a zero sum game, which leaves nothing for the suppliers. Either the supplier receives funds from another source or they will go bankrupt. This prospect is not in the best interest of either the prosumers, the supplier, or the government. The prosumers are favored in this scenario, whereas the electricity supplier pays for the distribution and the transmission operators pay for their services. The electricity supplier have either to charge all consumers for only a subset of the consumers' benefits or to cut their own profit; or the government has to pay for this mismatch through tax cuts for the electricity suppliers or direct investments. The as-is situation is unstable, without an intervention, the entropy of the system as a whole would increase to chaotic levels.

Homeostatic Observations. The system under observation still strives to encourage the generation of renewable electricity as a means of reducing CO_2 emissions. Therefore, we (as observers) assume that the government and the other actors would like to maintain the identity of the Dutch market (which is an ecosystem) where prosumers act as suppliers of electricity in the market.

Value. Value is anything that stabilizes the entropy that the system faces, hence is a need to change the interactions by the means of a new agreement for 'fair' fees. Here, one way is to reduce the payments for generated electricity (the solution that the Dutch government opts for) but also to regulate (any other means) the actors interactions. For example, any surplus can be donated to climate-change initiatives; the fees might stay the same but a surcharge for using the grid as a storage could be imposed.

5.5.4 Reduction of the Fee for Generated Energy

Figure 5.3 represents the new policy of the Netherlands, where the payment for electricity sold is lower than the fee for electricity bought: This is a subtle but very important detail to understand. The prosumer 'consume' activity buys electricity from the 'produce' activity if available (e.g., when the sun shines). If the amount of the produced electricity by the prosumer is not sufficient to satisfy their needs, additional electricity is bought from the electricity supplier. If the electricity generated, *at any point in time*, by the prosumer exceeds the electricity needed by that same prosumer, the electricity is immediately sold to the electricity supplier, but for a substantially lower fee than the prosumer needs to pay if they buy electricity from the supplier. If properly quantified, the net effect of this model is that the prosumer, under the same weather conditions that would hold for the netting agreement, loses money, as compared to Figure 5.2, because if, at any moment in time they have a surplus in electricity power, the electricity has to be sold under less favorable conditions.

Second Law of Thermodynamic Observations. After the payment for electricity sold by prosumers has been reduced, the system is in balance with regard to the actors that are depicted in the model. The electricity supplier and large electricity producers do not incur costs to

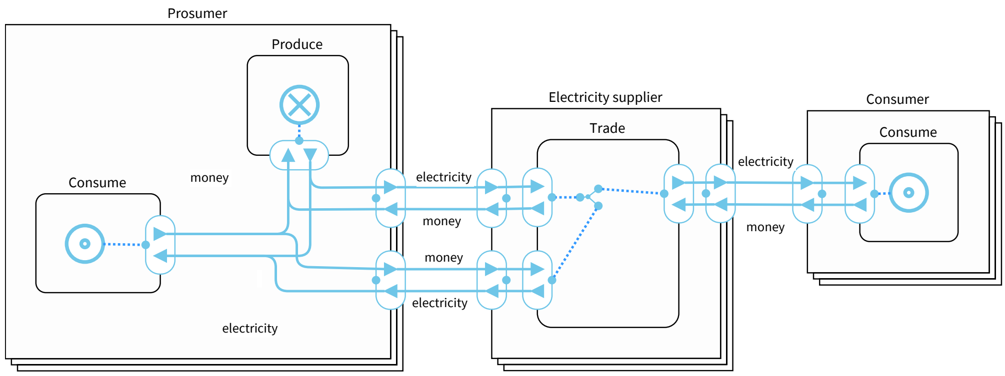

Figure 5.3 – Reduction of the payment for generated electricity

cover the high fee paid to prosumers. However, the system is still governed by the second law of thermodynamics. The entropy in the system would increase if all households continue to install PVs; the electricity supplier would be in danger of losing their business. The electricity supplier is a central node in this system: they are the only one who controls the electricity demand and supply equalization. As a result, everyone becomes dependent on them, and the power dynamics is shifted towards a centralized market with an intermediary that controls that market. Still, even this situation would cause a problem because the objective of the electricity supplier is to make profit. It is only through the government that the reduction of CO_2 emissions is a driving force in the market.

Homeostatic Observations. This last observation, that the reduction of CO_2 emissions and the profit maximization pull the market structure in different directions. The resulting market that decentralizes the electricity supplier's functions and services into local cooperations (presented in the next subsection) is an accommodation to these two identity maintenance goals.

5.5.5 Local Energy Communities

Figure 5.4 presents the Local Energy Community (LEC) model based on [Kaya et al., 2020] with an additional actor, namely the LEC. The prosumer's own consumption of generated energy is the same as in Figure 5.3. If the prosumer, at a particular point in time, cannot satisfy their energy needs with self-generated energy, they first try to buy energy from other prosumers who might have a surplus of energy. Prosumers who have a surplus of energy can sell it to other prosumers or consumers (those who do not generate electricity) who participating in the LEC. This reflects the peer-to-peer nature of this approach; the energy is traded between prosumers and consumers themselves, without any intermediate party that charges a fee for doing so (e.g., by the supplier). The LEC functions like a cooperation between prosumers and consumers; rules and prices are determined by the participating prosumers and consumers and there is no profit goal. The price that prosumers charge each other for energy is lower than 0.20 Euro per KWh (otherwise the energy could equally well be obtained from any supplier), but should be higher than 0.06 Euro per KWh (otherwise the energy could be better be sold to a supplier).

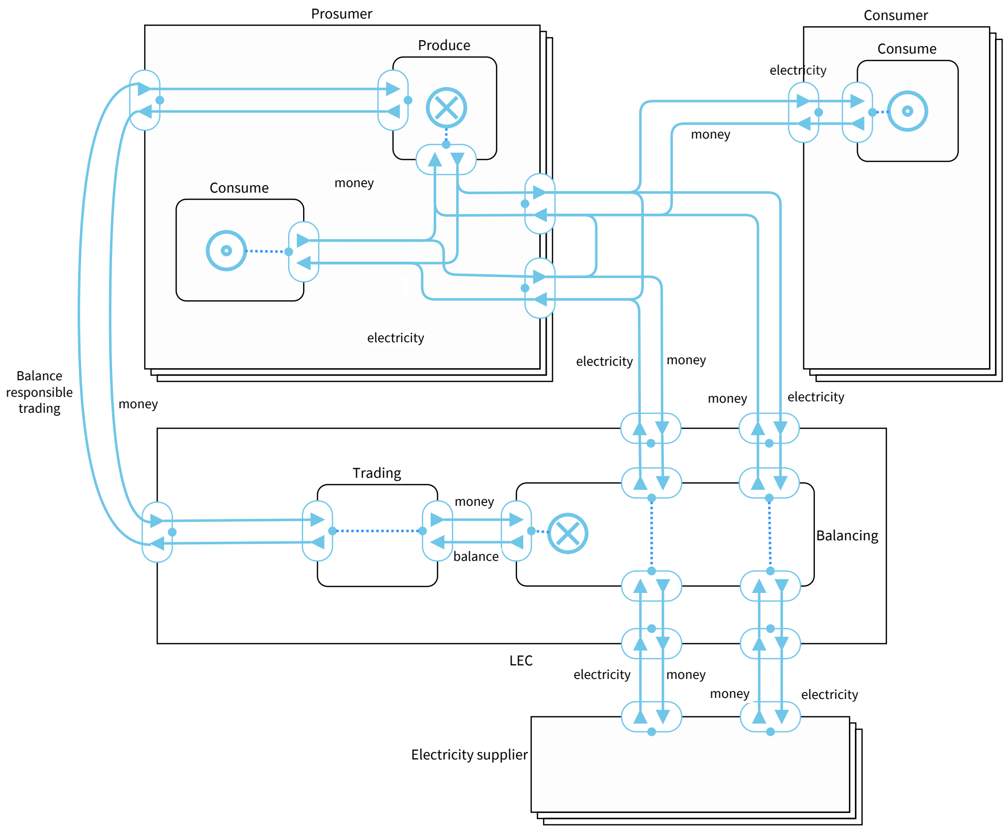

Figure 5.4 – The Local Energy Community (LEC)

The LEC is a balance-responsible party, meaning that it needs to forecast electricity consumption and supply based on local weather forecasts, and profiles of household energy-consumption (the latter are well-known). In the case where the LEC cannot provide sufficient energy for its participants, it buys the energy from a regular supplier. Similarly, if the LEC has a surplus of energy, it sells energy to a supplier. Obviously, the tariff to be paid to the supplier is less attractive than selling the energy to the participants in the LEC. To do all this, the LEC operates a trading platform that also includes the service of keeping the grid in balance. As the prosumers are the main culprit with respect for energy-grid imbalance, they pay the trading platform for trading and maintaining the balance.

Obviously, the electricity suppliers is a balancing actor and will resell the surplus of energy as generated by the LEC, or will compensate for any shortage of electricity as needed by the LEC. This energy can be provided to/obtained from other parties of the suppliers, early-generation generators, or even other suppliers. To avoid unnecessary complexity, this is not modeled.

Second Law of Thermodynamic Observations. In the LEC solutions, the prosumers are satisfied because the local community offers prices higher than the electricity supplier and lower for buying electricity. The households would continue with this arrangement, as it benefits them to be independent from the centralized grid, to have autonomy in their electricity consumption, as well as to participate in the market exchange at preferential rates. The problem comes from two sources. First, there is no one party with an overview of the whole grid and no one party that can optimize the market consumption (some producers will still be more powerful than others and could exert their market power on others in terms of prices or access to electricity). Second, local communities are not interested in maintaining the entire grid, or investing in its future renewal, or in buying other electricity generation sources (wind turbines) to participate in the overall market, or in any other long-term state-level investments.

Homeostatic Observations. The electricity supplier can still find a way to add value but would require a change in the identity of the system: Instead of focusing on profit maximization, with the help of the government, the electricity supplier could provide services to the LECs to minimize their CO_2 emissions.

Value The *prosumer* is a new identity that has emerged in this open-market structure. The consumer's value is to construct the producer part of their identity. They need to have certain outputs, for example, to participate in the grid and to produce electricity, and inputs, and to receive money. e^3 *value* is well-suited to express inputs and outputs as the value element in the models relies on reciprocity. For value to occur, it is not always the case that an input and an output are reciprocal.

5.5.6 Summary

All of the models and analyses (diagrammatic and textual) are subject to interpretations by the observer(s) who not only construct the models but create the system under observations in their minds and later agree (or not) with other observers about the elements in the model, the scope and details of the examples to be included, etc. The Dutch electricity-market case can be analyzed without the e^3 *value* and SEAM models, or can be analyzed based only on the models without hypothesizing 'what if' or 'what else', which leads to three different systems of market structure. The e^3 *value* and SEAM models are of value for our illustration because they are a tool familiar to the IS community and to us. With this example, we could have shown how the supply and demand for electricity has shifted. Traditionally, the demand is much higher in the winter, whereas the supply is lower (in the case of the PV cells). However, with the rising temperatures, the use of air conditioning has increased in recent years.

There are many assumptions underlying any model (graphical, textual, mathematical, machine learning, etc.) For a few examples of the assumptions that we have operated under until now in the Dutch electricity market, we list the following: Climate change is bad (for humans); we can do something about climate change; CO_2 emissions are a measure of how badly we pollute; an increase in CO_2 emissions leads to climate change; PV cells are a better source of electricity than conventional electricity generation methods; and more people would be encouraged to install PC cells if they could make a profit, not only to be energy-independent/loosely dependent on the grid.

Value for the different actors depends on the assumptions they hold, regardless of whether these assumptions are explicit or implicit. For example, a climate-change activist, who is acquainted with information beyond our understanding of the situation (as we are not experts in the field), would have an interpretation of value that is different. To be able to analyze such thorny cases, it is easier to abstract from the reality of real humans and to constrain ourselves to neat models. Yet, the acknowledgment of the different, albeit sometimes overlapping and other times contradictory, interpretations of what exists is the first step to building a common understanding and to participating in finding reasonable accommodations necessary to preserve the identity of the systems that we observe. We would imagine that the electricity suppliers would not concede to dissolve themselves, the Dutch people would not reject electricity altogether, and that the activists would not stop advocating for a decrease in the activities that damage the environment.

Right and wrong are categorical interpretations that serve little to guide us when we reflect about conflicting world views. Economic-value theories help us understand how to design for profit maximization; and environmental engineering guides us how to save the planet. Our interpretation of the state of affairs is that our proposed theory of value is versatile enough to accommodate the different viewpoints. Furthermore it is sufficiently novel as to combine and welcome knowledge from different disciplines in order to find a way to explain to each other what it is that we see and *value* before we proceed to what it is that we do.

5.6 Discussion

We reflect on the practical advantages of a theory, in the same lines of thinking similarly to other scholars who have recognized the role that theory building plays in academic pursuits [Van de Ven, 1989]. We also discuss the place of a theory of value in this point in time when we, as a society, observe many changes and challenges to our global and local systems due to the recent pandemic, ecological problems, and economic and political turns.

5.6.1 Why a Theory?

We understand there are varying opinions on the spectrum of whether a theory can stand on its own without empirical evaluation. Some researchers believe that evidence-based empirically validated and practice-based theories are the way to go in the software engineering and the information systems fields, as these are applied fields [Sjøberg et al., 2008]. This is a pragmatic view about the use of research in the domain and is concerned with giving practical advice that can be applied [Le Goues et al., 2018]. However, another interpretation is that theories are practical, as they abstract away from the specific cases in which the empirical data has been collected [Van de Ven, 1989] and that there are multiple stages of generalization and that both a theory-to-practice approach is just as valuable as grounded theory-building techniques that are a practice-to-theory approach [Le Goues et al., 2018]. To validate a theory, Wieringa [2014] proposes two tests: peer review and empirical tests. The peer review test comes prior to the empirical test and is a precursor for it. This is in line with the argument made by Whetten [1989] that “during the theory-development process, logic replaces data as the basis for evaluation.” We believe that, as researchers, it is our responsibility to first think and to discuss independently of industrial applicability through theory (construction).

Economic value is also a theory.

To illustrate our point that a theory of value could have an impact, we need look no further than the theory of value in economics. The way we think about value has been co-evolving with the theories that emerged throughout the centuries. The term value has a long history of philosophical debates. Recently, with scientific inquiries permeating all aspects of our world, economic theories have taken over the term *value* and have given the meaning of value that is traditionally understood as economic value; as a result, the term *economic* is oftentimes omitted. The two fundamental assumptions are that a definition of value would help in some way and that scientific theories are a valid source of generalized knowledge to be applied in our world.

To regard economic theories as valid, their assumptions have to be met in the real world. First and foremost, classic economics assumes *rational* actors, where the term *rational* equates actors' behavior that adheres to utility maximization for consumers and to profit maximization for producers. In the words of Agre [1999], "both computer science and economics [..] has started from a transparent, God's-eye conception of human beings that subsumes them into a wholly rational universal system, and moved toward an increasing appreciation that human beings are in fact finite, located and embodied." The theories in both domains have been moving towards a more realistic set of assumptions about human behavior. Economists grapple with human behavior because people do not adhere to economics and statistical models. Economic theory has used two ways to deal with the discrepancy between the behavior of their real subjects, homo sapiens, and the imagined homo economicus: Economists create either (1) additions to the utility-maximization theory, such as switching costs to explain how the homo economicus still makes a rational choice by staying in the Apple or the Android ecosystem, or (2) amendments to the conceptualizations of their subjects, such as bounded rationality [Simon, 1990] and behavioral economics [Kahneman, 2011] to explain our "irrational" and "bounded" nature.

To label people as irrational or as having a bounded rationality because they do not comply with a theory is a claim that subsumes the real world as a sub-category of science. Human 'rationality' accounts for many more variables and factors than any theory could encompass [Pinker, 1997]. Furthermore, neuroscience researchers have shown that people with only rational decision-making capabilities (i.e., people who has suffered brain damage that leaves them with rational thinking and excludes their emotions) are unable to reach a decision [Damasio, 2006]. Our "rationality" does not have a stop rule and would continue evaluating the never-ending possibilities and the constant flow of new inputs, unless our emotions influence our preferences. Therefore, not being rational in the absolute theoretical sense appears to be the most rational behavior.

To create a theory that takes all into account would be equivalent to having no theory at all; or, as Weick [1990] points out, the map would be as large as the theory, thus rendering useless the compressing shorthand nature of generalized knowledge that a theory is. Human intelligence is not having all information but being able to adapt in a changing environment [Pinker, 1997]. Searching for a perfect outcome is counter-productive and not smart in changing environment, as the time to react to a thread from the environment might be spent collecting more information, which would result in potential harm. However, in a socially constructed world the map creates the territory or, in other words, economic theories have created much of the world around, as we no longer live in a society that hunts (for the most part). Organizational and social structures follow the evolution of our society, then are conceptualized by theories, and academic and philosophical thought. By co-evolving the natural with the sciences of the artificial [Simon, 1996], our world has increased in its complexity. Theories have shaped our worlds yet are not predecessors to human behavior, rather an influence over the institutional structures in which humans operate. Science, and the scientific method, is a way to validate our assumptions about the world. Hence, theories (of value) are a powerful way to influence our society and need to be periodically updated, as we subject our theories to validation in the real world.

5.6.2 Explaining Existing Definitions of Value with Our Theory

Customer Value

Human beings and the organizations they create are predominantly interested in their own survival. Providing value to customers or other stakeholders, including employees, suppliers, and shareholders is a means toward attempting to ensure this survival. Customer satisfaction and customer value are mainly marketing devices to lure us into believing that the organization exists for us. It does not! Levitt, as we mention in the introduction, expressed the need for companies to deliver value to customers, as have others before him [Levitt, 1960]. Hailed as one of the founders of modern marketing, Levitt was not preoccupied with customer value. His seminal paper is all about ensuring the survival of companies by finding successive growth markets. The fallacy of thinking that companies exist to provide value to customers is easy to dispel. By simply reading the terms and conditions governing any sale from a supplier to a customer, it is evident that they protect the supplier more than the customer [Regev et al., 2013b]. Our definition of value provides a much stronger explanation.

Value-in-Exchange

e^3 *value* conceptualizes value, based on the notion of reciprocity: In our theory, reciprocity is embedded in the value concept according to the principle for openness of the system and its interaction (exchange) with an environment. We argue that value is a result of such an exchange - its output and/or its input. The same principles of interpretivism (Principle 1) and homeostasis (Principle 3) can be referred to when defining value in use [Vargo and Lusch, 2008]. Here, the service adopter interacts with a value network, where the adopter receives valuable benefits (subjective). We say that “adopter” is an identity provided to an entity from the UoD by an observer. Value ascription is related to this identity and its maintenance (also seen as the maintenance of a stable state).

Moral Values

Let us contextualize our theory of value regarding the values mentioned in many publications from the software engineering world [Ferrario et al., 2016], together with value-sensitive design [Friedman et al., 2008; van der Hoven and Manders-Huits, 2009] and, recently, the critical evaluation of the machine-learning academic output [Birhane et al., 2021]. The definition of "what is important to someone" could be made specific by explaining it as follows: Someone is an observer. "Important" are the inputs and the outputs that help an observer maintain and create an identity for systems. If we look at the concept of importance in this way, we can analyze the output of the ML community to see why performance, accuracy, generalizability is of value. These are characteristics that currently constitute a result in the ML academic milieu; and the observers of the academic system will output (publish) articles that adhere to the identity for being an ML researcher.

5.6.3 Identity Maintenance and Creation: Between Thought and Action

An observer "gives" an identity to each system they observe. If the observer recognizes an enterprise, for example, as a company that is environmentally conscious, then they would value what gives them the opportunity to reaffirm this conceptualization of an identity. Bodily, or physical, survival in its most primal meaning is a possible identity but is an instance of an identity maintenance and is applicable in only the most extreme cases (when someone's physical existence is in danger). To draw a parallel between humans and organizations, the survival of a company would mean to break even financially, without accumulating any profit or aspiring to have a vision or a mission beyond profit. Yet, survival of this kind is a necessary but insufficient understanding of the term identity maintenance.

Life, in its most common form, evolves by means of replicating itself towards more complex structures and means of existence until it reaches a point of saturation, where the current models of operation do not support the complexity and undergo a process of "revolution" to find other ways [Greiner, 1972]. For example, an organization might grow with a flat organizational structure until it reaches a few dozen employees but, after a while, it will need a different structure. This change would be provoked by the internal proliferation that all is going well and people are being hired. Once the need to change occurs, in a period of revolution, existing ways of working might not be possible and maintaining the identity of the company would be of value, which might be to contribute to a welcoming work environment and to continue to serve its customers.

However, no system is the same between two observations. The system, as a conceptualization, is actively constructed each time in an observer's mind; only through the memory of the observer can they equate their observations and identify that they have a memory of observing a system that they can recognize as a particular system before [Rychkova et al., 2019]. Changing too rapidly between observations would disintegrate the system's identity for the observer. Inputs and outputs, which help the preservation and update of the mapping between the observations and the stored memories, are of value. Every time a system is recognized as the system with an identity, i.e., a set of identifying variables I and an attribute set A composed of other variables, the observer has a new set of attributes to add to their memory of the system.

The fear of change might force everything to change simply in order for the observer to recognize their surroundings hence to see the identity that they gave to previously observed systems, including themselves. Hence, the fear of change (which is fear of uncertainty) is the very force that drives changes. Our fear of uncertainty is much more potent and poignant than our fear of risk [Bhide, 2003]; it deters us from moving in directions that are different from what is known. For example, a company that sells pens does not diversify its portfolio of products because it has to explore uncharted territories and later fails, rather it does not diversify because everyone uses digital tools to take notes these days.

Success is also a precursor to failure because systems have to jump from an well-established identity towards an unknown one. This is inline with Schumpeter's notion of creative destruction and crossing the chasm between early adopters and stable markets by Moore [1999]. In the height of their success, systems need to enlarge their set of identities, in order to withstand the entropy. Let us take the recent example of Meta, the company that now owns, among others, Facebook, Instagram, and WhatsApp, and the historical loss of more than 20% of their market value. If we are to follow the arguments made by [Zuboff, 2019], companies extract value from the behavioral surplus, i.e., the data that users generate on the websites and services. To let go of the control of this surplus (which is the "raw material" of the digital age), is to cease to exist in their current format: The identity survival of Meta relies on continuously pulling back their users into their ecosystem. As a society, we are changing our views about the threats that social networks pose to our rights to control the information that we consume and produce (input and output). To break out of the circle, we can see that Meta needs to change their identity through a gradual process of creative destruction to the very business models and mode of operation that created some of the most powerful enterprises the world has even known. This shift and exploration of new identities has been taking place with their recent introduction of the brand Meta and the strategy to further develop the metaverse.

This diversification is inline with the principle of requisite variety of Ashby [1957], similar to a portfolio diversification in finance. A single identity is a guarantee of failure yet, we, as humans are averse to uncertainty and fail to do the very thing that might help us survive in our next 'incarnation'. If we continue pouring resources into only the solutions we know, and to serve and maintain the clients we already have, we will not be capable of jumping on the innovation curve that will happen due to market forces (micro-view, people centric).

The re-invention of the self (a human or a company) requires resources and energy. Therefore, the process of finding ways to survive identity changes has to start at a stage when there are enough of the required ingredients. Yet, the survival of identity is as varied as human beings: a company might be on the brink of bankruptcy and still survive, even if it is no longer what it used to be. Nokia survived such a change when they failed to capture the smartphone market. Gradual change accumulates, the observers adjust and learn to associate the same label with different attributes. The Microsoft of today has little to do with an operating systems provider. Microsoft's portfolio includes games (e.g., Minecraft), developers tools and environments (e.g., GitHub and VisualStudio Code), a professional social network (e.g., LinkedIn), and cloud service infrastructure (e.g., Azure).

We mention in the introductory section the work of Weick [1979] who posits that organizations also think about the actions that they took, but only after the actions have occurred, or they see strategy as "retrospective sense-making." This is not to say that we act upon only impulses, without deliberate planning. Rather, that it requires intentional work to construct a new identity, meaning, notice, and direct actions that apply to a 'new' construction. In the words of [Frankl, 1985], "Everything can be taken from a man but one thing: the last of human freedoms - to choose one's attitude in any given set of circumstances, to choose one's own way." Nevertheless, the philosophical debate about whether free will exists is beyond the scope of this thesis. We posit that the intentionality of becoming, as in embodying a certain identity, is a strong motivator for system designers who seek to design ecosystems that enable actions that they deem fitting and contributing to the identity-to-be.

5.6.4 Is defining value necessary at all?

If we are to look at the principles that govern systems in general, value is only a term we use to help us explain the interactions we can observe. If this is true, why is it even necessary to wonder or understand what value is? It is our way of analyzing and designing service ecosystems that can make use of the body of knowledge of different disciplines, by transferring knowledge through the concept of a system. Value, even in economics, might have not been necessary in the first place. To quote Gesell [1958], "If the theory of value is of "fundamental importance" in economic science, is it not an astonishing fact that this so-called value is unknown in business life? In every other sphere of human activity science and life go hand in hand; in commerce alone nothing is known of the principal theory of the science with which it is connected."

Much has changed since the days of Gesell, and value is now prevalent in both industry and academia. The word is used to a point where it has lost all meaning due to the semantic satiation that we all experience. As a result, instead of pretending that the term does not exist or matter, thus subsuming its meaning within GST or desensitizing ourselves, we advocate for clarification through a theory of value. Still, the debate about and analysis of value has been disappearing in the economics field; and value is equated to either wealth or its subjective evaluation by the customers of a certain product. And as Mazzucato [2018] argues "if the assumption that value is in the eye of the beholder is not questioned, some activities will be deemed to be value-creating and others will not, simply because someone [...] says so, perhaps more eloquently than others." Therefore, value theories are of broad and current interest in order to have a conversation about which activities are valuable to us. Clarifying value through systems is a step in the direction of finding, or creating, order in a scene where many contributions already have been made. In this way, value could enrich the vocabulary and the explanatory power of GST, as much as other disciplines that use it, and it could prove to be a unifying concept, just as much as a system is.

5.6.5 Value for Societal Issues

Recently, there has been a wave of concerns about broad societal issues, such as sustainability and ethics. Researchers argue that topics that affect the population at large require a "whole-planet" systems-thinking approach [Easterbrook, 2014]. We believe that our theory of value can be used to explain the different viewpoints and to identify the points of friction. An analysis of the system from different view points is a means of revealing who is included in the system of interest and whose identity is maintained.

The Value of The Environment

Academics have estimated the value of ecological services, such as water supply and pollination [Costanza et al., 1997]. The motivation to do such an estimation is "because ecosystem services are not fully 'captured' in commercial markets or adequately quantified in terms comparable with economic services and manufactured capital[, as] they are often given too little weight in policy decisions." Hence, economic value is a driver behind policies and decisions, even on the level of the actions taken in favor of the environment. Yet the "services" that the environment provide are not fit to be valued with a price tag. It is a cynical view, nevertheless important. With our theory of value we do not have to estimate environmental services according to the narrow definition of value as price/wealth, rather we can analyze the value that the ecosystem services provide to us in order to preserve the human identity.

5.7 Conclusion

In this chapter, we have presented a theory of value that was built with the help of GST, by using principles and concepts from different domains, e.g., philosophy, physiology, and systems. We have presented the current literature on value in the fields of economics, marketing, and service science, among others, and we have described the different definitions and understandings of value. We have proposed a general definition of value; this definition could span the borders of the disciplines. With the help of our theory, we have derived a definition of value as an input or output that helps a system maintain its identity. We have illustrated, with an example, how to work with the theory and the definition of value for analyzing a case, and we have shown how to connect to other definitions of value, e.g., value-in-use, value-in-exchange, and public value. We have discussed the importance of these theories and the reason we propose a theory of value, the implications of a theory of value; we have also reflected on value as a cornerstone for resolving sustainability concerns.

6 [Principle] Reconciliation Heuristics for Modeling Methodologies

After proposing a value theory, which is independent of a modeling pattern in Chapter 5, we came to the conclusion that using together different methodologies is reasonable and realistic in a system-design process. In this chapter, we propose one more instance of the generalized principles. We propose heuristics for reconciling different methodologies. We generalize our findings to encompass not only the strictly speaking value-modeling methodologies but system-design methodologies in general. The set of heuristics is useful in order to (1) accommodate the many points of view, hence ensure the achievement of a requisite variety in the design process and to (2) guide the process of finding of a common understanding. The chapter is based on the paper: Blagovesta Kostova, Irina Rychkova, Andrey Naumenko, Gil Regev, and Alain Wegmann. Systems-thinking heuristics for the reconciliation of methodologies for design and analysis for information systems engineering. In *International Conference on Research Challenges in Information Science, RCIS*, 2020.

6.1 Introduction

Research in information systems (IS) engineering has resulted in so many methods, ontologies, theories, models, and languages that much effort has been expended in trying to reconcile them. The trend is to reach *a single true correct ultimate view* over a socio-technical system. Every attempt at reconciliation inescapably creates yet another artifact (e.g., method, ontology, language). IS engineering researchers are schooled mostly in the predominant positivist tradition where a method's ontology must represent reality, as closely as possible. This is similar to the way the law of gravity is a true representation of reality on earth, and to the way its value must be defined as closely as possible to match observations that are the same, regardless of the observers' culture and context. This objective observation of reality applies poorly to the socio-technical organizations where IS research is or should be conducted [Checkland and Holwell, 1998]. In a field where an objective reality is not shared among the researchers, the quest for a common ontology is futile. As engineers, we perceive complexity as a phenomenon that has to be broken down into smaller pieces that then have to be weaved back together, or as Jackson points out; "Having divided to conquer, we must then reunite to rule" [Jackson, 1990]. This engineering tradition has made its way into IS research, for example, through design with viewpoints [Kotonya and Sommerville, 1996; Nuseibeh et al., 1994], hierarchies of ontologies with domain, upper, core, and foundational ontologies [Borgo and Masolo, 2009; Guizzardi, 2005], model-driven system design (with UML, for instance), and business and IT alignment with the help of enterprise architecture methods [Zachman, 1987]. These efforts point in the same direction: We should analyze a system from many points of view but then synthesize a single one that represents the single true comprehensive view of the system under consideration. Some researchers trace these tendencies to the days when the models of computer systems ultimately had to be represented in machine code as a single source of truth [Jackson, 1990].

We challenge the assumption that, in the context of IS Engineering for socio-technical systems, it is necessary, or even possible, to reach a single representational format (methodology) that can unite all perspectives. Agreeing to disagree seems to be a better path. The basic assumption of the interpretivists is that all ontologies, methods, and theories are valid and useful in their given context because they are the product of a point of view of an individual or a group of people. From an interpretivist perspective, it is impossible to introduce a point of view that will invalidate, disprove, generalize, replace, or subjugate the others, as it will be *yet another* point of view that has no more (and no less) value than any other, *except for the individual or the interpretation context from which it originates.* Instead of describing how to map, merge, and reconcile to a single point of view, we analyze these efforts through the interpretivist research paradigm in order to show a different perspective as to the reasons we, as method designers and method users, do so.

We define reconciliation as an agreement and a shared understanding that might only exist momentarily then disappear as the people's world views, uniquely shaped by their experiences, begin to diverge again. Once an agreement is achieved, it is likely to dissolve over time, unless it is maintained similarly to any system subject to external and internal change. This maintenance is important because, in organizations (i.e., socio-technical systems), a lack of any agreement will lead to chaos and to the eventual demise of the organization as a single entity maintaining its identity. Therefore, organizations strive to prevent major disagreements from happening, by repeated and frequent exercises of reconciliation, explicit or implicit.

We propose a set of heuristics that are inspired by our experience in reconciling the modeling and design methodologies created by our own research group and other methods [Wegmann, 2003]. These heuristics are based on systems-thinking principles and are independent of our methods. The main take-away is that to reconcile different points of view, it is useful to go beyond the immediate ontology and to understand the differences in all epistemology, axiology, and ontology, thus forming a trilogy that together forms a world view.

The structure of this chapter is the following. In Section 6.2, we review existing literature to better understand the reconciliation domain. Then, we present the set of heuristics in Section 6.3. We illustrate the use of the heuristics in Section 6.4. In Section 6.5, we discuss our findings. We conclude in Section 6.6.

6.2 Problem Statement

We inquire into different fields of study that propose their points of view about the phenomena to be conceptualized, hence, modeled conceptually within the process of analysis and design of IS. The term *point of view* refers to different concepts (e.g., ontology, methodology, framework, model, language) in the different fields. We use the term *point of view* to avoid terminology confusion due to overloading constructs that are already in use in the literature. As a result, we reconcile our *point of view* with others by introducing yet one more *point of view*.

First, we look into the early work on ontology from the field of artificial intelligence for knowledge representation and sharing that defines ontology as "a specification of a "conceptualization"" [Gruber, 1993, 1995]. Later Guarino and Giaretta clarified the definition of ontology for it to also be a "synonym of conceptualization." [Guarino and Giaretta, 1995]. Most attempts to reconcile ontologies, however, assume the former definition by Gruber due to the implicit assumption that there is only one possible conceptualization [Hameed et al., 2004]. The single-conceptualization assumption leads to the goal of explicitly reaching a single specification/ontology.

There are two main approaches to reconciliation: (1) refinement and abstraction and (2) alignment (sometimes called matching [Euzenat and Shvaiko, 2007]). With the help of refinement and abstraction, models of different levels of detail can be (de)composed into more or less detailed ones, with the help of formally defined semantics [Antoniou and Kehagias, 2000]. Refinement has been used in multiple studies and is one of the main principles in computer science: for example, going between high-level specifications and formally verifiable specifications [Klein et al., 2009], value models to business process models [Hotie and Gordijn, 2019], and user stories and backlog items [Müter et al., 2019]. The refinement relationship is a semantic one and can rarely be fully automated. Alignment is used, for example, in ontology mapping for web services and semantic web-data representations [Euzenat, 2004; Noy and Musen, 2000]. Alignment deals with semantic heterogeneity and with semantically related entities in ontologies [Euzenat and Shvaiko, 2007], recently extended towards the term semantic interoperability [Guizzardi, 2020].

For an illustrative example of reconciliation in ontology-based IS research (without it being called reconciliation), we take the work by Nardi et al. [2015] who propose an ontological solution for the service domain. The ontology they propose, UFO-S, is a reference ontology for services [Nardi et al., 2015]. UFO-S is based on the Unified Foundational Ontology (UFO) [Guizzardi, 2005; Guizzardi et al., 2008, 2013; Guizzardi, 2006]. UFO has three modules: (1) UFO-A that covers endurants (objects) [Guizzardi, 2005], (2) UFO-B that covers events (perdurants) [Guizzardi et al., 2008, 2013], and (3) UFO-C that covers social entities [Guizzardi et al., 2008; Guizzardi, 2006]. UFO-S, on its own, is built in multiple parts for the different phases of a service life-cycle: service offer, service negotiation, and service delivery. UFO-S is a reference ontology. It is not as general as a foundational ontology and not as specific as a domain ontology. Hence, even using UFO-S means that for a domain of application (or an interpretation context), a modeler would have to introduce another conceptualization for their particular case.

Ontological work is not the only example where the phenomenon of reconciliation between methodologies, theories, ontologies, and conceptualizations on different abstraction levels exists. Zachman [1987] and Sowa [1992] proposed an overarching framework (in essence, a matrix model) that describes an IS architecture in terms of the fundamental questions (what, how, where, who, when, and why) and discipline-dependent views. The resulting enterprise architecture model does not invalidate other models but only introduces a possible structure to integrate, for example, UML diagrams [Fatolahi and Shams, 2006] or SEAM models [Wegmann et al., 2008], and methods for using the framework [Pereira and Sousa, 2004]. The Zachman framework was initially thought of as representing everything there is to represent about an organization and its IS. But in the subsequent 30 years, we saw the development of numerous enterprise methods and frameworks (e.g., TOGAF [Haren, 2011]) that led to a "jungle of enterprise architecture frameworks" [Schekkerman, 2004]. The creators of these later methods and frameworks introduce points of view that, in their intended context, are as valid and useful as Zachman's. This shows that whatever framework that is supposed to describe everything will be superseded by others.

We believe that the assumed problem that research communities might be trying to solve is the lack of a single methodology. There is an implicit belief among researchers that there must exist such a single point of view and that it is the ultimate one. Here, we put forward the idea that having all these points of view is not a problem to be solved per se. On the contrary, it shows that there is no established status quo rather mostly disparate schools of thought. These different opinions are valid and valuable for us to be able to express the nearly unlimited points of view that exist when we design an IS. In his seminal work on the nature of scientific revolutions, Kuhn observed that in the preface of a "scientific status quo" before everyone in a domain agrees on something (shared understanding), everyone has to define their own universe and to start from the beginning, because there is no common ground to build upon [Kuhn, 2012]. We strongly believe that method designers and method users will always strive to reach an agreement. Hence, we propose some heuristics for guiding the inevitable reconciliation efforts that will continue to occur in the academic and the industry domains of IS Engineering.

6.3 Systems-Thinking Heuristics for Reconciliation

The point of departure for our heuristics is interpretivism. In our conceptualization (which is simply another point of view), ontology is the most visible part of the observer's worldview that is called systems philosophy in [Regev et al., 2013a; Wegmann, 2003]. The other parts are epistemology and axiology. Epistemology roots the knowledge held by the observer about their reality, the hidden part of the conceptualization. Axiology is the choices the observer makes (explicitly or implicitly) about which entities to observe in their reality and those to include in their ontology. To attempt to reconcile ontologies at the ontological level is like trying to mix sugar with cold tea. They do not merge well. One needs to heat the tea first. To reconcile ontologies, we need to understand the epistemology and axiology of the people who define the ontologies and try to understand their similarities and differences. This is usually called social construction.

6.3.1 Heuristic 1. Reconciliation as a Process of Accepting Change

To reconcile points of view is to change their creators' minds at the epistemological and axiological levels. We believe that one of the most difficult endeavors is to change people's minds about deeply held beliefs. If it is possible at all, it usually takes time. For example, according to Haldane, there are four stages of acceptance (of a scientific theory): "(1) this is worthless nonsense, (2) this is an interesting, but perverse, point of view, (3) this is true, but quite unimportant, (4) I always said so" [Haldane, 1963].

6.3.2 Heuristic 2. Just Enough Change

A corollary of the previous heuristic is that change must be in just the right amount, not too little and not too much. If there is too little change, no one will notice that a reconciliation has taken place. If there is too much change, the identity of the reconciled points of view will be lost for the observers. In some cases, the best course of action is to take a moderate approach to change. Or, it can be best to take the most conservative option with an absolute resistance to change. And in some other cases for a system it can be best to reach out to high entropy states that disintegrates the identity. The latter option should not be neglected in consideration. In practice it happens as frequently as the former two.

6.3.3 Heuristic 3. Requisite Variety

Requisite variety is a heuristic for studying the responses of a system to existing or future threats [Ashby, 1957; Narasipuram et al., 2008; Regev and Wegmann, 2006; Weinberg, 1982]. Weick [Weick, 1995] shows that, for effective action in a situation with high ambiguity, it is necessary to maintain as many different points of view as necessary in order to "to grasp the variations in an ongoing flow of events." All of the points of view are valid for a context, and all of them are necessary to maintain a requisite variety. For a reconciliation, this means that researchers need to suspend their willingness to reduce the variety in the points of view they seek to reconcile, until they have made sure that this variety is not needed in the domain they describe.

6.3.4 Heuristic 4. Understanding the Philosophy of Each Ontology Creator

As ontology is only the visible part of the world view of its creator, it is useful to instantiate a process of social construction in order to explore each creator's epistemology and axiology. Keeping to the philosophical foundations, epistemology and axiology, enables us to see the source of our differences and to potentially reach a consensus. Remaining on the level of only ontology creates a lack semantics and prevents us from understanding what it actually means to agree or disagree. Staying on the level of only epistemology begets a lack of syntax and a concrete form that we can act upon.

Let us take an example and ask ourselves, “Is a tomato a fruit or a vegetable?” The tomato, as a signification, can be related to either depending on the classification we use. One way to understand which classification to use, with the use of epistemology, is a representation that can be connected to the contexts → “I’m at home, Mom told me tomatoes are a vegetable”, “I’m at school, the teacher told us that tomatoes are a fruit.” With the use of axiology, the observer can chose the “right or appropriate” context, once this context is identified → “For dinner, we don’t put tomatoes in the fruit salad.”, “On the test, I should mark tomatoes as a fruit.”

Hence, in our work, ontology is used in the broad sense to signify the multiple ways with which we can represent the given concepts (tomato and pomodoro[I] are two ways of naming a round red plant). Epistemology enables us to relate the conceptualization to contexts. And axiology enables us to reason about ethical choices (e.g., about good and bad, beautiful and ugly), as well as about moral values. These definitions are inline with the systemic paradigm as proposed by [Banathy and Jenlink, 2003] and used in our own work [Regev et al., 2013a; Wegmann, 2003].

6.3.5 Heuristic 5. Practicality

In practice, there are reconciliation techniques (alignment, refinement) that have their trade-offs, we can understand each and apply the one that makes sense. Both refinement and alignment are well-recognized ways for reconciling ontologies and models. We can achieve alignment through introducing a new entity (fruit) that a “reconciled” point of view includes, because it has some basic properties (attributes) that two or more other entities from different models (e.g., apple, tomato) have in common. With the help of generalization, this alignment will give us one more point of view that departs from the specific context of the other points of view. The resulting models will not contradict in the cases where they do not share interpretation contexts. In the cases where these models share interpretation contexts, conflicts of interpretations are possible. In case of conflicts, generalizations of this sort will resolve the conflicts on a more generic level of interpretation. But, on the specific levels, the conflicts will remain. For example, if we use an algorithm to use an instance of a type *Fruit* in our fruit salad, yet a tomato is treated as a fruit at home, there might be a conflict because the generalization abstracts away the context of interpretation (tomato is a fruit in class but not a fruit at home.)

6.3.6 Heuristic 6. Duration of an Agreement

Nothing lasts forever, but some things last longer than others. We need to know what is being institutionalized/cemented in our systems through automation. Some reconciliations persist

[I] We could interpret pomodoro as pomo d’oro, meaning a golden apple. Hence, the tomato becomes a golden apple, if we only look at the representation (ontology) of methods. We anecdotally call this heuristic the “Golden Tomato” heuristic.

longer than others. For example, an agreement to map the *ID* field from *Database 1* to the field *PersonalID* from *Database 2* could be done on a white board and could be stable for only a few hours while the discussion continues. Or, it could become a longer-lasting reconciliation that is institutionalized by scripting the mapping between these fields. In both cases, there is a reconciliation, yet the level of automation is different. For implementing an IT system, we need to be able to come up with long-lasting agreements that we could codify in a specification, and then in code. This way, we could express the system to be built, in a formal verifiable form (*verification*). Still, to ensure the *validation* of the system, we should not forget that the agreement is not final, and that the process is continuous.

6.4 Illustrative Example

To develop a specification of an information system (in a typical project, for example), we can investigate the settings in which the system will operate and can reach an agreement from various stakeholders about the operations that the system should support [Zave and Jackson, 1997]. The views of people and the as-is situation in the initial steps of the requirements process are usually a subject of analysis and design, with methods that apply to motivation, goals, sociology, psychology, etc. To express the IT specification, these views are taken as input in a requirements process that, at the end, yields a more precise description of the functionality of the IT system. The format of this specification is varied and is in varying degrees of formalism: informal, semi-formal (UML diagrams, semi-structured specifications, user stories), formal e.g., (design-by-contract, formally verifiable specifications). To conduct a (socio-technical) system analysis and design, IS practitioners use different methods and tools.

We use, for an example, a conference submission information system. We scope the example to highlight only certain specificities of the methods in use. We illustrate the use of our heuristics for relating a UML use-case diagram (UCD) and user stories. The choice of these two methods is dictated by their widespread use hence by the fact our readers are likely to be familiar with the methods. The two models can be used in many methodologies to communicate between different stakeholders hence are versatile and applicable in many contexts. We also select these two because of the nature of their differences to also emphasize the variety of mediums in IS methods: a UCD is pictorial and a user story is text based.

A **UML UCD** models the functionalities of a system and the actors who use these functionalities [Fowler and Distilled, 2003]. We use the basic version of a UCD. We explore how to relate a UCD with a user story. A **user story** is a semi-structured way of expressing system requirements. The user story originated in the practice of agile methods. A user story usually follows the following format: "As a `«type of user»`, I `«action»` so that `«reason»`" [Cohn, 2010]. User stories employ the vocabulary of the system's users/customers and have to be further refined into concrete technical specifications (known as Backlog Items).

Figure 6.1 depicts a UCD that includes three actors: (1) reviewers, (2) authors, and (3) PC chairs. These three actors have a common ancestor actor: a user. The conference system has three functionalities (download a paper, assign papers to reviewers, upload a paper) that the

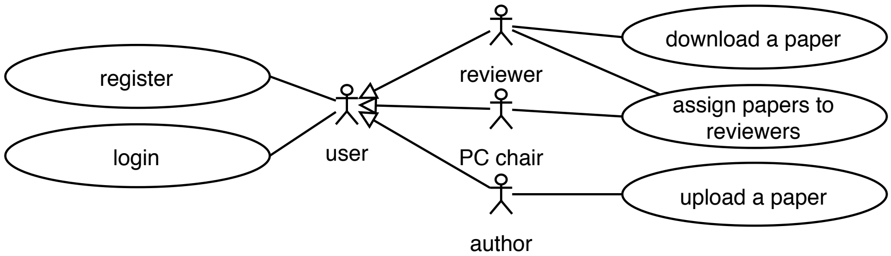

Figure 6.1 – Use case diagram of a conference management information system

actors use and two functionalities that the user has (register, login). The PC chairs and the reviewers share the 'paper assignment' functionality, whereas the authors use only the 'upload a paper' functionality. To construct a user story that is aligned or based on the UCD, we can relate only the ontology elements and create a user story such as: "As an author, I can upload a paper in the conference system."

However, without any interpretation and context, the first two discrepancies become apparent. (1) The author is related to a user. Does this mean that a user can upload a paper as well? It is not possible to show the inheritance of an object in user stories? (2) In the UCD, there is no mention of the reason the author, or any other actor, would like to use any functionality. In use cases, it is not possible to show the intentions of actors. If we are to meaningfully relate the two or to use them as complementary to each other, then the need for *Heuristic 4 to use the epistemology, axiology, ontology* of methods is in place. Some authors proposed ways to map the two models with the use of alignment and refinement *Heuristic 5* [Wautelet et al., 2016] or annotated and extended one of the two [Cockburn, 1997; Wautelet et al., 2014]. To illustrate *Heuristic 6*, the duration of the reconciliation proposed by our basic example is short-lived, whereas the rules coded in a computer-aided tool could last longer [Wautelet et al., 2016]. These works do not invalidate the original models, they give one more point of view (*Heuristic 3*) that can be used when we deem it to be more appropriate for the context of interpretation. Moreover, this continuous generation of knowledge around UCDs and user stories is the process of reconciliation that continues to occur (*Heuristic 1*).

To illustrate our heuristics, we also reflect on a meta-level about our choice of points of view. The heuristic that we can highlight here is *heuristic 3 on requisite variety*: there are many points of view, many methods and models, that we could have used in our analysis. For example, only under the name UML are there various diagrams such as use case, sequence, class, responsibility, and state diagrams [Fowler and Distilled, 2003]. All of these diagrams have their use and can complement others, or they can be used by themselves. This can also be said for the other methods that we could have selected to "reconcile" the UML UCD with, for example, a value-based method [Gordijn and Akkermans, 2003b]. The other heuristic we exemplify here is *heuristic 1 on reconciliation being a process*. In the initial iterations of our work, we selected to relate methods that we created in our research. Yet, we decided to use better-known methods for the design and analysis of IS in order to introduce fewer changes (*heuristic 2 on just enough change*) and to focus mainly on the change that our heuristics could represent as a new point of view that the reader could potentially find easier to reconcile with.

6.5 Discussion

6.5.1 Why these heuristics?

The heuristics we describe here are tightly coupled with our experience of reconciling the methods that we created over the past 20 years and with our quests to relate to others [Kostova et al., 2019b; Lê and Wegmann, 2005; Wegmann and Naumenko, 2001; Wegmann et al., 2008] and to connect different perspectives within our own methods [Kostova et al., 2019a; Regev et al., 2013a; Wegmann et al., 2007]. However, throughout the literature search and given our understanding of the field of IS engineering, we have seen the efforts of connecting different points of view being repeated as patterns. The reformulation of the problem of reconciliation as an ongoing practice is a new idea we put forward. Yet, much academic work has already mentioned their different methods being valid only in particular cases. Furthermore, true to interpretivism, we believe we also offer a point of view with our set of heuristics and not simply *the* set. We have seen other such heuristics or principles (cf. [Klein and Myers, 1999; Winograd and Flores, 1986]). A future avenue for exploration is to consider the different sets of heuristics that exist in other contexts in the domain of IS and to reconcile the reconciliation heuristics. And even though no one set is exhaustive nor are all of its constituent principles valid in every context, we subscribe to the view expressed by Klein and Myers that the "systematic consideration [of the set of principles] is likely to improve the quality of future interpretive field research in IS (especially that of a hermeneutic nature)" [Klein and Myers, 1999].

6.5.2 "Technology is neither good nor bad, nor is it neutral"

One more method, with its corresponding ontology, epistemology, and axiology, is neither good nor bad, nor is it neutral. It is created **for a context** as an academic endeavor, with an objective to *communicate* and to *share* a person's experience with others (i.e., researchers, students), for a more pragmatic attempt *to create a common ground* with a group of people (experts from various domains) for the purposes of discussion and analysis of a situation, and *to find an agreement* on a particular problem/solution. Ontology reconciliation will continue to take place. The question is as follows: Are we, as researchers, cognizant that, by introducing more conceptual work, we are reconciling our point of view with the points of view of others, thus creating a new point of view by interpreting through our own philosophy and our context of interpretation?

6.5.3 Are all points of view valid, yet some just a bit more[II]?

Any methodology, with its corresponding methods, models, theories, and artifacts can (but, being subjected to fallacies, not necessarily has to) be valid and useful within a particular context where it is defined and used. Outside of this context, everything is possible: its validity and usefulness can theoretically be anywhere within the range "absolute–limited–nil". Let us use Boltzmann's entropy as an analogy: $S = k \cdot ln(W)$, where W is statistical weight, and k is

[II] "All animals are equal, but some animals are more equal than others." from *Animal Farm: A Fairy Story*, 1945 by George Orwell the number of possible state configurations within a statistically described thermodynamic system. If we now apply this analogy to methodologies, we can say that, within a social system, we can find a set of these methodologies. Any of the methods defines a set of conceptual configurations that rely on valid conceptual states within the social system. Hence, any one from the set contributes to the statistical weight. A conceptually rich method will define a rich set of states, and a conceptually poor method will define a poor set of states. Every state contributes to the system's statistical weight. However, the contributions of each to the overall social system's entropy might be unequal. The contributions are probabilistic.

Applying the analogy of Boltzmann's entropy, we could say that a particular methodology, or a point of view, regardless of how conceptually rich/poor and probabilistically frequent/rare it is, contributes to the statistical weight of conceptualizations of the social system in which it belongs. A contribution of a particular methodology to the social system's entropy depends on the probability of reaching the states of its conceptualizations within the interpretation contexts of this social system. The more frequent the states are, the lesser the contribution to the system's entropy is.

6.5.4 A Word on the Context of Interpretation

A particular interpretation context can be defined as the corresponding particular state of a system's conceptual configuration. Any methodology that describes or models the system can be evaluated, with regard to its usefulness for a description of this particular conceptual configuration. A richer ontology (with a higher language expressiveness [Jackson, 1990]) has a larger probability of being useful. An ideal ontology would cover all conceptual states of the system, even the high-entropy states. All ontologies are equally valid, as there is no one point of view which is superior or inferior to the other (for this there needs to be an objective observer of observers, or the so-called super observer, who does not exist [Weinberg, 1975]). If "all ontologies" is an unlimited set, then it is logically impossible to define a context where all of them will have the same degree of validity and usefulness. Hence, reconciliation or any effort to make an overarching ontology within a methodology is yet another point of view. Although it tends to reduce disorder (conflicts, variety, inconsistencies) by enabling actors to express their current beliefs regarding the state of the observed system, it cannot cancel, improve, or rule on the rest.

An ontology can be perceived as independent of context. In this case, an ontology has (1) no dependency on a context to which it could be potentially applied in an attempt to describe the context, and (2) no dependency on an observer who could try to apply the ontology in order to describe some context. An interpretation context is a conceptualizable state perceived as existing or is designed to exist within a system that is being modeled by someone (by an observer, by a modeler, by a group of people, etc). Multiple contexts can exist for a given system. Interpretation contexts are (1) dependent on observers/modelers, and (2) contain conceptualizable representations of some entities within the system, these representations can be described by one or several ontologies. Different ontologies can be either more or less useful in their attempts to describe some representations within a particular interpretation context.

The potential for the success or the failure of a methodology within a given interpretation context does not depend on a modeler who applies it, rather on only the conceptual richness or poorness of this methodology, with regard to the representation needs required by the context. If we seek to represent the state of a system, a data-flow diagram might not be the most informative [Jackson, 1990].

6.5.5 Knowledge Representation for AI/ML: the Wave of Automation

There is a trend to connect data that have been generated independently by different sources to enable interoperability and uniformization of formats to ease data sharing [Wilkinson et al., 2016]. Our set of heuristics could be classified towards the wave of semantic interoperability efforts [Guizzardi, 2020]. Here we pause to pose the question, Should we aim for interoperability and all this uniformization of data formats? Enabling more analytics to be done on the data that we can connect, given that we have shown that irreversibly some of the context of generation of these data is lost in the (model-to-model) translation, might lead to unpredictable consequences. The advancement in semantic interoperability enables data from different sources to be cross-referenced hence to build representations of individuals and groups that could be seemingly labeled as context-rich, even though the context in which the data were generated is decoupled from any information system.

There is an implicit assumption that it is better to allow these uses and to enable more automation through the use of AI/ML-powered systems that use these rich data sets, because humans are perceived to be the weak link in any system [Bainbridge, 1983]. Yet, before we understand the technologies labeled as AI and ML, we should “tread softly because we tread on”[III] uncharted territory of technology than can be employed for the automation of decision making that optimizes predominantly profitability of enterprises [Kulynych et al., 2020]. And even if we succeed with automating the human out of the process of translating between models and methods in the context of IS Engineering, the next question is, How and who will handle the mistakes that such automation would eventually lead to? According to Bainbridge, the human who would have to take control over the failure would have to be specialized and highly trained even more than the people whose tasks are being automated [Bainbridge, 1983].

6.6 Conclusion and Future Work

In this chapter, we have presented a set of heuristics for the reconciliation of methodologies for design and analysis in the domain of IS Engineering. We have presented some current literature on conceptual and ontological work, as well as enterprise architecture, to illustrate how different domains already accommodate various methods and models. We have put forward the idea of reconciliation as a recurrent practice in the context of IS scholarly and industry works in order to find place for the knowledge we generate. Our heuristics are built on the notions of interpretivism, entropy, and well-known principles of computer systems

[III] “Tread softly because you tread on my dreams.” from *Aedh Wishes for the Cloths of Heaven*, 1899 by William Butler Yeats design such as abstraction, refinement, and alignment. We have explored the futility of reconciliation solely on the level of ontology and have proposed a way to look at differences on a philosophical levels that includes epistemology, axiology, and ontology; but never only on one. We have illustrated the use of our heuristics with the help of an example modeled with a use case diagram and user stories. We plan to further explore and categorize the epistemological principles that help us better understand the differences and points of intersection, as well as to extend the reconciliation towards research artifacts. For the future, we will inquire into the reconciliation process and into the heuristics on the level of method users, as opposed to the level of method designers, whose perspective we explored in the current chapter.

7 [Principles for Patterns and Practice] Application for Services and Privacy

The last step of the experiential learning process is the application of the generalized knowledge created in the previous step. In this chapter, we apply the principles of value and reconciliation to new domains, namely, services and privacy. These domains have their own patterns and practice. We seek to enrich them by looking at the phenomena with the GST lens. This chapter constitutes our work-in-progress on the future research avenues that we would like to explore further. The Privacy section is based on a working paper.

7.1 Services

As we have seen in the industrial experience described in Chapter 4 and the academic literature on value in Chapter 5, services are used to model value. Services are the application of competences for the benefit of others hence a means to create value for others [Vargo and Lusch, 2008]. Service systems are configurations of resources, e.g., socio-technical components that interact in a value creation process to deliver value to a service adopter [Maglio and Spohrer, 2008; Maglio et al., 2009]. Moreover, services are "a means of enabling value co-creation by facilitating outcomes that customers want to achieve, without the customer having to manage specific costs and risks" [ITIL, 2019]. Service science assumes a service system to be the basic unit of analysis of the value exchange [Maglio et al., 2006]. In these value networks, the value added by the socio-technical elements determine their place in the configuration of components.

Value is defined as "an improvement in a system, as determined by the system or by the system's ability to adapt to an environment" [Maglio et al., 2009]. Furthermore, "value emerges from achieving goals" [Sales et al., 2018]. We might conclude, based on these two propositions, that the goal of a service system is always improving or delivering benefits. Value is exchanged through services, and as the service-dominant logic defines, it is also co-created between providers and adopters of the services. These definitions commit to the goal-seeking organizational model [Checkland and Holwell, 1998].

We make another observation, in relation to the definition of value that the service literature uses: value is linked to risk [Sales et al., 2018]. The Common Ontology of ValuE and Risk (COVER) formalizes "use value" [Sales et al., 2018]. COVER makes the following ontological commitments on the nature of value: Value emerges from the effects on goals, is neither "good" or "bad", and is relative, experiential, and contextual. Risk is the counterpart of value. With our theory of value, we can explain the dual nature of risk and value: Risk is the possibility that an input or an output is of value.

7.1.1 Service Definition

Using the definition of value and the service literature that we have reviewed, we propose the following definition of a service:

Definition 6 (Service)**.** A service, an exchange between systems, facilitates desired outcomes by redistributing value and risk.

Our definition is a reinterpretation of the definition of service, given by [ITIL, 2019], informed by the duality of value and risk [Sales et al., 2018] and combined with the definition of value we provide. The existing definitions of service conceptualize only value and do not reflect that services redistribute value *and* risk. For example, a cloud-service provider offers to their adopters the outsourcing of the cost of building, managing, and maintaining a servers' infrastructure. There is value for the provider of the service, there is value for the adopter, and there is a cost and risk for both.

7.2 Privacy

Another application of our principles concerns privacy. Privacy is a vague term that can be interpreted to accommodate the views of many people. The vagueness accommodates a variety of interpretations, as the concept of privacy was developed from legal and social perspectives. However, software engineering requires precise specifications of the systems that stakeholders implicitly or explicitly expect. Requirements engineering (RE) brings order and gives structure to requirements from vague needs, and it further refines requirements into software specifications. Even though standard RE methods account for flexible and self-adaptive systems by allowing reconfiguration at runtime [Whittle et al., 2009], the requirements have to capture a well-specified set of behaviors (cf. [Omoronyia et al., 2013]) for these methods to be effective for privacy. Even though researchers have already looked into the topic of the vagueness of privacy [Bhatia et al., 2016], their scope is still limited. Studies have found that software developers find privacy requirements and privacy guidelines to be vague, abstract, theoretical, and/or complex [Hadar et al., 2018; Senarath and Arachchilage, 2018].

With the accumulation of research on privacy and privacy RE, trends emerged similarly to the way privacy is conceptualized in privacy research paradigms [Danezis and Gürses, 2010; Gürses, 2010]: (1) *Privacy as Confidentiality*: a predominantly computer-science perspective related to security engineering. (2) *Privacy as Control*: making organizations transparent and accountable for data they have. (3) *Privacy as Practice*: enabling system users to continuously negotiate the boundary of data collection. During a software engineering project, these three research paradigms are likely to appear as viewpoints from the many stakeholders (users, business analysts, security and privacy experts, managers, and legal experts).

We review here the privacy literature in light of how privacy is defined. Then, to accommodate the different points of view of privacy, we propose a definition of privacy from a GST point of view.

7.2.1 Privacy Paradigms

Privacy research has accumulated a critical mass of publications for scholars to observe the emergence of schools of thought, or privacy research paradigms [Danezis and Gürses, 2010; Gürses, 2010; Gürses and Diaz, 2013]. The privacy research paradigms are characterized by different assumptions about what the privacy problem is and, subsequently, about what solutions are proposed to investigate and/or alleviate this problem. The categorization of research in paradigms is not a hard division; a solution from one privacy paradigm might address the privacy problem of another privacy paradigm. We use the privacy paradigms to help us bring order and reason about privacy research. To explain and illustrate the three privacy research paradigms, we use a petition system as an example. A petition is an instrument for citizens to express their opinions by presenting a formalized request or complaint of public or private interest to their authorities. The mechanism of petitions is similar the world over. Figure 7.1 represents the process of paper-based petitions. A `petition organizer` collects a number of signatures from `citizens`. When the necessary threshold is met, the organizer presents the signatures to the `authority`. The authorities then validate the signatures. Translating this paper-based scenario into a digital one (Figure 7.2), the petition organizer can provide a petition system. Citizens can sign a petition by submitting a form with information (e.g., `name`, `email`, `ZIP`). After the petition is closed, the `petition organizer` sends the data collected by the `petition system` to the `authorities`. The `authorities` validate the petition by checking the records with a `registry`.

Looking at these two scenarios already gives us an idea of the complexity of specifying what privacy is. What data is exchanged and is visible to whom? If the petition system is provided by a third party, do they have access to the citizens' data? Can petition organizers validate the identity of the signers by cross-referencing a national registry before sending it to the authorities? These questions concern both the mechanisms of engineering and deploying the petition system and the scope of knowledge of each actor. To analyze the different privacy requirements that each privacy research paradigm covers, we develop the example under each paradigm. If developers are instructed to integrate privacy as a requirement in a reference

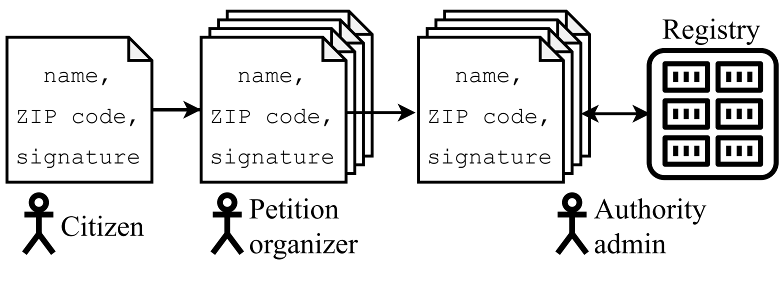

Figure 7.1 – Paper-based petition

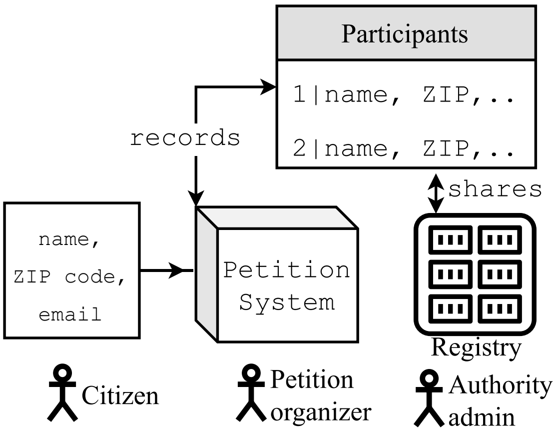

Figure 7.2 – Electronic petition

system, this leaves privacy concerns to their interpretation [Senarath and Arachchilage, 2018]. We look at the different possibilities of refining the concept of a privacy-preserving software system as possible specifications that start from the same initial requirement (privacy).

Privacy as Confidentiality

Privacy as confidentiality encompasses privacy solutions that adhere to the historical perspective of the "right to be let alone" [Brandeis and Warren, 1890], and it aims at hiding certain information (i.e., users' identities, data, the actions taken within the system) [Danezis and Gürses, 2010; Gürses, 2010; Gürses and Berendt, 2010]. To illustrate a petition system that adheres to the privacy-as-confidentiality paradigm, we use as a basis a system that was developed under this paradigm [Diaz et al., 2008]. Among other requirements for the system, the designers identify the following ones for signifying privacy-preserving in the context of a petition system: (1) *confidentiality* – "data exchanges between a citizen and the e-government servers must be kept confidential", plus traffic analysis protection is required to ensure that third parties "are not able to determine that a citizen accesses the e-petition server", and (2) *signer anonymity* – "The e-petition server must not be able to identify the citizens." Figure 7.3 depicts a possible petition system developed under the privacy-as-confidentiality paradigm. The `citizen` is now provided with an anonymous credential mechanism (a chip card) that they use to sign the petition in the `petition system`. Yet, the `petition system` has no data

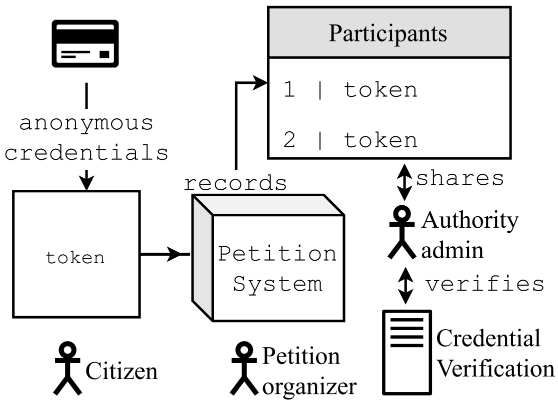

Figure 7.3 – Electronic petition under privacy as confidentiality

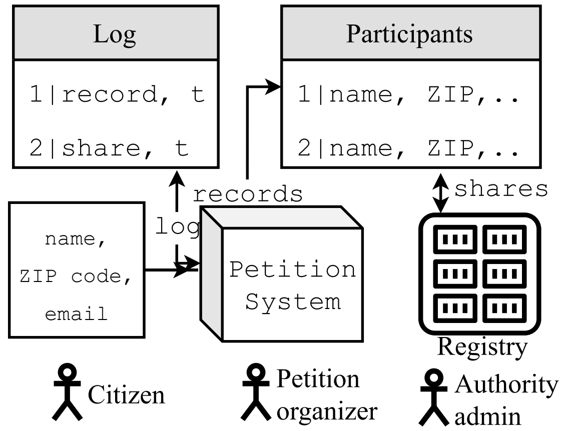

Figure 7.4 – Electronic petition under privacy as control

that links the anonymous credentials to the identity of the signer. However, with the help of the used protocol [Diaz et al., 2008], the `authorities` can verify that the credentials are valid.

Privacy as Control

Under the privacy-as-control paradigm, a typical design of the petition system would resemble Figure 7.4. The system would include additional control mechanisms such as the `log` that keeps information on actions, for example, a new `record` or when the `petition organizer` shares the list of `participants` with the `authorities`. This log is a common mechanism for accountability as mandated by data-protection laws, such as the General Data Protection Regulation [Commission]. The *privacy-as-control* paradigm is concerned with the accountability and transparency of data processing [Danezis and Gürses, 2010; Gürses, 2010] in order to deliver the meaningful context for the use of the data of individuals hence provides a means for instrumentalizing the notion of informational self-determination [Rouvroy and Poullet, 2009]. Under the solution space of privacy as control, there are other mechanisms, which enable individuals to control the data processing, such as the deletion and rectification of data, identity management systems, and the access policies.

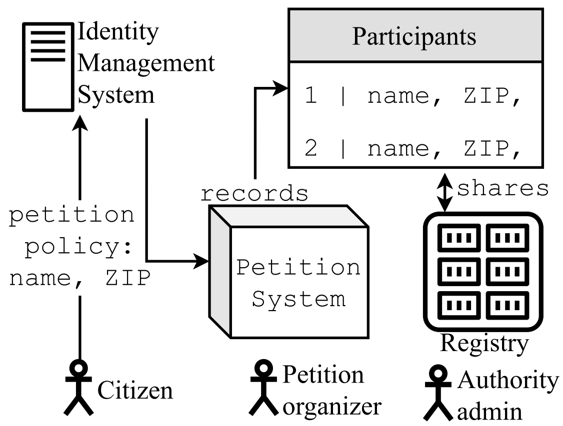

Figure 7.5 – Electronic petition under privacy as practice

Privacy as Practice

The *privacy-as-practice* paradigm dictates that the boundary of the individual's identity is dynamically negotiated and the identity is continuously socially co-constructed. The privacy ethos of privacy as practice is to limit unwarranted interference with the construction of one's own identity" [Agre, 1999]. The *privacy-as-practice* paradigm builds on the *privacy-as-control* paradigm, as this control paradigm reveals which actions are taken with regards to the identity. But this also extends the notion of control towards the individual who can actively negotiate their boundaries and not just be notified of them. For example, in Figure 7.5, an identity-management system that learns the preferences of the `citizen` and adapts the information that is sent, according to evolving preferences and context appropriateness, is a possible solution to be developed under the privacy-as-practice paradigm. Adaptive privacy systems fall under this paradigm [Omoronyia et al., 2013].

7.2.2 Privacy Definition

Privacy and its relation to identity are studied in the privacy literature (cf. [Hildebrandt, 2006]). The definition of value presented here is tied to the identity of a system given by an observer, when the concept of privacy is taken into account: Identity is closely related to the information that individuals and groups allow in and that can influence their identity-building process (and reality perception) and the information that is allowed out of the system and that can be shared with others. We posit a definition of privacy as a corollary to our theory of value. In terms of privacy, the control of input and output is of value. The notion of privacy that signifies the right to construct our identities, which is understood to be a dynamic process, for example, "the freedom from unreasonable constraints on the construction of one's own identity" [Agre, 1999]. With the theory of value, we extend the definition of privacy for the construction of identity to also include the process of identity construction and recognition of observed systems. As identity is dynamic and related to people's interactions with the world around them, a person's identity is arguably that which exists around them.

Definition 7 (Privacy)**.** Privacy is that which the observer defines as an acceptable input and output in order to construct and maintain an identity for a system.

Complete independence from any outside influence is impossible, as systems that do not interact with their environment converge towards pure chaos. In other words, in the absence of outside actors or the environment (as labeled by an observer), identity is meaningless when there is nothing for us to differentiate ourselves from others. A system needs to interact with other systems in order to construct its identity. But the input a system receives and the output it emits are observable, hence observers identify the system through these inputs and outputs. Privacy is that which a system strives to control, in terms of its identity construction and identity recognition.

8 Conclusion

Value is an important concept in scholarly and applied domains. In this thesis, we have contributed to its clarification. Our main contributions in the thesis are the following:

In Chapter 2, we gave foundational background to concepts that we used throughout the thesis, namely, GST, interpretivism, and SST methodologies. We have discussed the limitations on interpretive research; they are valid for the rest of the presented material. In Chapter 3, we have presented the PPP structure for SST. We used the PPP structure to classify the remaining chapters.

In Chapter 4, we reflect on our experience with a concrete project. We have presented heuristics about the to organization of requirements-elicitation workshops for the integration of low-code information systems. We used a service canvas, which relied on an implicit value definition, to elicit and to document the requirements. The practical experience led us to further explore the concept of value, and in Chapter 5, we have presented our theory of value. We define value as *an input or an output that helps a system to construct and to maintain an identity for an observer.* In the subsequent Chapter 6, we have presented a set of heuristics for the reconciliation of design and analysis methodologies. After modeling example cases throughout the thesis and from our other experiences, we find that the use of multiple modeling representations for any project would entail the co-existence of artifacts that could be related with the heuristics for reconciliation.

In Chapter 7, we have presented our exploratory work on applying the definition of value in the research ares of services and privacy. We have proposed a definition of a service that links value and risk (*A service is an exchange between systems, which facilitates desired outcomes by redistributing value and risk*). We have also proposed a definition for privacy. *Privacy is that which the observer defines as an acceptable input and output in order to construct and maintain an identity for a system.*

Our future research agenda includes the following:

First, a validation of the proposed definitions in practice. As we have seen in Chapter 4, SEAM is used by practitioners, who also interpret what a service is. It would be of interest to obtain in a rigorous manner feedback on the proposed definitions. The current validation of the theory of value and the reconciliation heuristics is unstructured and originates from the academic circles, to which the works have been presented. A way forward is to design a qualitative study to obtain more feedback and to expand the pool of participants to industry practitioners. Another way to validate the proposed theoretical constructs is to update the service canvas – with our definition of a service – or another modeling pattern, to reflect and capture the appropriate changes, then to observe the differences for the design of new ecosystems and the analysis of existing ones. These experiments could be initially carried out with example test cases to test the correspondence between the modeling pattern and the principles (instrument validity), then with students, and finally with business analysts (validity of the treatment).

Next, the PPP structure is our approach for explaining and organizing the knowledge that we have created throughout the years. PPP is our own meta-principle for knowledge structuring in the space of SST, but it is not the only one. Our next steps include a study on how SST knowledge is created, taught, and applied.

Finally, a future research avenue is to explore the domain of privacy: for example, the theory of value and the reconciliation heuristics served to conceptualize the space around the various existing privacy research paradigms and to formalize a definition of privacy that could connect them. In the future, the heuristics for reconciliation could be explicitly applied to privacy engineering and, specifically, to the requirements-elicitation process. Another possible way forward is to create a specialized modeling pattern to communicate privacy alongside other requirements. We plan to validate the proposed privacy and service definitions with researchers and practitioners in order to evaluate the applicability of the theory of value.

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Shoshana Zuboff. *The age of surveillance capitalism: The fight for a human future at the new frontier of power.* Profile books, 2019.

Blagovesta Kostova

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PROFILE

- Focused on business-technology alignment, combining industry & research experience
- Languages: English, French, German (basic), Bulgarian

PROFESSIONNAL EXPERIENCE

EPFL, LAMS, Research Assistant (Lausanne, Switzerland) **Oct 2016 – present**

- Close collaboration with industry partners in the domains of consulting services and enterprise software
- Publishing & organizing in the privacy, (micro)services, and requirements engineering academic communities
- Teaching Assistance: Enterprise and Service-Oriented Architecture, Business Design for IT Services, Software Engineering, Negotiation Techniques, Organizational Behavior
- Supervised >20 Master and Bachelor individual students' projects

Microsoft Research and AI, Research Intern (Seattle, USA) **Jun 2019 – Aug 2019**

- Design and implementation of the EVA compiler for the Microsoft SEAL fully-homomorphic library to automate the use of cryptographic protocols for deep neural network inference and general programming
- Technologies: Python, C++, TensorFlow, Protocol buffers

Inpher Inc., Senior Software Developer (Lausanne, Switzerland) **Jun 2015 – Sep 2016**

- Development of a security Software Development Kit (SDK) to enable search and share on encrypted data
- Ran multiple Proof-of-Concept projects in parallel to discover a technology-market fit
- Engaged in market and business analysis, customer discovery and development, investors relations
- First employee and first software developer, established a software dev process with test-driven development and Scrum
- Technologies: AWS, Hadoop, Java, the MEAN stack

EPFL, REACT, Computer Scientist (Lausanne, Switzerland) **Aug 2014 – Jun 2015**

- Development of knowledge management social media platforms for humanitarian efforts
- Active involvement with the main stakeholder, Doctors Without Borders, during the 2014 Ebola outbreak
- Technologies: the MEAN stack

Ciela Norma AG, Software Developer (Sofia, Bulgaria) **Nov 2012 – Jul 2014**

- Development of a mobile and web information reference system for legal professionals (>70k users)
- Engaged in the requirements engineering, design and planning phases
- Technologies: ASP.NET MVC, C#, jQuery, JavaScript, CSS

Application Software Systems, Software Developer (Sofia, Bulgaria) **Apr 2012 – Oct 2012**

- Development of an Enterprise Resource Planning (ERP) system used by pharmaceutical companies
- Building ERP systems with a custom code-generating engine that translated a template specification into a running implementation
- Technologies: Silverlight, C++

EDUCATION

PhD in Management of Technology, EPFL (Switzerland) **2016 – 2022**

- Thesis: A Theory of Value for Service Ecosystems under the supervision of Professor Alain Wegmann

Master in Management of Technology, EPFL (Switzerland) **2014 – 2016**

- Thesis: Early Customer Development in Technology Ventures (Inpher Inc.)

Bachelor in Software Engineering, Sofia University (Bulgaria) **2011 – 2014**

VOLUNTEERING

LauzHack, the largest Swiss student hackathon **2017 – 2021**

- President for 2 physical editions, managed a team of >20 people, coordinated with EPFL's internal departments, hosted >250 students, solicited and managed relationships with (>10/year) sponsors
- Head organizer for online edition in April 2020 with >600 participants, close collaboration with the EPFL's VP of Education, generated substitute projects for discontinued semester projects

PolyProg **2017 – 2019**

- Organizer of the Helvetic Coding Contest, the largest Swiss programming competition

PUBLICATIONS

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[2] **Kostova, B.**, Rychkova, I., Naumenko, A., Regev, G., Wegmann. A, 2020. "Systems-Thinking Heuristics for the Reconciliation of Methodologies for Design and Analysis for Information Systems Engineering", in International Conference on Research Challenges in Information Systems

[3] Dathathri, R., **Kostova, B.**, Saarikivi, O., Dai, W., Laine, K., Musuvathi, M., 2020. "EVA: An Encrypted Vector Arithmetic Language and Compiler for Efficient Homomorphic Computation", ACM SIGPLAN Conference on Programming Language Design and Implementation

[4] **Kostova, B.**, Gürses S., Wegmann, A., 2020. "On the Interplay between Requirements, Engineering, and Artificial Intelligence", International Workshop on Requirements Engineering for Artificial Intelligence

[5] **Kostova, B.**, Etzlinger, L., Derrier, D., Regev, G., Wegmann, A., 2019. "Requirements Elicitation with a Service Canvas for Packaged Enterprise Systems", International Conference on Requirements Engineering

[6] **Kostova, B.**, Gordijn, J., Regev, G., Wegmann, A., 2019. "Comparison of Two Value-Modeling Methods: e^3value and SEAM", International Conference on Research Challenges in Information Systems

[7] **Kostova, B.**, Wegmann, A., 2019. "Co-Design of Business and IT Services", International Conference on Microservices

[8] **Kostova, B.**, Nessler, N., and Wegmann, A., 2018. "Co-Design of Business and IT Services – a Tool-Supported Approach", International Conference on Service-Oriented Computing (ICSOC) Workshop

[9] **Kostova, B.**, and Wegmann, A., 2018, "Technology-Transfer Requirements Engineering (TTRE) – on the Value of Conceptualizing Alternatives", International Workshop on Conceptual Modeling in Requirements and Business Analysis (MREBA)

[10] **Kostova, B.**, and Wegmann, A., 2018, "Service-Oriented Business Design for Engineering Students", Frontiers in Education Conference (FiE)

[11] **Kostova, B.**, 2017, "A Proposition for a Design Method of Service Systems", International Conference on Service-Oriented Computing (ICSOC) PhD Symposium

[12] **Kostova, B.**, Tapandjieva, G. and Wegmann, A., 2017, "Teaching Business Design at an Engineering School – Principles/Patterns/Practice", ISPIM Innovation Symposium