Applying Transdisciplinarity Principles in the Information Services Co-creation Process

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Abstract— Increasing popularity of the notion of service in the enterprise applications development leads to the new types of inter-organizational collaborations. We can observe a shift in this collaboration from simple exchange of services to the co-creation of transdisciplinary services offering a new and unique value to the involved partners. In this paper we define the notion of transdisciplinary information service and we discuss the main principles, namely communication, collaboration, co-innovation, and agility, to be considered in the transdisciplinary information services co-creation and we identify the existing approaches and techniques that support the implementation of these principles. Finally, we introduce our proposal for the elaboration of a method family supporting the co-creation of transdisciplinary information services. This method family aims to provide a flexible and agile process model based on transdisciplinarity principles and allowing to combine method chunks from different disciplines in order to support collaborative creativity, modeling and development of transdisciplinary services.

Keywords- information service, transdisciplinarity, co-creation, co-innovation, collaboration, method family

I. INTRODUCTION

The notion of service plays a more and more extensive role in the enterprise development. Most of the enterprise management and production is based on the exchange of different kinds of services: services to the customers and/or citizens, services to support the inter-organizational collaboration as well as services to complete intra-organizational activities. In many organizations and companies the concept of service becomes a cornerstone in their collaboration, innovation and value creation processes.

This growing popularity of the notion of service leads to the new types of inter-organizational collaborations. We can observe an increase in transition from traditional enterprises to the networked ones and the need for a new type of information systems (IS) – inter-organizational IS – is growing.

Furthermore, we also observe that the domain of information technologies (IT) delivers more and more new systems, platforms, architectures, which aim to facilitate the IS development process and to transform IS into more flexible, adaptable, sustainable and service-oriented ones. Of course, the adoption of these new technologies needs to establish new ways of thinking and new ways of working.

In this context, information systems engineering is moving towards the adoption of service-oriented architectures where intra- and inter-organizational business activities are carried out with the help of information services. Information services are considered as a new means to deal with the complexity, modularity and interoperability of the constantly growing IS [2, 3]. Design and development of information services and information service-driven architectures become key to the success of organizations and their business.

Chesbrough and Spohrer [6] argue that there is still a lack of a strong foundation for designing and managing service systems and service value creation networks. As a response to this argument, new approaches are emerging. For example, Le Dinh and Nguyen-Ngoe [22] presents a conceptual framework for designing service-oriented inter-organizational information systems. In [23] a conceptual framework based on information overlap analysis is provided as a foundation for a thorough understanding of services systems and modeling service value creation networks. A conceptual framework for service modeling in a network of service systems is proposed in [24]. Last but not least, Regev et al. [37] discuss service systems and value modeling from an appreciative system perspective.

However, all these approaches consider services systems, networks and their architectures rather than the definition of service itself. Besides, the transdisciplinary context and the potentiality that it offers to innovate and create new values are not really investigated. In this paper we aim to explore the opportunities that offer the mix of multiple disciplines (e.g. in an inter-organizational context) in the new information services, that we name transdisciplinary information services, creation process. The theory of transdisciplinarity and the fundamentals in communication, collaboration, innovation and agility are the main drivers of our research in the field of transdisciplinary information services co-creation.

Based on these principles and following situational method engineering approach, we aim to define a method family for the co-creation of transdisciplinary information services. The notion of method family [42, 4] allows us to deal with the multiplicity of service engineering situations and to offer the possibility to define a particular method line for the situation at hand. Our method family will provide a flexible, agile and situation-driven process model where various method chunks from different disciplines will be combined in order to support collaborative creativity, modeling and development of
transdisciplinary services. In this paper we introduce our preliminary work in this project.

The rest of the paper is organized as follows: in section 2 we define the notion of transdisciplinary information service. Then, in section 3, we introduce the approach for the transdisciplinary information services co-creation and we discuss the four main principles to be considered in this approach (communication, collaboration, co-innovation and agility) and the existing approaches and techniques that support the implementation of these principles. In section 4 we introduce our method family for the co-creation of transdisciplinary information services that we formalize with the help of a process modeling formalism called Map. Section 5 concludes the presentation and discusses our future perspectives.

II. TRANSDISCIPLINARY INFORMATION SERVICES

Arni-Bloch et al. [2] define an information service as “a component of an information system representing a well defined business unit that offers capabilities to realize business activities and owns resources (data, rules, roles) to realize these capabilities”. And conversely, an IS is seen as built of a collection of interoperable information services [3]. This approach aims to reduce the fragmentation of IS and to facilitate legacy IS evolution by integrating new services. More exactly, in this approach the definition of an information service includes four interrelated information spaces: static, dynamic, rule and role. The static space represents the data structure of the service (the set of classes and their relationships), the dynamic space defines the capabilities of the service (the set of actions), the rules space defines the set of rules that govern the service (business rules, integrity constraints, pre- and post-conditions of actions), and the role space defines the organizational roles that have rights and responsibilities on the service actions. As an example, let us consider the service for merchandise transportation planning used by a transportation company. The simplified version of this service including the four information spaces is illustrated in Figure 1. As shown in this figure, the static space of this service includes the definition of goods, their categories and transportation conditions, the definition of trucks and their categories, the drivers and served destinations, etc. The dynamic space defines the actions like creation/modification of goods, trucks, drivers, route planning including the association of goods to the corresponding truck, allocation of the driver and definition of the itinerary, etc. The rules space defines the business rules as for example, which goods cannot be transported together, what kind of truck can be allocated to each category of goods, the category of driver to be allocated to a category of route, etc., and integrity constraints as for example the truck size must be sufficient for the allocated goods volume. Finally, the role space defines the actors that will use this service, such as transportation manager, driver, and quality supervisor, each of them having a particular responsibility: while the transportation manager can create, modify or delete the routes the driver can only read information related the route allocated to him, etc.

In the inter-organizational collaboration context, several organizations are involved in the common service creation and are equally responsible for its quality. In such a situation, there is no one clearly defined service provider and/or service consumer, each partner is supposed to provide and aims to consume service information and capabilities. In this case, an information service needs to take into account the transdisciplinary aspects – to serve several disciplines at the same time while providing personalized as well as common information and capabilities.

Figure 1. The simplified information model of the information service supporting merchandise transportation planning.
The scope of the information service has to cover the needs of each related discipline and, at the same time, it has necessary to go beyond the scope of each individual discipline. Each of the four information service spaces has to be reconsidered:

- **static space**: there is a need to guarantee that the shared data is unambiguously understood by all involved disciplines;
- **dynamic space**: a distinction should be made between common, personalized and overlapping actions and their effects on each discipline;
- **role space**: a clear definition of roles and responsibilities by discipline is necessary in order to identify and resolve inconsistent overlaps and conflicts. Besides, new transdisciplinary roles can be created;
- **rule space**: because of the overlapping actions and new transdisciplinary roles, it can be necessary to create new transdisciplinary rules to ensure their consistency and the integrity of the related data.

Based on this reasoning, we define the transdisciplinary information service as an information service which represents a business unit supporting the inter-collaboration of two or more disciplines. All disciplines share the same information space but each discipline is offered with customized capabilities.

As an example, let us consider the creation of a service for the transportation and storage of dangerous materials (liquids, gas, radioactive substances, etc.). A large number of organizations would be concerned by this service: the owners of dangerous materials, public security, transporters, warehouses, customs, police, hospitals, etc. The competence and the knowledge of each of these professions are necessary to make this service possible. In comparison with the simple transportation planning service described above (Figure 1), the static space of this transdisciplinary service will be extended with the information related to the security of the transportation (available hospitals, road conditions, storage conditions, security requirements, permissions and certificates, etc.). The dynamic space will have to offer new actions related to the new data management as for example, the possibility to define the new security conditions for each type of material, the itinerary definition based on the related route map, warning notifications, etc. The rule space will include new rules related to the new business activities, as for example, the fact that the police will have to validate each itinerary, the sufficient number of policemen is associated to the convoy to ensure the security of the transportation. Finally, the role space will include several new roles like police responsible, public security administrator, hospital manager, etc. The simplified version of this service is illustrated in Figure 2.

### III. Fundamentals for Engineering Transdisciplinary Information Services

While traditional IS development mainly focus on one discipline (one business area), creation of new transdisciplinary information services requires a transdisciplinary approach where a range of professions with different competences and different knowledge background have to collaborate. In this section we define first the notion of transdisciplinarity in the information services development context. Then, we discuss four principles, namely communication, collaboration, innovation and agility that in our opinion are fundamentals to enable transdisciplinary information services co-creation.
A. Transdisciplinarity

First of all, the difference has to be clarified between the terms “interdisciplinarity” and “transdisciplinarity” because both of them mean interaction between two or more disciplines. The prefix “inter” is defined as “between, among, in the midst of, reciprocally, shared by” \(^1\) and therefore represents an interaction and interchange between the disciplines. Differently, the prefix “trans” is defined as going “across, beyond, through” \(^2\) the limits of each involved discipline. In line with this definition, Nicolescu \([30]\) states that transdisciplinarity “concerns that which is at once between the disciplines, across the different disciplines, and beyond each individual discipline”.

According to Max-Neef \([27]\), “transdisciplinarity, more that a new discipline or super-discipline is, actually, a different manner of seeing the world, more systematic and more holistic”.

Therefore, while the interdisciplinarity concerns the transfer of methods from one discipline to another, the transdisciplinarity promotes the creation of a completely new transdisciplinary and holistic approach on the basis of methods, techniques and tools of different disciplines.

Young \([48]\) identifies four main components that determine transdisciplinarity:

1. The presence of research questions generally emerging because of changing circumstances (e.g. new technologies or new business models) that generate complex and elusive problems;
2. The subject matter determined by the overlap of multiple disciplines;
3. The distinctive lenses created by the systematic use of multiple methods drawn from multiple disciplines;
4. A solution that is greater than the sum of its parts.

Therefore, a transdisciplinary approach for the development of information services has to consider the scale, complexity, elusiveness and novelty of the problem, and to provide guidance (methods, patterns, techniques) based on the cross-cultural expertise, knowledge and data.

According to Somerwille and Rapport \([44]\), transdisciplinary approach is something more than only bringing together people from different disciplines – a “magic ingredient” is required to carry out the co-creation process successfully. This magic ingredient is identified as a “transcendence” which is defined by \([44]\) as “the giving up of sovereignty on the part of any one of the contributing disciplines, and the formation, out of the divers mix, of new insight by way of emergent properties.” In the transdisciplinary services co-creation process, each discipline not only has to find its own interest and value but also it has to be able to contribute to the common new value co-creation. Establishment of a win-win situation is very important for all involved disciplines in order to foster their collaboration and orchestrate processes among them, but it is not sufficient. To achieve transdisciplinarity, it is necessary to create a more advanced situation called “win more–win more” \([36]\) situation where involved firms not only create a common value but also efficiently create a unique value.

Most of the value co-creation approaches and frameworks are limited to the inclusion of customers in the service/product creation process \([32, 33, 36, 10]\). They mainly aim to enable customers, users and/or citizens in creating, modifying and integrating services to develop individualized solutions that meet their unique needs. In the field of IS, the co-creation of services is not only about customers’ involvement it is also about the collaboration of all concerned information service partners.

To summarize, this brave new transdisciplinary information services development situation raises a few tricky questions: How to involve all the related disciplines in the transdisciplinary service creation? How to make all these involved people work together? How to ensure that they understand each other? How to transform and/or unify their ways of working and their ways of thinking? We look for the answers to these questions by analyzing what is really particular in the transdisciplinary services creation or more exactly co-creation. In this perspective we identify four principles that we believe are key in the transdisciplinary information services co-creation process:

1. the communication between the participants from different disciplines involved in the service engineering project,
2. their collaboration in creating shared services,
3. the co-innovation where each discipline brings means not only to discover its own value but also to create a new transdisciplinary value, and
4. the agility of the engineering process.

We discuss these four principles in the sub-sections below.

B. Communication

While the communications process itself is not really a problem because of multiple existing communication tools and channels, to guarantee that all information exchanged between the involved partners is complete and unambiguous is a big challenge in the transdisciplinary service co-creation.

Communication plays a critical role in the process of knowledge gathering and sharing where several different actors aim to reach a common understanding. The situation becomes even more critical when the actors are from different disciplines. Different disciplines generally mean different knowledge, different experiences and especially different vocabularies. All these factors hinder the achievement of a high quality communication and need to be taken into account seriously.

Use of ontologies is considered as a potential solution to ensure communication and knowledge sharing between different professions working in a common information

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\(^1\) http://www.merriam-webster.com/dictionary/inter-
\(^2\) http://www.merriam-webster.com/dictionary/trans-
services development project [49, 50]. Domain ontologies can help people to familiarize themselves with other disciplines involved in the transdisciplinary service co-creation and to learn their vocabularies. However, learning from domain ontologies is probably insufficient. The particularity of a transdisciplinary approach is that it generally goes beyond the scope of any involved application domain and aims to create something totally new. Therefore, it requires its own ontology – a common language dedicated to the new transdisciplinary service domain – which helps to agree upon a shared terminology and a set of constraints on the objects in the ontology.

Defining a common ontology can appear a rather cumbersome task; the same word can mean a different thing for persons from different disciplines. It needs to be created collectively by all project partners, with at least one representative by involved discipline and with the help of an appropriate method. Besides, a facilitator could be relevant to assist the construction of this common ontology.

Several generic ontology engineering approaches and tools have been proposed in the literature and can be adapted to the transdisciplinary ontology creation. Uschold and King [46] propose a skeletal methodology for ontology building while Gruber in [15] defines the basic ontology design criteria. Among the more elaborated ontology engineering approaches we can mention METHODOLOGY – a complete ontology development process from scratch or by reusing other ontologies [8], DOGMA – a methodological framework for “highly reusable and usable, easy to build and smoother to maintain” ontology engineering [20], UPON – an approach for large-scale ontology building based on unified software development process [7], OntoLearn – an approach for the extraction of domain ontologies from websites and other available documents [29], On-To-Knowledge (OTKM) – an approach for ontology development in the domain of knowledge management [45], TOVE – a formalized method for building ontologies based on competency questions [47], etc.

In Table I we summarize the main challenges and existing solutions related to the communication in the transdisciplinary context.

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Solutions and techniques</th>
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</thead>
<tbody>
<tr>
<td>Common understanding</td>
<td>Domain ontologies</td>
</tr>
<tr>
<td>Knowledge gathering and sharing</td>
<td>Creation of a common ontology</td>
</tr>
<tr>
<td>Information exchange</td>
<td>Ontology engineering approaches and tools</td>
</tr>
<tr>
<td>Communication</td>
<td>Multiple communication channels and tools</td>
</tr>
</tbody>
</table>

C. Collaboration

Co-creation of transdisciplinary services generally means inter-organizational collaboration. In this work we are particularly interested in the collaborative modeling and design of information services. Similarly to the IS engineering, information service creation uses various modeling techniques as a support for service requirements elicitation and design. Even more, modeling is considered as the main activity in the service co-creation process where a number of people actively contribute to the creation of models representing different perspectives of the service.

Various approaches and tools supporting collaborative modeling are emerging [5, 38, 39, 40, 41], each of them considering different techniques to share knowledge and to co-create models. For example, Hoppenbrouwers et al. [18] consider modeling as a structured conversation supporting knowledge elicitation, creation and dissemination. Rittgen [38] investigates the role of conversations and loud thinking during collaborative modeling sessions and characterizes collaborative modeling as a negotiation process. In [39] Rittgen identifies a set of problems that are often uncounted when doing modeling in groups and proposes means for solving these problems.

The roles that individuals can have in a collaborative modeling are also discussed in the literature. For example, [11] identifies two principal roles: the domain expert who creates the initial informal model (generally described in a natural language) and the system analyst who abstracts the corresponding formal model. The role of domain expert is also mentioned in [5] together with the roles of modeling mediator, model builder and collaboration engineer. A particular attention we pay to the role of modeling facilitator [38] which is necessary to help in the integration of different views and different models. This role is even more important in the transdisciplinary approach.

The transdisciplinary approach for service engineering needs a common design framework hosting people with different knowledge and skills (business, marketing, information, governance, security and computing) and supporting their collaborative modeling activities. Having a collaborative modeling tool is essential to support asynchronous co-modeling where people from different disciplines contribute to the common models directly from their work spaces. Besides, such a modeling platform should offer guidance for the selection and use of different modeling techniques and tools according to the particular situation of the service development project at hand. To enable this type of facilities, the framework should adopt Situational Method Engineering (SME) principles [16]. SME claims that each software engineering project needs its own method, the most appropriate to the project situation, which can be constructed “on the fly” by assembling method chunks satisfying project requirements and matching its particular situation.

From the state-of-the-art point of view, we can mention the collaborative modeling architecture (COMA) proposed in [40] and the concept of cross-pollination space (CSP) is introduced in [50] as a collaborative platform enabling collective, transdisciplinary and co-creative activities for the generation of ideas and design of new business services. This CSP is based on the use of several ontologies (legal, domain, knowledge, etc.) and the concept of information kernel. While ontologies aim to enable communication and collaboration of people from different disciplines, the objective of the information kernel is to define the semantics of services. As stated in [50], this cross-
pollination space mostly intends to act as support in the service innovation phase (considering that the service lifecycle is composed of five phases: innovation, exploration, design, engineering and sustainment). In order to support the whole information service engineering process this CSP should be extended into a more general service development framework including method chunks for all service engineering phases.

It is not sufficient to provide a good collaboration platform in order to ensure the success of transdisciplinary service engineering. The motivation of people involved in this process also plays an important role. Collaboration in an enthusiastic and cohesive team is generally much more productive than in an apathetic and fragmented one. Therefore, it is important to increase participants’ motivation and involvement in a transdisciplinary service co-creation and to maintain their interest until the end of the project. That could be done with the help of gaming and competition elements. While games and team building techniques in general help to break the tension and anxiety in the team, the competition elements aim to stimulate persons’ incentive. In [14] Gray et al. provides a catalogue of games to support creativity and innovation sessions. A few games are especially dedicated to the team building, warming up before a collaborative session or increasing participants’ interest and curiosity.

Another challenge to be considered in a transdisciplinary service co-creation process is confrontation. People with different professional and knowledge background have to work on a common project – to decide on service scope, features, information, rules, etc. However, their perception of the world, and therefore of the service under consideration, is naturally different. It is important to attain an agreement in a multidisciplinary team that there is no “one common truth”, that there are as many truths as partners in the team and each “personal truth” has to be respected. In extreme cases, it is necessary to set up a special role of team mediator. Mediators use various mediation, conciliation and negotiation techniques to open, or improve, the dialogue between disputants, aiming to find invariants in different visions and to lead the group to a common arrangement.

Table 2 summarizes the main challenges and existing solutions related to the collaboration in the transdisciplinary context.

**TABLE II. COLLABORATION CHALLENGES AND SOLUTIONS**

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Solutions and techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co-modeling</td>
<td>Collaborative modeling platforms</td>
</tr>
<tr>
<td>Co-design</td>
<td>Design frameworks</td>
</tr>
<tr>
<td>Motivation</td>
<td>Cross pollination space</td>
</tr>
<tr>
<td>Confrontation</td>
<td>Team building and warming techniques</td>
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<tr>
<td></td>
<td>Interest and competition increasing games</td>
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<td></td>
<td>Mediation, conciliation, negotiation techniques</td>
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</tbody>
</table>

**D. Co-innovation**

Innovation, or rather co-innovation, is in the heart of the transdisciplinary approach. The co-creation of new and unique value requires the participants to be creative and to think differently. A methodological support is necessary to foster imagination, originality and creativity of the service co-creators. New method chunks inspired from innovation games and creativity techniques need to be included in the transdisciplinary service co-creation process.

In [31] Osterwalders and Pigneur propose a novel approach for business model generation with original canvas, business model patterns and strategies for rethinking business models. This approach can be easily applied for positioning the new transdisciplinary services in the inter-organizational business models. Besides, the authors propose several creativity techniques like “story telling”, “empathy map”, and “visual thinking” that can be adapted to the information services innovation and idea exploration. All these novel techniques help to define the roles of participants and the ways to exploit their knowledge and skills, to create the atmosphere of confidence and trust between the co-creators and to foster their imagination.

Another collection of innovation games like “buy a feature”, “product box”, “remember the future” proposed in [17] as “product” innovation tools can be customized to service creation.

In information systems and software engineering domain, use of creativity techniques is mainly encouraged in the requirements elicitation and domain information discovery phase. Maiden et al. [26] consider requirements engineering as a creative problem solving process and presents a collection of creativity theories, techniques, tools and training that can be adopted to improve requirements engineering research and practice. A tool supporting creative thinking during requirements elicitation process is presented in [21]. In [25] Maiden et al. report on their very positive experience in applying creativity techniques during the requirements process for an aircraft traffic control system. The authors also discuss lessons learned, report the main encountered problems and provide recommendations to overcome them. For example, they report that creativity techniques based on analogical reasoning (comparing the analysis domain with other completely different domains) need step-by-step guidance and time to illuminate analogical ideas. The authors also insist on the necessity to structure and plan creativity workshops, to find a champion for each workshop and to give participants some period to let off steam before being creative. All these techniques and recommendations seem to be really suitable to support co-innovation in the transdisciplinary information services domain; they are summarized in Table 3.

**TABLE III. CO-INNOVATION CHALLENGES AND SOLUTIONS**

<table>
<thead>
<tr>
<th>Co-innovation</th>
<th>Solutions and techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value co-creation</td>
<td>Business model generation techniques</td>
</tr>
<tr>
<td>Creativity</td>
<td>Creativity workshops</td>
</tr>
<tr>
<td>Innovation games</td>
<td></td>
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</tbody>
</table>
E. Agility

Transdisciplinary co-design process needs some agility. People from various disciplines have to share their knowledge and co-create new values through common models. They need to be able to understand, discuss and modify models produced by their partners. In this context, the values of agile modeling such as communication, simplicity, feedback, courage and humility, defined in the Agile Manifesto [1], make a real sense. Models are necessary to ensure information transfer and communication but at the same time they need to be sufficiently simple and clear for all participants. They facilitate rapid feedback of participants but at the same time they ask the participants some courage to take important decisions and some humility to accept that each participant is also an expert in his/her own domain. Sketching, rapid prototyping and other simple visualization techniques can help the development team to visualize, evaluate and adapt the new information service more easily.

According to [9], the power of agile methods is that they are people-oriented rather than process-oriented, adaptive rather than predictive and promotes incremental and iterative development. Their role is to support the development team in their work instead of prescribing what they have to do and in which order. The transdisciplinary approach needs this agility in order to motivate people from multiple disciplines by providing them with “tangible” results (models, prototypes of the service) and reacting to their observations and remarks (modifying models and prototypes) very quickly. Traditional development phases like requirements engineering, analysis, design, development, etc., generally providing a particular deliverable in the end of the phase, do not have the same sense neither the same ordering in an agile transdisciplinary approach. They rather need to be intertwined into an incremental and evolutionary process organized in short cycles where all models, prototypes and code progress together from one cycle to another.

While agility and creativity are indispensable in the transdisciplinary co-creation of services, today’s agile methods do not explicitly support creativity and innovation because of the short durations of sprints that can discourage the incubation and reflection needed for creative thinking. Therefore, it is important to reach a smart combination of the two principles (innovation and agility) in order to help transdisciplinary project teams explore innovations and develop solutions in parallel.

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Solutions and techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incremental and evolutionary process</td>
<td>Agile methods</td>
</tr>
<tr>
<td>Rapid feedback</td>
<td>Prototyping, visualization and simulation techniques</td>
</tr>
<tr>
<td>Creative thinking</td>
<td>Combination of innovation and agility principles</td>
</tr>
</tbody>
</table>

IV. TOWARDS A METHOD FAMILY FOR THE CO-CREATION OF TRANSDISCIPLINARY SERVICES

The approaches and techniques mentioned in the previous section could significantly improve the quality of the transdisciplinary information services co-creation process if used in time and in an appropriate way. On the other hand, selecting and combining them with more traditional service design and modeling approaches requires considerable method engineering knowledge and effort. Therefore, the aim of our work is to facilitate this method engineering task by providing a new method, or more exactly a family of methods, supporting the co-creation of transdisciplinary information services. This family of methods has to provide a flexible, agile and situation-driven guidance allowing to combine method chunks from different disciplines in order to support collaborative creativity in design and development of transdisciplinary services.

Anyone could ask why we are talking about a “family” of methods. The answer is simple – there are so many different co-creativity situations that one method designed in a traditional way cannot consider all of them. The multitude of existing techniques and approaches also do not facilitate the method engineering task. Our objective is not to deal with one situation but to consider the variability of situations and approaches and to provide guidance to easily create a method specific to the situation at hand. So, naturally, our work is based on Situational Method Engineering (SME) (state of the art review available in [16]) principles and techniques. SME promotes modularization and formalization of method knowledge in the form of autonomous, interoperable and situation-driven method chunks [28, 35], fragments [16] and recently method services [19]. In particular we apply the assembly-based SME approach as proposed in [35, 28]. This approach enable to achieve a multi-level modularity in method structure and a high-level flexibility and agility in method application process, and to ensure that the method takes all engineering situations into account and provides the best fitting guidance for the project at hand. It is founded on the Map [43] process modeling formalism, which allows to express complex process models in intentional terms instead of fixed ordered steps. It provides a representation system based on a non-deterministic ordering of intentions and strategies in the form of a labeled directed graph where intentions are nodes and strategies are edges between intentions. The power of Map is in the fact that is allows to include multiple ways to achieve intentions, i.e. many strategies can be defined for achieving an intention. Besides, each intention can be completed at any time providing that the pre-conditions to do that are satisfied. Therefore, we consider that Map is the most suitable formalism to specify the process perspective of a family of methods – the commonality of method lines is represented in terms of common intentions while their variability is captured in terms of multiple strategies supported by various engineering techniques.

Originally, the assembly-based SME approach is dedicated to the “on the fly” method construction for a particular project situation. However, redoing this process every time from scratch can be quite expensive and time-consuming. In order to avoid this difficulty, we combine the assembly-based approach with the notion of method family introduced by Rolland in
method family and method chunks assembly as proposed in requirements specification, method chunk selection for the adapted from [4], then we follow with the method family following way: we start with the method family scoping analysis and method family realization phases. According to [35] assembly-based situational method construction is composed of three steps: (1) method requirements specification, (2) method chunks selection and (3) assembly of selected method chunks into a complete and coherent method. The method family engineering approach introduced in [4] starts by the phase named method family scoping which is followed by method family requirements analysis and method family realization phases.

In our work we combine these two approaches in the following way: we start with the method family scoping adapted from [4], then we follow with the method family requirements specification, method chunk selection for the method family and method chunks assembly as proposed in [35].

1) **Method family scoping:** The method family scoping step consists in defining for the method family: the application domain, the engineering lifecycle to be covered, the major functional areas and the engineering principles to be respected. In our case, we define the method family scope as follows:

- **application domain:** transdisciplinary information service development,
- **lifecycle:** we aim to cover the full service engineering lifecycle starting from service requirements specification to service implementation,
- **functional areas:** our method family aims to provide a support for the main service engineering areas that are service innovation, exploration, design, engineering and evolution,
- **engineering principles:** the method family should take into consideration the four transdisciplinarity supporting principles discussed in the previous section namely communication, collaboration, co-innovation and agility.

2) **Method family requirements specification:** The requirements specification for a method family is based on the intentional process modeling principles as proposed in [34, 35] and consists in identifying the engineering intentions that the method family should help to satisfy and the main strategies to achieve these intentions. Therefore, the requirements are specified in the form of a generic process map where commonality of methods is captured in process intentions (represented as nodes in the graph) and variability is captured in strategies (represented as arcs in the graph).

The obtained map has to fit in the method family scope defined previously. In particular, it has to cover the transdisciplinary information service co-creation lifecycle and its functional areas mentioned above, which lead us to the identification of four main intentions named as follows:

1. **Discover service value:** this intention concerns service identification and innovation phase; for each involved discipline the value to be obtained from the service and the innovation that it will bring to the discipline has to be discovered and agreed between all participants;
2. **Specify service requirements:** deals with service exploration phase where requirements of all disciplines and their actors are elicited, negotiated, formalized and validated;
3. **Design a service:** consists in collaborative modeling of different and complementary service perspectives (data, activities, roles, rules, etc.);
4. **Engineer a service:** deals with service prototyping, implementation and validation.

As discussed in section 3, there exist various techniques, approaches and tools supporting the realization of these four intentions. That allows us to formalize multiple generic strategies to achieve the four intentions as illustrated in Figure 3. For example, we see two complementary strategies to discover values offered by the service: one based on semi-formal modeling languages and approaches that we call **Value models** and the other, more informal, based on creativity workshops and game-based technique and aiming to foster innovation and inspiration of the project participants that we call **Creativity and gaming** strategy. To complete and consolidate this discovery we consider brainstorming and validation techniques.

Service value discovery can be followed by service requirements specification or by ontology-driven service design especially when domain ontologies and/or a common transdisciplinary ontology has to be created to facilitate the service co-creation process.

For service requirements specification more traditional **Requirements engineering, Conflict resolution and validation** techniques can be applied together with the **Creativity-based** ones. Then, service design intention can be reached with the help of the **Collaborative service modeling** techniques. Finally, **Agile development** techniques are suggested to support service engineering phase followed by **Visualization and simulation** techniques which help to refine service requirements or even service value.

3) **Method chunk selection for method family:** Once the generic process model is created, method chunks have to be selected for each section in this map (map section ::= <start intention, target intention, strategy>). Several method chunks can be offered for each section in order to increase the variability offered by the method family. For example, we can identify **Business model canvas** [31], **e3value model** [12], and **i* combined e3value model** [13] as three method chunks fitting the section <Start, Discover service value, with Value...
In fact, more method chunks will be included richer the method family will be.

4) Assembly of method chunks: Finally, the last method family construction step is to assemble the selected method chunks as proposed in [28] and to provide guidelines how to progress in the method family map in order to ensure a proper combination of method chunks. In fact, the Map formalism includes progression guidelines (next intention selection and strategy selection guidelines) that aim to help the method user to find the best way in applying the method. They verify if the pre-conditions for achieving an intention are satisfied and in case of multiple strategies allowing to achieve the intention, they provide arguments and recommendations which strategy to choose. For example, once the service value is identified for each service partner (i.e. the intention Discover service value is achieved), the next intention selection guideline will suggest to progress towards Specify service requirements if service terminology and domain ontology is clear for all participants. Otherwise, it will propose to create its ontological model, i.e. to progress toward Design a service following ontology-based strategy.

At this step, our method family represents a generic process model for services co-creation supported by a collection of techniques for each process step. The obtained process map includes several different ways to go from one intention to another and provides guidance for the decision-making and progression at each process step. From this perspective, it shows that the whole service co-creation process can be very flexible, agile and situation-driven according to the path we choose in this process model.

The application of this method family in practice would consist in:

1. Defining the method line by choosing the path in the family process map, i.e. by selecting the most appropriate strategies to achieve the four intentions. The obtained result will be a sub-map of the family process map;
2. Selecting for each method line map section the most appropriate method chunks. These method chunks are selected from the family collection based on the particular service co-creation project characteristics such as the range of the concerned disciplines, the size of the involved enterprises, the scope of the project;
3. Validating the obtained method consistency and completeness.

The method family for the transdisciplinary information services co-creation is still in its exploration and design stage. Our aim was to introduce it and to solicit the interest of the researchers and practitioners to design method chunks for this method family.

V. CONCLUSION

While the use of the concept of service and service-oriented approaches is growing in the IS development, especially to support new inter-organizational collaboration needs and opportunities, the transdisciplinary context of these new developments is not well explored in the literature.

In this paper we discuss the notion of transdisciplinarity and its perception in the intra- and inter-organizational services engineering. Transdisciplinary information services co-creation is the main preoccupation of this paper.

First we define the notion of transdisciplinary information service as a particular information service dedicated to support collaboration of at least two (but generally more) disciplines from the same or different organizations by offering them a new and unique value.
Then, we identify and discuss four main principles to be considered in the transdisciplinary information services co-creation that are communication, collaboration, co-innovation, and agility. We also identify existing approaches and techniques that support the implementation of these principles.

Finally, based on these four principles and following situational method engineering approaches, we define a new method family for the co-creation of transdisciplinary information services. This method family aims to provide a flexible and agile process model where various method chunks from different disciplines can be combined in order to support collaborative creativity, modeling and development of transdisciplinary services. This method family being in its early development stage, we need to further explore its value, to complete and evaluate it by instantiating for real transdisciplinary service co-creation cases. This is our current and future preoccupation.

REFERENCES


