4R of Service Innovation: Research, Requirements, Reliability and Responsibility

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***Abstract*—This research aims at resolving the challenges arising from the processes of service innovation and evolution. It continues and extends our works concerning different aspects of services innovation and analyzes the "4R" phenomena of service engineering: service research, service requirements, reliability and responsibility in services. By studying the interdependence of these aspects for services development, we investigate the phenomenon of corporate social responsibility and discuss its development through the information kernel of services. In order to integrate the 4R-analysis for service innovation, we propose a framework for innovation in services and illustrate the role of responsibility in the development of its information kernel. Finally, we discuss a usage scenario implementing this approach, which is related to the treatment of authorization requests for building at the canton of Geneva.**

Keywords-service; service innovation; requirements; reliability; compliance; corporate social responsibility

I. INTRODUCTION

Today, services have become the key element for all aspects of business and corporate activities, whilst the importance of their innovation process can hardly be overestimated. Indeed, dynamic collaborative processes of services innovation and evolution form the kernel for development and communication in the organizational context of an enterprise, and define the main principles of the corporate management within the services society [1].

Based on the current state of the art on modeling initiatives and services and studying the phenomena of innovation and evolution for supporting services, this research is within a series of works aiming to define the notion of corporate social responsibility, identify the main challenges for services innovation, study the interdependence of different layers of services and develop a methodology for services innovation while taking into account the challenges in both conceptual modeling and practical implementation.

By underlining the increasing importance of collaborative creation in services and the role that responsibility plays in it, we show how such collaborative creation becomes one of the main factors in innovation in services in services society.

This paper is structured as follows. In Section 2, we present the general state of the art concerning the problem of service innovation and analyze its complex aspects. Section 3 describes our approach for service innovation and focuses on its main axis: research in services, requirements for services development and engineering, reliability in services, the notion of responsibility in services innovation, and analyses their interdependence through the phenomenon of corporate social responsibility. A conceptual framework representing different (R-)layers of services and their interdependences is introduced in Section 4. Section 5 describes a simplified usage scenario illustrating the proposed approach. Finally, section 6 concludes the paper and discusses the envisaged future works and perspectives of this research.

II. GENESIS AND STATE OF THE ART

We start by introducing the existing definitions of the main concepts related to the problem of corporate social responsibility and services through innovation and corporate management, by analyzing and arguing these notions and thus, by constructively describing their semantics in the context of our research.

A. Service

In our previous research [15], we described a service as the result of a process of acquiring knowledge in the context of the IS (information systems) engineering, defined at the junction of the organizational domain, the ontological domain, the technological domain and the informational domain.

Consequently, it is based on four dimensions: (i) *ontological* dimension; (ii) *informational* dimension; (iii) *technological* dimension; and (iv) *organizational* dimension. The ontological dimension of a service describes not only all the invariants of the information system domain, in particular knowledge and concepts, but also some business rules and roles of actors, which are independent of the information system development. The informational dimension of a service defines the information semantics necessary for defining services. This dimension of a service describes the static aspects, the dynamic aspects and the integrity constraints aspects. The organizational dimension of a service relates to the business rules, the organizational roles, the responsibility zones and business processes inside an enterprise/organization. It allows one to clarify the decisions and responsibilities inside the enterprise/organization. The technological dimension of a service allows one to study the

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implementation of the specified entities. It is a challenge of choosing the appropriate technology, the informatics architecture and the corresponding environment, in order to implement this service.

B. Innovation and Evolution of Services

There is a certain ambiguity in general understanding of the phenomenon of innovation. Traditionally, it is seen as introduction of something new: a new material, way of doing, a new concept, etc. This definition is however different from the widely used meaning of the notion of innovation – the process that aims at bringing new features into an existing entity (concept, good), renewing something that already exists, i.e., evolution of an existing thing. On analyzing these aspects [15], we identify different but interdependent phenomena: innovation and evolution. Innovation represents the process that allows the change of state of the component of a system, so precipitating the emergence of a system, whose characteristics or behaviors are different from the previous time [3]. It can be thus viewed as the source of evolution. In other words, we envisage innovation as a dynamic and participative process that leads to co-creation and value creation of a product (artifact, method, etc.) thanks to its evolution.

Defined by both *dynamic* and *collaborative* characteristics, each of these processes (i.e., innovation and evolution) generally leads to *sustainability* of a product (good, process, service, etc.). In their interdependence, they also contribute to enriching the semantics and usability of related services and knowledge bases. Indeed, lets us take an example of the process of evolution of e-government services. While they are developed and modified, the corresponding regulatory ontologies are also modified and enriched, and new organizational contexts are identified and adopted. In other words, both innovation and evolution processes result with added value to a product, service, related knowledge bases, information systems and services in their dynamic environment.

C. Requirements for Service Engineering

By meeting the challenge of designing sustainable services, service engineering addresses the specification, the compliance and the management of interoperability of services across public institutions or governmental organizations.

The service compliance aims to enhance the quality of services to offer to the stakeholders. We consider that the verification of compliance is based on three criteria: (i) how to build a stable service from the organizational context?; (ii) how to support evolution of services?; (iii) how the interoperability of services is managed? [5].

The phenomenon of service compliance with legal aspects is nowadays gaining increasing importance.

Indeed, the institutional activities are governed by legal sources represented by a set of laws, which regulates their execution. The compliance of services with legal aspects is a crucial issue for each public administration. This issue becomes more difficult with the fast-evolving dynamics of laws [7].

Another challenge is to describe how to get service engineering and legal compliance in closer interaction. The main issue is to consider the requirement for service compliance analysis and for service overlap management when we engineer services.

In order to face these new challenges, we proposed a methodological approach for service specification [2]. It aims to describe the interactions among the organizational layer, the informational layer of a service and the responsibility dimension in order to verify the compliance of services.

D. Reliability

Reliability is normally seen as the ability of a service to perform a required function, under stated conditions, for a stated period of time. In service design, reliability reflects a measure of how long an IT-service can perform its function without interruption or how likely required outputs will be delivered within a stated period of time.

According to the definition of the Technical Committee on Communications Quality & Reliability [14], the service reliability is a complex notion, which combines the 3 following characteristics: (i) accessibility – a service is available when it is required; (ii) continuity – a service has an uninterrupted duration when required by a customer; (iii) performance – a service is designed and able to meet the customer's expectations.

It is important to note that our vision of reliability concerns both its interdisciplinary and temporary aspects: a service and an information system are known to be reliable if they are coherent for different information systems and/or services integrating them, as well as for different time frames of the lifecycle of the same information system/service.

E. Responsibility

To define the phenomenon of responsibility, we rely on the research [5]. The authors propose to model it as a state assigned to an actor to signify him its accountabilities (accountability defined at [10] as a process of being called to account to some authority for one's actions) concerning a business activity and the capabilities and the right necessary to perform it (the right represents the resources provided by the company to an employee required to perform the accountability. Moreover, the authors point to its interdependence with the phenomena of capability, right and accountability, and put these concepts into the core of the methodological approach for services specification, by particularly specifying the links between the organizational and informational layers of services and by enriching the model with the responsibility dimension.

In this context, the concept of responsibility is composed of the accountabilities to perform an obligation in a business activity and it specifies, at the same time, the rights and the capabilities that are required therein.

In the further research [2], these conceptual findings allowed to develop a meta-model that show the interdependencies between the four layers of services (i.e., ontological, organizational, technical and informational) and

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the concept of responsibility, by integrating capabilities, rights and accountability.

Such a complex model enlightens the fact that the responsibility dimension contributes to the added-value of a service since it facilitates the alignment between the different layers. Indeed, on the organizational layer, responsibility is assigned to a role that performs business activities, the informational layer identifies the responsibilities-required knowledge, the responsibility on the technical layer can partially be incorporated in security and or accessibility characteristics, and the ontological layer allows one to correctly specify the business rules, the ontological roles and the fundamental concepts dedicated to specify this service, whilst taking into account the responsibility requirements.

F. Research in service innovation: towards collaborative decision constructing

It is difficult to overestimate the importance of innovation in the development of new services that are aimed at answering the challenges our services-based society brings today.

By relying on the interactive exchange and functioning of interoperable services [1], our services-oriented society, is, to some extent, dependant from the progress and innovations in services. Services are becoming "mirrors" of specific competences (e.g., knowledge, skills, technologies) of one economic entity for the benefit of another economic entity. Hence, whilst value creation occurs when a resource is turned into a specific benefit, the classical supply chain is thus re-conceptualized as a network of service systems, the service value creation network [9].

To answer come of these challenges, in [8], we proposed our approach for innovation in services thanks to collaborative decision constructing, and demonstrated how decision constructing can be supported by the processes of knowledge actionalising during the process of service innovation.

Introduced in this work, we consecutively developed the methodology for collaborative decision constructing, which is practically implemented in the CPS, a collaborative platform for services innovation.

III. TOWARDS CONCEPTUALIZING THE PROCESS OF SERVICE INNOVATION: 4R-ANALYSIS

This research aims at answering the challenges of the process of service innovation and evolution. Based on our previous works [2], [8], [15], its motivation is to investigate the interdependence of "4R" aspects of service innovation: service research, service requirements, reliability and responsibility in services.

A. Service Research

Recently, the complex problem of research in the services domain has attracted significant interest in both academic and business worlds.

In the context of this work, we focus on selected aspects of this problem, which highlight the importance of co-creation in services development and identifying the information kernel of a service, by taking into account its different layers (i.e., ontological, organizational, informational and technical).

Based on our approach for innovation in services, we claim that the information kernel is developed thanks to the collaborative decision constructing process [8] and is defined by the interdependence of its layers [6].

This leads to an (initially) intuitive idea to study if the responsibility dimension provides an additional added value to decision-constructing processes. Consequently, it is debated that this makes the process of innovation in services more efficient.

B. Service Requirements

By analyzing service requirements, we focus on the 3 main processes: identification of services, service compliance and service specification. The interoperability characterizing these processes and their interdependence ensure the quality of service integration into existing and developed information systems, as well as allows creating added value in the process of service engineering.

The problem of service identification in the processes of services innovation and evolution was discussed in [15] where we analyzed the role of initiatives for developing the services information kernel, which describes the knowledge required for creation of a service.

The process of service identification benefits from another important aspect of service engineering: the compliance of services with legal aspects.

In [7], we introduced a novel approach that allows establishing and clarifying the links between laws and services, in particular the alignment between the amendment of laws and the evolution of services. In other words, we use laws as a source of knowledge to analyze and construct the ontological level of an institutional domain. The exploitation of these sources of knowledge permits one to find stable concepts and invariant concepts. The analysis of the legal framework permits one to identify the main characteristic concepts of the domain, the ontological roles and the ontological business rules (cf. Figure 1). We use the ontology model elaborated from the legal framework to design the IS Kernel.

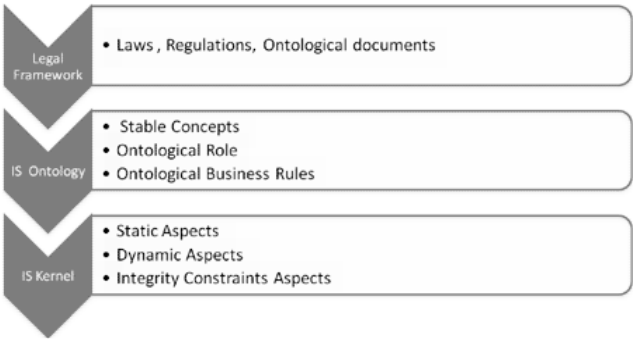

Figure 1. IS kernel and the compliance of services with legal aspects

One of the main advantages of such an approach is to explicitly match the legal framework, which provides the

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basis of the activities of a public administration to the developed services.

Another challenge in the context of service engineering concerns the specification of a service upon multiple already existing IS. Linking ISs with regulations / laws they have inherited from is a primary importance for people in charge of managing legacy ISs.

In [6], an approach for the specification of domain services upon multiple existing information systems is proposed. This approach is based on the construction of a referential around the services and the analysis of its required data. More precisely, it helps to preserve the legacy information system by creating services upon them via a common base capturing the overlap between all related information systems.

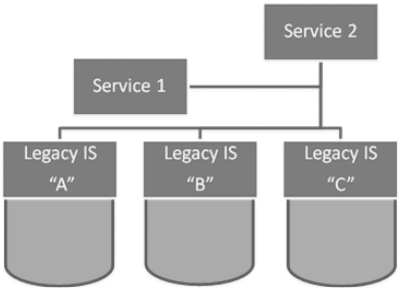

Figure 2. Specification of domain services upon multiple existing information systems.

In fact, this approach is adapted to transform legacy information system, since organizations are forced to continue to operate taking into account these existing applications and legacy information systems (cf. Figure 2).

C. Service Reliability

In the context of services society, where the problem of sustainable development needs to be considered and addressed, it is also important to study how to use services to identify the sources of added value, to elaborate an approach aimed at facilitating effective diffusion of scientific knowledge and technology transfer, and to develop knowledge infrastructure and networks.

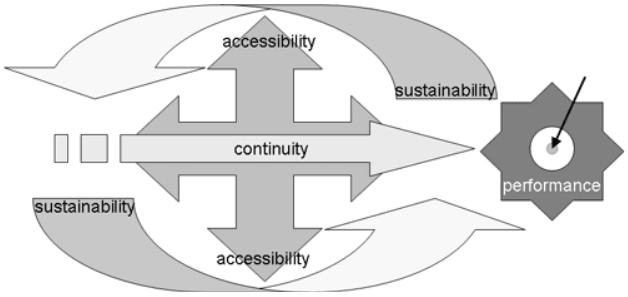

Figure 3. Reliability and its components.

We thus propose to enrich the notion of service reliability by integrating the characteristics of sustainability (cf. Figure 3). Indeed, today we are interested in how services might contribute to sustainable development, how they should be developed to increase the added value of related processes, which is the approach for making them most adaptable for business environments.

The accent is put on sustainable services, which we envisage as services that are capable of adapting to their environment, to dynamically integrate the ever-changing conditions of the environment, and as such to be sustainably coherent with its evolving challenges.

Analogically, it seems promising to enrich the notion of service reliability by integrating the sustainability criterion. Service reliability can be envisaged as a complex notion combining the 4 interdependent characteristics: (i) accessibility (availability when required by an actor/service); (ii) continuity (an uninterrupted duration when required by different actors/services); (iii) performance (being designed and implemented in the way to meet the customer's requirements); and (iv) sustainability (possibility to dynamically and coherently integrate the ever-changing conditions of the environment).

D. Responsibility in Service Innovation

Analogically to Corporate Social Responsibility (CRS), there is no unique definition of the Responsible Research and Innovation. It is often seen as a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products [12].

In order to explore the phenomenon of responsibility in service innovation, we first need to concretize the notion of a service in the context of service engineering. We propose to envisage a service as the result of a process of acquiring knowledge in the context of the information system engineering. It corresponds to an action or series of actions to characterize the relationships between the stakeholders.

While adapting the approach for responsible research and innovation, the services are thus developed by respecting the following aspects [13]: (i) the deliberate focus of research and the products of innovation to achieve a social or environmental benefit; (ii) the consistent, ongoing involvement of society (incl. public & non-governmental groups) during the innovation process; (iii) assessing and effectively prioritizing social, ethical and environmental impacts, risks and opportunities, alongside the technical and commercial; (iv) where oversight mechanisms are better able to anticipate and manage problems and opportunities and which are also able to adapt and respond quickly to changing knowledge and circumstances; (v) where openness and transparency are an integral component of the research and innovation process.

E. Corporate Social Responsibility: interdependence 4R's through services layers

Initially, the notion of Corporate Social Responsibility was defined in [4] as "the continuing commitment by business to behave ethically and contribute to economic development while improving the quality of life of the

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workforce and their families as well as of the local community and society at large".

At the same time, despite the main motives – to improve qualitatively (the management of people and processes) and quantitatively (the impact on society) – are the same, and an international standard to provide guidelines for adopting and disseminating social responsibility (ISO 26000 – Social Responsibility) is being developed by the ISO, it is up to companies to define their own CSR objectives.

In the context of this research, we argue that corporate social responsibility for the problem of innovation in services is defined as the interdependence of layers of services: ontological, organizational, informational and technical. Moreover, the responsibility dimension provides a promising added-value since it facilitates the alignment between the different layers : the organizational layer (a responsibility is assigned to a role that performs business activities), the informational layer (the responsibilities required information), and the technical layer (the responsibility has an existence at the technical layer: e.g., by assigning the role of a facilitator during the decision-constructing process or by defining the criteria for accepting or refusing the initiative in the process of service innovation [15]).

IV. CONCEPTUAL 4R-FRAMEWORK FOR INNOVATION IN SERVICES

In this section, we introduce a conceptual framework for innovation in services by focusing on the 4 layers and the responsibility dimension.

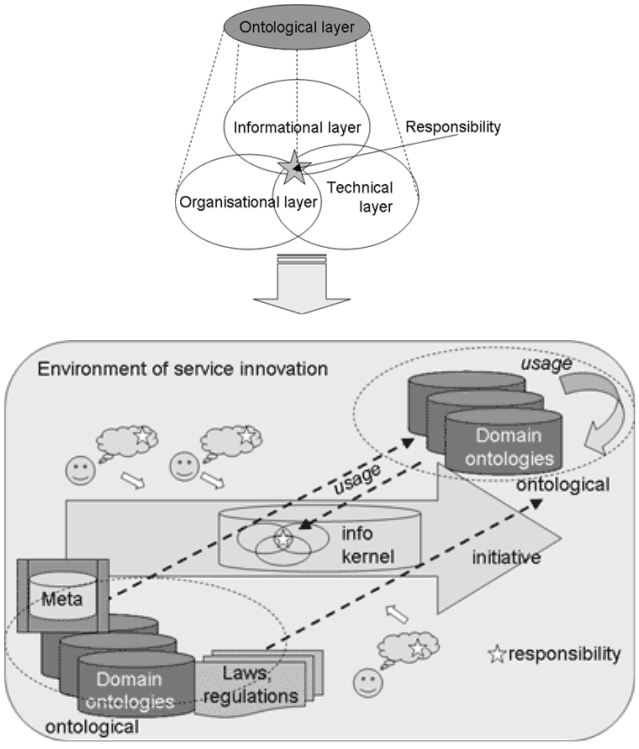

Figure 4. Responsibility in the framework for innovation in services.

Based on the analysis of the main service layers and the responsibility dimension [2], we argue that responsibility is the phenomenon that is concretized thanks to the interdependence of the ontological, organizational, informational and technical layers of a service and defines the essential conceptual information related to this service. In other words, the responsibility dimension allows one to identify the information kernel of the service.

From a different viewpoint, our model for constructing the collaborative environment for services innovation [8] is developed thanks to the process of knowledge actionalising, which helps to identify the information kernel of a corresponding initiative leading to service development. It also means that the information kernel of an initiative serves as a starting point for the process of service innovation, which, thanks to multiple interactions with the decision-making actors, the existing ontologies and the usage-based feedback, leads to concretizing the information kernel of a developed service.

V. USAGE SCENARIO

In order to illustrate the 4R-analysis for service innovation, let us consider the following case related to the treatment of authorization requests for building at the canton of Geneva. This case study was done in the context of our project collaboration with the Center of Information Technology at the Canton of Geneva (Switzerland).

At the Canton of Geneva, requests for building permits are submitted to the department responsible for construction. As soon as the legal conditions are met, the department shall issue the building authorization.

Authorization requests are subject to an advisory notice to municipalities, departments and agencies concerned. The Department's decision is based primarily on the notice of architectural committee or on that of the Committee on monuments, nature and sites. It takes into account those issued by the municipality or the competent department.

There are several stakeholders concerned by this services: (i) Directorate of building permits; (ii) Directorate General of Water; (iii) the architectural committee; (iv) Committee on monuments, nature and sites; (v) Department of Geology, soils and wastes; (vi) Land Registry; (vii) Energy Department; and (viii) Protection Administration of the population

In order to facilitate the access to the information, a national commission has been charged to define the appropriate service.

Research. We use the legal framework, which describes the conditions to manage the access to confidential and public information related to authorization requests. The fundamental concepts and relationships (e.g., who decides if a building is compliance to existing norms; which are the accessibility requirements to take into account, etc.) are defined on the ontological level, the roles and business activities are manages at the organizational level (e.g., which is the procedure for certification, timescale for handling the authorization request, etc.). All related knowledge is specified on the informational level and processed on the technical level. As the result, the decision-constructing

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environment handling authorization requests is developed as a specification of the global framework of the cross-pollination space, and it is enabled by services interoperable with the existing legal framework.

Requirements. The answers to the main challenges for requirements modeling are in fact acquired thanks to the dynamic development of the cross-pollination space for handling authorization requests. Indeed, (i) "how to build a stable service from the organizational context?" is ensured by the fact that the information kernel of the CPS is based on the organization context itself; (ii) "how to support evolution of services?" is possible thanks to the dynamic evolution of the information kernel according to the feedback from the usage; and (iii) "how the interoperability of services is managed?" is ensured at the ontological layer of the CPS for its semantics, at the informational layer for its statics, dynamics and integrity, as well as at the technical layer for services realization.

Reliability and responsibility. These characteristics are closely connected to the ability of a service to handle authorization requests according to the updated legal base (ensured at the ontological layer) and for a stated period of time (handled at the technical layer). Moreover, thanks to the dynamic enrichment of the CPS by the knowledge of decision-makers, one can witness a certain shift in defining the quality of a service: from "technical" reliability to "human" responsibility of individual and collective decision-makers.

In other words, the interdependence of services layers of a service for handling authorization requests permits the capitalization of contributions from each of them (i.e., ontological, organizational, informational, and technical) and as such – ensures the corporate social responsibility for development of such a service.

VI. CONCLUSION

This paper was developed in the scope of research concerning different aspects of innovation in services and particularly focuses on the analysis of the 4Rs of service innovation: service research, requirements, reliability and responsibility in services. By analyzing these phenomena, we showed that it is thanks to their interdependence that the responsibility dimension in the process of service innovation can be identified. From a different viewpoint, we argued that the responsibility dimension within the decision-constructing process is dynamically constructed as the information kernel of a service initiative. This research thus demonstrated how the responsibility dimension defines and guides the process of developing the information kernel of an initiative leading to the creation of a service, and as such, the process of service innovation itself.

Among the main perspectives envisaged for this research, we are to focus on: (i) the formalization of the responsibility dimension and the study of its interoperability in the both contexts of services layers and the decision-constructing model; (ii) the analysis of the measurability of the responsibility dimension and its integration into a services lifecycle; and (iii) more complex and more heterogeneous case studies with further conceptualization and generalization of the acquired results.

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