

# A Method to Analyze, Diagnose and Propose Innovations for Complex Ecosystems: The InnoServ Project

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**Abstract.** Understanding and modeling complex ecosystems, where a great number of entities interact in different ways, is a great challenge in the information systems' domain. In this context, the *InnoServ* project aims to understand and support innovations around fragile people considering public, private and volunteering structures. The aim of this paper is to present the *ADInnov method*, which facilitates the analysis, the diagnosis and the proposition of innovations for complex ecosystems. This method has been extracted in an empirically way, from the lessons learned in the *InnoServ* project combining different techniques such as expert interviews, goal modeling and serious games. This method could be used in other areas where it is necessary to analyze complex ecosystems. Drawing out and discussing the results of the *InnoServ* project, we prove the efficiency of our method.

**Keywords:** Method · Services · Complex ecosystem · Business processes · Organizational innovations

## 1 Introduction

The western countries deal with a great problem, which is the necessity to avoid the hospitalization of the non serious cases and to favor the home care. A lot of organizations propose housework, but sometimes, a lack of services appears and the fragile people must be hospitalized (even if the situation does not require hospitalization) [1]. A person is considered “fragile” if she permanently settles in a medical and/or social

fragility situation implying dependency (e.g., people receiving care at home for a chronic disease, elderly and/or disabled people that do not require hospital care but a regular support at home or people requiring long-term or temporary medical care) [1].

The *InnoServ* project<sup>1</sup> (Innovation in Services for Fragile People) tries to find organizational and low-tech-based solutions to maintain as long as possible fragile people at home in total autonomy. The project aims to understand and support innovation strategies and services around a fragile person. One of the initial aims of the project was to build a generic process model for fragile people home. Such a model is extremely complex: an intricate ecosystem with a large number of actors playing various and variable functions, diversity of scenarios and special cases, abundance of flows, various interaction kinds, etc. Complex ecosystems, where many entities interact in different ways can be found in many fields such as Physics, Economics, Mathematics or Computer Science [2]. In the context of Information Systems, such ecosystems are found in Virtual Organizations (VO) [3], collaborative business processes (choreographies) [4] or multi-agent systems [5]. Understanding and modeling these kinds of systems is still a great challenge. To overcome this complexity in the *Innoserv* context, the challenge of the project has been repositioned to study and improve the ecosystem around the fragile person: identify blocking points, organizational and technical solutions to meet them, and build the introduction of these solutions.

Starting from the specific domain of the *InnoServ* project, we have generalized the method until proposing the *ADInnov method* (Analysis, Diagnose, Innovation) that could be used in other areas where it is necessary to analyze a complex ecosystem. *The originality of this method relies in the consolidation of the empirical approach that has been used, integrating the lessons learned during the project.* The application of this method lead to several organizational innovations designed to improve efficiency and quality to take care of fragile people. These results prove the efficiency of our method. The innovations are mainly focused on the people and organizations around the fragile person.

The key concepts terminology is explained in Sect. 2. Section 3 describes the method, developing in detail the different phases. We draw out conclusions and future work in Sect. 4.

## 2 Context of the Study and Key Concepts

Effective solutions adapted to fragile people are yet to come. Technological solutions are only part of them. Organizational innovations, designed to improve care efficiency and quality are necessary. As a consequence, the *InnoServ* project undertakes this task in France. This project is one of seven co-financed projects by the French National Agency of Research (ANR) as part of its *Innovative Societies*<sup>2</sup> program. It is a multidisciplinary project that gathers eleven partners including six laboratories, an innovation research federation, an association, a local authority and two companies.

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<sup>1</sup> <http://bit.ly/1cvUC25>.

<sup>2</sup> <http://bit.ly/1OxinTq>.

Launched in March 2012, it reaches today its fourth and last year. A second part of the project is envisaged to be starting in 2016.

Figure 1 captures the key concepts of the *InnoServ* ecosystem, which are then used to present the method. An *actor* is a type of physical or legal person who operates under its own business. Note that we call « actor » a type of actor. For instance, “nurse”, or “physician” are (types of) actors. A *function* corresponds to a skill or responsibility in the ecosystem involved in the realization of a concrete service in the ecosystem. This notion is equivalent to the well known notion of “role” in the business process management domain [6]. However, we decided to use the term “function” which is more adequate in our multidisciplinary domain. Figure 1 also shows that nurse and physician are both health professionals. Health professionals refer to individuals or certified institutions working in physical or mental health with knowledge and specialized expertise to maintain or improve the health care of individuals. We will not go into detail in all the defined functions. More information can be found in [3, 7]. Note that an actor can play several functions and a function can be played by several actors. An example illustrating this case is given in the next section.

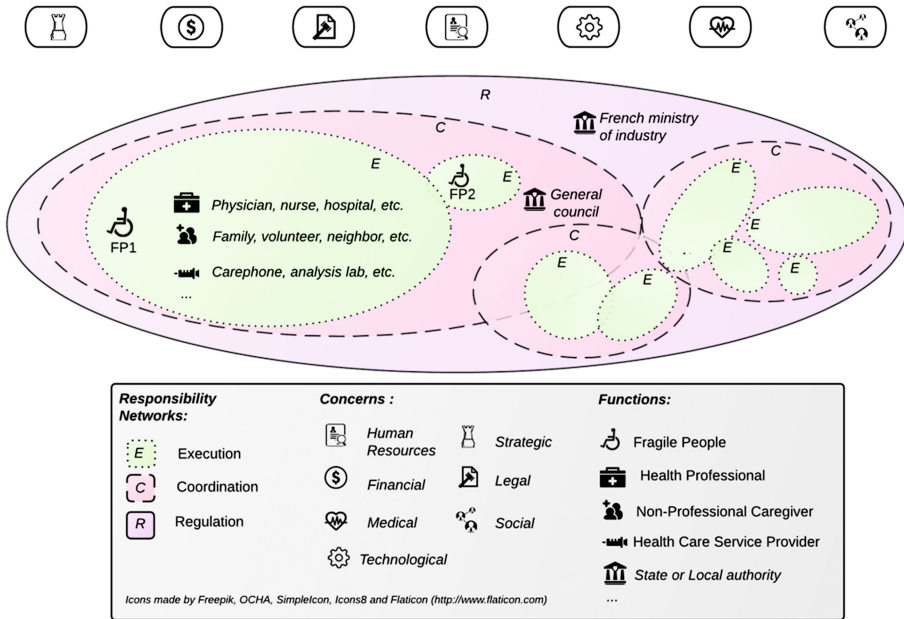


Fig. 1. Illustration of the responsibility networks, concerns, actors and their functions

In order to manage the ecosystem’s complexity, a decomposition approach is needed [8]. We propose the concept of *responsibility networks* (RN) to tackle this problem. A responsibility network is a view on the ecosystem determined by the proximity (e.g., national, regional, individual, etc.) between a target (e.g., the fragile person) and its concerns. A *concern* relates to a cross-cutting issue in the responsibility

network that determines a point of interest of a provided service (e.g., financial, medical). In Fig. 1 responsibility networks are represented as ellipsis more or less close to the fragile person. In our case, the following responsibility networks are identified: *Regulation* deals with new laws and rules concerning home care of fragile people; *Coordination* deals with home care organization of fragile people; and *Execution* focus on the direct interaction with the fragile person.

In the *InnoServ* ecosystem, seven concerns were identified: *Social*, *Medical*, *Human Resources*, *Technological*, *Financial*, *Legal* (refers to legislations), and *Strategic* (refers to plans to achieve a goal). In an *Execution RN*, social and medical concerns will be the focus. Concerning *Coordination RN*, human resources and technology concerns will be more important whereas in *Regulation RN*, financial, legal or strategic concerns are essential. Nevertheless, this point does not avoid having for example financial concerns in the *Execution RN*.

A *blocking point* corresponds to a concrete problematic in the context of a responsibility network or a concern. An example of identified blocking point for the *Execution RN* is: “There are skill problems for the care activity concerning some actors. There are also problems of unavailability as well as lacks of required actors for care giving”. One or more blocking points can be identified concerning a responsibility network and a concern (in an exclusive way). *Goals* are prescriptive statements about the system, capturing desired states or conditions [9]. Goals are hierarchically organized, starting from high level goals which can be iteratively refined into sub-goals. Goals do not define here the intentional process level, but the objectives to resolve blocking points. One of the goals resolving the aforementioned blocking point is: “Have available actors in the fragile person’s house”.

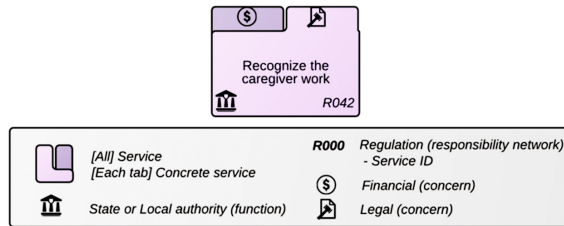


Fig. 2. Illustration of a service divided in concrete services categorized by concerns

A *service* relates to a delivery consisting in the provision of technical and intellectual capacity or the provision of useful work for a beneficiary. A service is attached to a responsibility network and is composed of one or several concrete services treating a concern. A concrete service is performed by one or more functions. In Fig. 2, we illustrate the following service “Recognize the caregiver work”. This recognition can be done in a legal way (i.e., recognizing the caregiver status) and in a financial way (i.e., establishing a salary for caregivers).

Note that the concepts presented in this section are generic terms that can be considered independent from the *InnoServ* project. Therefore, they can be easily transposed to other domains.

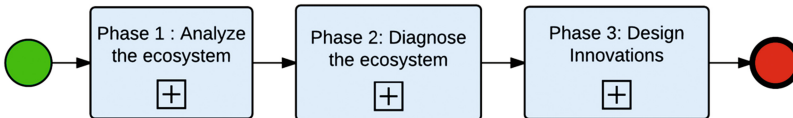
### 3 *ADInnov*: The Empirical Method Extracted from the InnoServ Project

This section presents the method extracted from the *InnoServ* project, called *ADInnov*, which stands for Analysis, Diagnose and Innovation. An overview of the method is given in Sect. 3.1. Sections 3.2, 3.3, 3.4 develop each of the three main phases of the method, presenting some important results of each phase. Section 3.5 discusses related work.

#### 3.1 General View of the *ADInnov* Method

The *ADInnov* method follows a three steps process in order to elicit the innovation needs of the considered ecosystem and formulate innovation strategies (Fig. 3):

- **Analyze the Ecosystem:** the first phase studies the ecosystem and aims to identify responsibility networks, concerns, actors and their functions.
- **Diagnose the Ecosystem:** this phase studies the ecosystem’s strengths and weaknesses. It mostly focuses on the goal models’ construction relying on the previous identification of blocking points and responsibility networks.
- **Design Innovations:** this phase proposes to use empirical approaches such as serious games in order to reach the goals defined in the previous step, resulting on the proposition of organizational and service innovations. This phase proposes a way to illustrate the innovations via a set of scenarii.



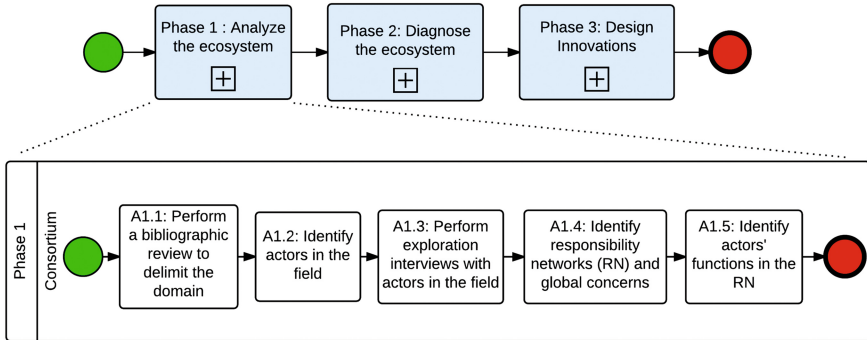
**Fig. 3.** General view of the *ADInnov* method

Most of the activities of the method are realized by the consortium, which have multidisciplinary representation from the eleven partners (6 research laboratories, an innovation research federation, an association, a local authority and two companies). A consortium’s subgroup that gathers people called “animators” performs some activities in order to prepare and animate the consortium activities. Several activities are performed by the actors in the field of the specific domain (such as the physicians, the council administrators or the caregivers in the *InnoServ* project), mainly through interviews. Actors in the field put forward essential information to analyze, diagnose and propose innovations in the specific domain.

The three steps of our methodology are developed in the following sections. The phases are presented in detail and results for each phase are also put forward.

### 3.2 Phase 1 - Analyze the Ecosystem

Phase 1 analyzes the ecosystem. Figure 4 illustrates the different activities that compose this phase. The aim of these activities is to draw up a map of the studied eco-system.



**Fig. 4.** Phase 1 - analyze the ecosystem

The first step to perform is a bibliographic review in order to gather the domain information (A1.1). This step is crucial to identify and describe the target of the studied eco-system (in our case, the fragile person). The next step consists in identifying the actors in the ecosystem (A1.2). We contact these actors and perform exploration interviews in order to complete the understanding of the domain (A1.3). Then, the ecosystem has to be decomposed in different responsibility networks and global concerns (A1.4). As previously explained in Sect. 2.2, we identified three responsibility networks in the *InnoServ* ecosystem: *Execution*, *Coordination* and *Regulation*. Moreover, seven concerns were identified: *Social*, *Medical*, *Human Resources*, *Technological*, *Financial*, *Legal*, and *Strategic*. Relying on responsibility networks, the functions played by actors can be completed (A1.5).

**Results of the Phase 1:** The bibliographical review and the exploration interviews should result in a report that gives a good understanding of the domain. The *InnoServ*'s bibliographic report is described in [1]. At the end of this phase, the responsibility networks and concerns in the ecosystem are identified. Actors and their functions are also identified resulting in a model such as the one presented in Fig. 1.

### 3.3 Phase 2 - Diagnose the Ecosystem

The diagnose of the ecosystem should provide insights about the major blocking points. The different activities concerning this second phase, which is focused on goal modeling, are developed in Fig. 5.

The consortium identifies a first set of blocking points according to the responsibility networks and the concerns identified in the previous phase (A2.1). The first blocking points are potentially extended thanks to the interviews (targeting the actors in the field). The interviews take into account the actors' responsibility network in order to

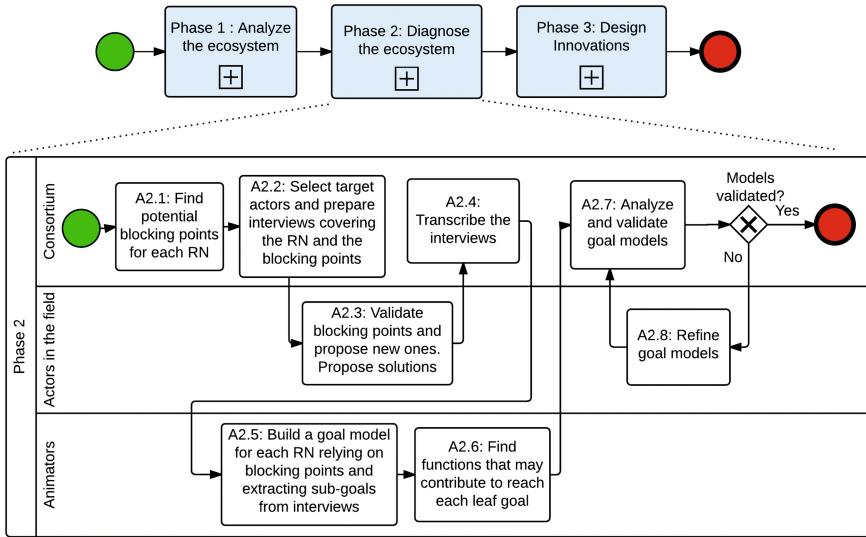


Fig. 5. Phase 2—diagnose the ecosystem

cover all of them (A2.2). Interviews may outline possible or partial solutions to the blocking points. Inquiring actors in the field helps validating and proposing new blocking points (A2.3). The interviews also provide clues about potential and partial solutions. The interviews have to be transcribed in order to be exploitable (A2.4).

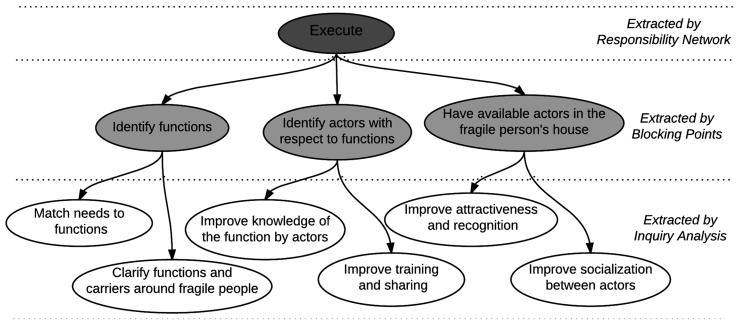


Fig. 6. Excerpt of the execution goal model indicating the origin of the goals

Simple goal models are built relying on responsibility networks and concerns. We suggest to develop a first version of the goal models by a subset of the consortium playing the role of animators (A2.5). Figure 6 illustrates an excerpt of the goal model corresponding to the Execution responsibility network. The figure shows that the root goal corresponds to the responsibility network. Then, the first sub-goals are extracted from the blocking points identified in the previous phase. Sub-goals are developed by analyzing the interviews, so they will correspond to the resolution of the blocking

points. Here, new blocking points could appear. Functions that contribute to reach the goal model have to be identified (A2.6). This will help (in the next phase) to propose services resolving the goals performed by the identified functions. The goal models have to be analyzed by the consortium in order to validate them (A2.7). Iterations can be considered to refine the goal models until they are validated (A2.8).

**Results of Phase 2:** The main result of phase 2 is the set of goal models such as the one shown in Fig. 6 covering the different responsibility networks. What is interesting here is that the high level goals have been extracted from the blocking points, so the sub-goals focus on resolving these issues. The interviews (which also relied on the blocking points) are used to construct the goal models. The fact of attaching the actors to the leaf-goals will highlight potential lacks that could imply the proposition of new functions. This case is treated in the next section.

### 3.4 Phase 3 - Design Innovations

Phase 3 aims to propose innovations to achieve goals (and thus resolve blocking points) by playing a serious game (Fig. 7).

First, the animators explain the serious game, which is a Lego game<sup>3</sup> in our case and root goals are chosen. These root goals correspond to the responsibility networks to be treated (A3.1). Then, the different members of the consortium play scenarios (A3.2). Everyone put on a function hat in order to propose innovation services to resolve the blocking points. To propose the services, the consortium members rely on the sub-goals extracted from the interviews that were identified in the previous phase. In parallel, the consortium members propose innovations. For example new services or new necessary functions can be proposed in order to reach the defined goals (A3.3). A consolidation work has to be performed in order to check the coherence and the good alignment between goals and innovation services resulted from the previous phases (A3.4). Then, scenarios (i.e., story boards) are defined relying on dependency relations between services (A3.5). A scenario is a current language text, that can be illustrated, based on a specific case to exemplify the innovations. A simplified version of the homecoming scenario, which is one of the *InnoServ* case studies, is described as follows: “*Mrs. Dupont is a widow woman in her late 80’s. She lives alone in a small village in the mountains. She was taken to the hospital emergency services due to a fall while at home. Since the accident, she had considerable lost autonomy. In addition, she has always faced economic difficulties. Returning home becomes complicated. Her brother wants to help her organizing her necessities*”. This case is the starting point of the scenario. The actors in the field will have to validate the evolution scenarios (A3.6) before building the animated scenario that serves as demonstrator of the project’s innovations (A3.7).

Figure 8 shows the scenario where the members of the consortium worked in order to find solutions to the blocking points concerning a responsibility network. The goal model constructed in the previous phase serves as guide to propose organizational and

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<sup>3</sup> <http://www.lego.com/fr-fr/seriousplay/>.



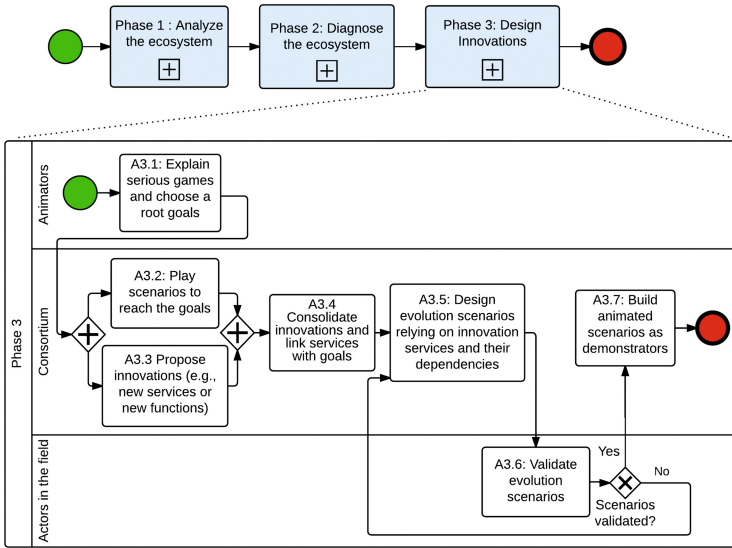


Fig. 7. Phase 3 - design innovations

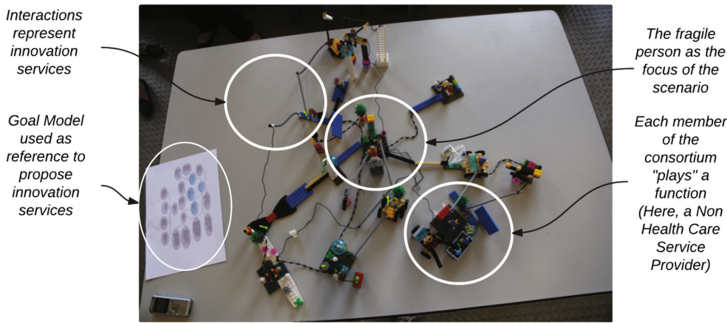


Fig. 8. Scenario applying a serious game approach to propose innovations

service innovations. The example highlights a function played by a member of the consortium, the *Non Health Care Service Provider* (i.e., personal home- assistance).

**Results of Phase 3:** The serious game session can lead to a set of services in order to reach the goals extracted from the blocking points. Each service responds to a specific goal and proposes a set of alterations on the ecosystem. This phase may also result in the formulation of organizational changes. In the case of the *InnoServ* project, a set of services<sup>4</sup> and several organizational changes were induced, such as the introduction of two new functions: the **Orchestrator**, which refers to a function that uses the resources near the fragile person and performs the prescription services for a fragile person and

<sup>4</sup> <http://bit.ly/IHvtq0t>.

the **Coordinator**, which refers to a function responsible for organizing, coordinating and managing territories. The coordinator assigns the orchestrators and arbitrate their requests. These two functions implies extending the prerogatives of some actors. Nurses, for instance, could become orchestrators. The use of serious games will lead to concrete implementation of the organizational innovations and services. This implementation has to be illustrated graphically in an animation film format, which is used as demonstrator. This animation is now under construction in the case of our project, but we have already built an illustrated storyboard.

### 3.5 Method Synthesis and Related Works

The method presented in this paper, extracted in an empirically way, combines several techniques to diagnose, analyze and propose innovations in the context of complex ecosystems. For the analysis and diagnose phases, we rely on conceptual modeling as a reliable requirement engineering elicitation technique to “facilitate communication, uncover missing information, organize information gathered from other elicitation techniques, and uncover inconsistencies” [10]. In the diagnose phase, we used a simplified version of the goal models that are used in the KAOS method [9].

Analysis methods in the Information System’s community such as Merise [11] or SSADM [12] provide systems’ analysis techniques relying on sub-problem decomposition. This decomposition governed by the flow of information between the system and its environment or between different actors in the ecosystem. Michael and Mayr [13] propose a domain specific language in order to model a person’s daily activity. The authors focus on a similar but very concrete situation, which allows a process oriented approach. In our case, we tried at first to represent all the flows between actors/functions. This approach allowed us to better understand the ecosystem but it has been proved to be very difficult to be implemented comprehensively. The concepts of *responsibility network* and *concern* (i.e., both representing different point of views of the ecosystem) are the answers to this problem in order to manage the complexity of the ecosystem.

For the innovation propositions, serious games were used. The effectiveness of this technique has already been proven in other methods such as the one proposed by Santorum et al. [14] in the context of business process management (BPM).

## 4 Conclusion and Future Work

We have presented the *ADInnov* method to analyze, diagnose and propose innovations for complex ecosystems. The “Analyze” phase proposes to explore the domain, identifying actors and their function. It also divides the ecosystem in different views to manage its complexity. The “Diagnose” phase focuses on finding blocking points which are completed and validated by actors in the field. It also develops goal models to project solutions to these blocking points. The “Design Innovation” phase relies on serious games to play scenarios in order to reach the goals defined in the previous phase. Here, innovation services and organizational innovations are proposed. The innovations are animated in order to be illustrated and validated by actors in the field.

The *ADInnov* method is built in an empirical manner, inspired by the different techniques in the *InnoServ* project context, which aims to understand and support innovation strategies and services around a fragile person. By showing up the results of the different phases, we illustrate the application of the method.

We have also presented the terminology used in the method. In future work, we consider developing a domain specific language to capture all the possible organizational innovations resulting from the method. We also consider to apply the method in other domains in order to validate the genericity of the terms and the applicability of all the used techniques.

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