Shifts in Foci and Challenges in the Field of Information Systems Development Methods

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Abstract—Continuous changes and extensions of enterprise information systems (IS) are the main causes of their fragmentation and redundancy. The notion of service and service-oriented engineering emerges as a prospective approach to deal with IS evolution. The shift from IS to information services systems (ISS) requires to re-think the fundamentals of IS development methods and to re-align them with the brave new ISS development practice. In this paper we analyze this shift and we identify the challenges entailed in the field of IS development methods.

Keywords—information service, information system, information services system, transdisciplinarity, co-creation, sustainability

I. INTRODUCTION

Many observations reveal a great change in the domain of Information Systems (IS) that are widespread everywhere in our Society. Privet as well as public business are realized with the help of IS that become larger and larger and their management turn out to be more and more difficult and imprecise. After various extensions, evolutions and additions of new components, the whole IS architecture becomes obscure, fragmented, with more and more redundant data and processes. To make evolve legacy IS becomes a real challenge at the strategic level of enterprises. In addition, we can observe an increase in transition from traditional enterprises to networked ones and the need for a new type of 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 are very attractive for IS development but need a new way of thinking and a new way of working to adopt them.

The notion of service and service-oriented engineering emerges as a prospective approach to deal with IS fragmentation, interoperability of different IS components and evolution [1, 3, 4, 8, 30] as well as to support inter-organizational IS development [19, 20] by redesigning IS architecture into a service-oriented one [8, 13, 20, 33]. However, this approach requires a deep transformation of the IS concept into a new Information Services System (ISS) concept. That does not only mean the structural transformation; the way of analyzing and designing information services and systems, the way of thinking and the way of collaborating have to be reconsidered. The focus and scope of traditional IS development methods have to change from engineering of big, complex and monolithic IS to rather small, modular, sustainable but still complex information services and their composition into services systems. This shift in paradigm creates a strong need to re-think the fundamentals of IS development methods and to re-align them with the brave new ISS development practice.

In this paper we present our understanding of this emerging transformation of the IS world into the ISS world and we reveal the challenges entailed by this shift in the field of IS development methods. These challenges do not concern the structure of methods but their content. It recent years it was widely acknowledged that IS development methods have to be modular and situational in order to perfectly fit the development situation at hand. The state of the art review presented in [14] analyzes approaches, techniques and tools available for a full situational method construction from the method fragments/chunks. In this paper we rather analyze what kind of method chunks the new methods need to include and what type of support they should offer to the service-oriented IS engineering.

In the next section we consider the shift in paradigm in the domain of IS and we introduce our perception of the notions of information service and services system. In section III we discuss the evolution problem in the domain of IS and how to attain IS sustainability with the new service-oriented paradigm. Section IV examines the notion of transdisciplinarity as a shift in the way of engineering new inter- and intra-enterprise services and services systems by including people from various disciplines. Then, section V considers how to make all these people work together with the objective to co-create new services. Finally, section VI summarizes the challenges for new service-oriented IS development methods and concludes the paper with a list of research questions for future works and perspectives.

II. SHIFT IN PARADIGM

The concept of service is not new; it is fundamental in various disciplines like Economy, Marketing and Public Administration. However, the importance of services has significantly increased in recent years with the emergence of Services Oriented Computing (SOC) using web services [7]. The notions like Services Oriented Architecture (SOA) [11, 18,
21, 24] and Software as a Service (SaaS) have opened the door to the new trend – service orientation – not only at business level but also at technology and information levels.

According to [7], “SOC reinvents the way enterprises work together: common tasks in a business process or supply chain can be easily outsourced to external service providers for both performance and cost reasons”. This is true, especially when a new inter-organization business has to be created from scratch or the existing one is completely re-engineered. However, this is not so easy then the existing intra-enterprise business has to evolve by preserving legacy systems which cannot be easily replaced.

In the domain of IS, service orientation offers new opportunities to deal with fragmentation, interoperability and sustainability problems. But, at the same time, the shift from IS to Information Services Systems (ISS) brings new challenges that ISS engineers have to overcome.

A. The Concept of Information Service

While the concept of service is widely used in both computer and business sciences, its definition differs considerably from one area to another and even within these areas. In [28] Quartel et al. classify services into six categories:

- **Service as an interaction** between service provider and service consumer where the latter captures the value created by the former [16].
- **Service as a capability** offered by a system or an entity providing it to produce some intangible benefits to its consumer. According to [6], in the business science community “services are business activities that often result in intangible outcomes or benefits; they are offered by a service provider to its environment”. Similarly, in the IT domain, OASIS defines a service as “a mechanism to enable access to one or more capabilities…” [21].
- **Service as an operation** or a method defined on an object or a component in object-oriented and component-based design.
- **Service as an application** or a software component – typically a Web service. For example, W3C [35] defines a web service as “a software system designed to support interoperable machine-to-machine interaction over a network”.
- **Service as feature** offered on the top of a basic service provided by a company or a system (e.g. in the telecommunications domain).
- **Service as an observable behavior of a system** – the set of all possible interactions between the system and its environment observable at a particular interface.

From this classification we can notice that the focus of each definition is either on business or technical aspects of a service. However, in the domain of IS, these aspects cannot be considered separately. Business activities and rules, technology and information have to form one unit that allows the organization to perform the related business.

In most of these definitions, the concept of service is built on an input-output schema where the autonomy of a service can be defined easily. But, in the more general IS situation, services have to share classes, integrity rules, roles, events, processes; their autonomy must be defined in a different way.

Finally, the information aspects are completely forgotten in these definitions. In the IS domain, information represents the knowledge necessary to make the business run: to carry out business activities, to report on business performance and to take decisions for the future.

Based on this reasoning, a new type of service – information service – is introduced in [5]. This concept is built upon the concept of IS component including activities, technology, information and organization aspects. The proposed information service metamodel represents a kind of extension of other services metamodels such as: WSPER [9], WSDL [36] or Service specification reference model [2].

An information service in [3, 5] represents a business unit with a precise semantic. It provides the information space and capabilities to the actors that have the responsibility to use them in order to perform their daily activities restrained by the regulation polices.

The notion of information service aims to transform an integrated and rather rigid IS architecture into a more flexible, modular and sustainable one where services can be modified or replaces and new services can be integrated. Design of a new information service is somehow similar to the design of an IS. While the scope of a service is much smaller than the one of an IS, its development is not really much easier. A service has the same facets to be modeled as an IS (i.e. data, processes, rules, roles) and the complexity of the models can still be very high. What is different is that the context, in which the service will be used, has also to be analyzed and the ways the service will be combined with other services have to be defined. Conventional IS development methods do not support these new activities. They represent a challenge for new service-oriented IS development methods.

B. Information Services System

There are certainly several different ways to deal with the shift from enterprise legacy IS to a service-oriented ISS. We see three possibilities (see Fig. 1):

- **The first possibility** is to consider that services are defined upon the legacy IS – they represent different interfaces to access existing data and processes. It can be quite difficult to reconsider a monolithic IS as a collection of services even though the IS itself will not endure any particular transformation. The main difficulties in this type of transformation include the identification of services in the legacy IS, identification of organization roles having responsibilities on these services and specification of appropriate interfaces for each <service, role> couple.

- **The second possibility** is to consider that in the future the IS will be composed only of services. This situation needs a deep transformation of the IS. The legacy IS has to be “decomposed” into a collection of services
Current service-oriented approaches like Service Oriented Architecture (SOA) [11, 18, 21] propose to rebuild enterprise IS architecture in terms of autonomous services to be composed in different ways. In this perspective, services have to be elaborated from scratch in order to avoid any overlap between them. Therefore, we can say that their proposal fits in the second category but represents a rather extreme solution. However, the IS lifecycle is a continuous incremental and evolutionary process, i.e. applications and services are regularly added to the IS. It is not possible at each iteration to rethink the entire IS in order to guarantee the autonomy and correctness of the existing and new services. For that, we need methods supporting IS evolution in a modular and flexible way as proposed in [24] but also by preserving legacy IS consistency and regulation policies as discussed in [3].

In all three cases, the evolution of the new IS will be achieved through its extension with new services. Therefore, the challenge for new ISS methods is to respond the question: how to integrate a new service into an existing IS?

A service-oriented and situation-driven approach dealing with legacy IS evolution is proposed in [3, 30]. This approach is based on the analysis and resolution of the overlap between the legacy IS and the new services and helps to preserve the core IS as much as possible thanks to the integration impact analysis. The approach proposes several method chunks for each overlap situation. Application of a method chunk has an impact on the legacy IS and/or the new service. A more or less important transformation can be necessary in order to guarantee the consistency of the extended IS. A set of indicators are proposed in [3] to evaluate the impact that the application of the method chunk will have on the legacy IS and the service itself. They help the engineer to select the method chunk with the lowest impact.

III. SUSTAINABILITY

One of the main reasons of the shift from traditional IS to ISS is the need to gain in sustainability. Sustainability here means the ability of a system or a service to evolve in line with the changes that the organization undergoes. As discussed in the introduction of this paper, enterprises are subject to constant changes and variations that their legacy IS are not able to follow easily. This problem hinders the enterprises to pursue their activities and to reach their business strategies and objectives. Service-oriented paradigm aims to facilitate the evolution of enterprise IS throughout the evolution of information services and new services integration into the existing IS by preserving the legacy IS consistency and regulation policies.

Development of new services has to take into account the fact that services will have to evolve. Papazoglou [24] identifies four types of service changes: structural (changes on messages, interfaces, operations), business protocol (changes on external massaging behavior), policy inducted (changes in policy assertions and constraints on the service which specify business agreement among interacting parties) and operational behavior (effects and side effects of changing service operations). This classification is particularly suitable to web services. In order to adapt this classification to the domain of information services we extend the definition of some categories with a few additional elements that we consider important to be mentioned:

- In the category of structural changes we include information structure changes that we consider as the most difficult ones to deal with. Modifications of classes, attributes, operations, rules, etc. can be very delicate once the service is in use.
- In [24] business protocol changes concern only external service behavior. We extend this category
with the changes in internal organizational service behavior, i.e. changes in organizational roles, responsibilities and rights to perform service operations.

- Similarly, in [24] policy inducted changes deal only with policies and constrains that specify external service behavior. We extend this category with changes concerning internal service rules: business rules, pre-, post-conditions of operations and integrity constraints.

Depending on the gravity of transformation and the effects and side effects they cause, the changes can be considered as shallow or deep ones [24]. While shallow changes are localized to a service and are relatively easy to realize, the deep ones have cascading effects on other services of the enterprise ISS or on services of the business partners or even on the entire value-chain. The realization of this type of changes requires a deep understanding of the scope of the change and the impact that the change will produce on all involved services. In the ISS domain, problems arise mainly because of the overlap of information services (overlap of data, activities, roles, rules). Because of this overlap, any change in one service can lead to a conflicting and/or inconsistency situation in other services: overlapping activity allocated to several roles, business/integrity rules violated, duplicated data, incoherent flow of activities, etc.

The quest for sustainability in information services and ISS infers a few challenges for the new ISS development methods:

- In order to support information service evolution, the models representing different facets of the service/ISS need to be able to evolve. This evolution can only be guaranteed by the appropriate quality of their metamodels and modeling guidelines. Most of the well known modeling techniques (e.g. different UML diagrams, BPMN) are based on metamodels which do not support the evolution corresponding models because of their exaggerated complexity and semantic ambiguity. Besides, the lack of modeling guidelines and modeling quality rules hinder the construction of reliable, consistent and evolutionary models.

- Further, the consistency between models has to be ensured in case of the evolution of one of them. That implies the need for interoperable models, i.e. interoperable metamodels.

- Finally, it is not sufficient to have models that are able to evolve and are interoperable. We also need to create guidelines (method chunks) formalizing different ways to conduct evolution, to measure the impact of the changes made and to validate the interoperability and consistency between models.

In [37] the authors propose to use an information kernel as a pivot model to conduct service evolution. A situational method supporting new services integration into a legacy IS is presented in [3, 30].

IV. TRANSDISCIPLINARITY

While traditional IS development mainly focus on one discipline (one application domain), creation of new information services requires a transdisciplinary approach including various professions with different competences and knowledge. According to Nicolescu [22], “transdisciplinarity concerns that which is at once between the disciplines, across the different disciplines, and beyond each individual discipline”. Differently from the interdisciplinarity, which 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.

In the inter-organizational perspective several organizations can be involved in a new service creation and be equally responsible for its quality. Moreover, it can be impossible to allocate this service to one of the partners or to clearly determine service provider and/or service consumer because each partner will provide and consume service information and 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: owners of dangerous materials, public security, transporters, warehouses, customs, police, hospitals, information security, etc. The competence of each of these professions is necessary to make this service possible. Besides, the new service will have to be coupled with several existing IS (involved companies, public administration, etc.) and the knowledge about these existing IS is indispensable.

This new information service development situation raises new questions: how to make all these involved persons 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? Use of ontologies is considered as a potential solution to ensure communication between different professions and their collaboration in creating new services. However, defining a common ontology can appear difficult (the same word can mean a different thing for persons from different disciplines) and insufficient. A common design framework hosting people with different skills (related business, marketing, information, governance, security and computing) and composed of methods chunks and modeling tools (best fitting the situation at hand) is necessary to support the transdisciplinary approach of service development.

The concept of cross-pollination space (CSP) is introduced in [37] as a collaborative platform enabling collective, transdisciplinary and co-creative activities for the generation of ideas and design of new business services. The CSP is based on the use of several ontologies (legal, domain, knowledge, etc.) and the concept of information kernel which defines the semantics of services. As stated in [37], the 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). Therefore, it is necessary to extend the CSP into a more general service development framework including
method chunks supporting the whole information service lifecycle.

V. VALUE CO-CREATION

Another shift that IS development has to undergo concerns the business value creation process. In service-oriented paradigm companies cannot continue to create their products and services alone and hope that they will have a high success in the market. They have to open their internal value creation processes to their customers and their partners in order to benefit from their skills, knowledge and innovative ideas and in return to offer them better products and services. This type of collaboration is called value co-creation.

Most of the literature in management science defines value co-creation as a process by which products and services are developed jointly by companies and their customers [26, 27, 29]. Inclusion of customers in the service/product creation process is the main shift in private firms’ way of working. Public organizations, generally governed by laws, regulations and strict governmental hierarchy, also begin to involve citizens in the public service innovation and e-government projects. 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. This is essential in the inter-organization services development where creation of win-win situation for all partners is very important in order to foster their collaboration and orchestrate processes among them. Moreover, co-creation emphasizes on continuous improvement, communication and learning. In [29] this situation is called “win more–win more” situation because the involved firms not only create a common value but also efficiently create a unique value.

In this value co-creation perspective, the challenge for the new ISS development methods is to enable the co-creation of services in all their lifecycle phases by providing collaboration and creativity supporting method chunks and modeling tools:

- Co-creation means co-innovation. The aim of the new ISS methods is to foster imagination, originality and creativity of the service co-creators. They need to include new method chunks inspired from innovation games and creativity techniques. Innovation games like “buy a feature”, “product box”, “remember the future” proposed in [15] as “product” innovation tools can be adapted to service creation as illustrated in [34]. Besides, creativity techniques like “story telling”, “the empathy map”, and “visual thinking” proposed in [23] for new business models generation can also be adapted to information services design. All these techniques should help to define the roles of participants and the ways to exploit their knowledge and skills, and to create the atmosphere of confidence and trust between the co-creators.

- Co-creation also means collaborative modeling where a number of people actively contribute to the creation of different models. Approaches and tools supporting collaborative modeling are emerging [32, 33]. In [32] Rittgen proposes a number of factors relevant to achieve a good model in a collaborative modeling process. Among them, we can mention the role of facilitator which is necessary to help in the integration of different views and different models. There is also a need to increase participants’ motivation and involvement which could be ensured with the help of gaming and competition elements. Access to the information via a collaborative modeling tool and support of the communication are essential in case of asynchronous co-modeling.

- Co-creation goes together with agile development. 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. Rapid prototyping and visualization techniques can help to visualize and evaluate the solution more easily. Besides, the development process should support this agility, which means that traditional development phases like requirements engineering, analysis, design, development, etc., generally providing a particular deliverable, do not have the same sense neither the same ordering any more. They are rather intertwined into a one incrementally and evolutionary way of working where all models progress together based on common information kernel.

- Co-creation will certainly generate confrontation. People with different professional and knowledge background will have to work on a common project – to decide on service scope, features, information, rules, etc. They need to be able to accept that there is no “one common truth”, that each partner has his/her own perception of the world and therefore of the service under consideration. Mitigation, negotiation and observation techniques can be useful to find invariants in different visions and to lead to common arrangement.

Las but not least, the guidance for managing the co-creation process should be provided by the new ISS methods.

VI. SUMMARY OF CHALLENGES AND CONCLUSION

Due to the constant changes in the enterprise governance, economy, organization, business activities and distribution channels, as well as evolution of information technologies, the enterprise legacy IS became heterogeneous and specialized by trade, department, service etc. with redundant data and processes. The evolution of such IS becomes more and more difficult and therefore its sustainability is corrupted. In the resent years, the service-oriented paradigm emerges as the most suitable approach to face this problem. We can observe the trend to move from integrated and monolithic IS to modular and flexible services systems as intra- and inter-organization solutions. This shift of paradigm is welcome but requires a new way to consider IS engineering. The methods to be applied in this new type of development have also to be redefined.
In this paper, we recognize a few shifts in foci when moving from traditional to service-oriented IS development; in particular, we analyze:

- the shift in paradigm,
- the shift from unsustainable and short-lived IS to sustainable and evolutionary development of ISS,
- the shift from mono- and/or inter-disciplinary to transdisciplinary approaches, and
- the shift from rather lonely IS creation to services co-creation.

In this perspective, we identify the challenges that these shifts entail in the field of IS development methods which have to be aligned with the new ways of thinking and the new ways of working. Table I summarizes the challenges discussed in the previous sections and proposes a few research questions as a motivation for future research works in the domain of method engineering for the ISS development.

We do not discuss here the structural aspects of methods because we consider that it is already widely accepted that situational method engineering techniques should be applied. It is clear that the new ISS development methods need to be modular, flexible, and adaptable, made of well-defined fragments/chunks or even method services. The most important now is to consider the new types of service engineering techniques necessary to support the ISS development and how to guide the new ISS development processes.

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<td>Form unsustainable and short-lived IS to sustainable ISS</td>
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<td>From mono- and interdisciplinarity to transdisciplinarity</td>
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