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A meta-design approach to the development of e-government services^{☆, ☆ ☆}

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ABSTRACT

This paper describes a meta-design approach to the development of online services for citizens of a government agency. The goal is to transfer the development of government-to-citizen services from professional software developers to administrative employees, without forcing employees to acquire any programming skills. The approach encompasses two main phases. The first phase analyzes the different perspectives of the stakeholders involved in service creation and usage – employees, citizens, software developers and human–computer interaction specialists – in order to derive a meta-model of e-government services. The latter applies the meta-model to design and develop an end-user development environment that properly supports employees in creating an instance of the service meta-model, which is then automatically interpreted to generate the service pages for citizens. A pilot application of the proposed approach is illustrated with reference to a specific class of e-government services offered by the Brescia Municipality, even though the approach is general enough to be applied to different kinds of e-government services and application domains. The results of the evaluation with a group of municipality employees provide initial feedback from the government field and show how to proceed along this research direction.

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1. Introduction

Government agencies at national, regional and local levels are increasingly integrating Information and Communication Technologies into their processes, both within their organization and in their interfaces with citizens, business organizations and other government agencies. In particular, with the provision of public services on the

Web (the so-called *e-government services*), they aim to make services “twice as good, in half the time, for half as much” [1]. In other words, compared with phone and paper channels, online services should save administration costs, be provided faster and be tailored to the needs of citizens and businesses [1].

In this paper, the focus is on Government-to-Citizen (G2C) services [2], which allow citizens to carry out a variety of activities, such as paying taxes, enrolling children in schools, getting a driver's license, asking for an appointment reservation at the government agency to discuss specific problems, etc.¹ We have been involved on this topic by an Italian government agency, the Municipality of Brescia, since 2008 [3]. Brescia is a 200.000 inhabitants-town in Northern

[☆] This paper has been recommended for acceptance by S. Levialdi.

^{☆☆} The authors wish to dedicate this paper to the memory of Piero Mussio. During their collaboration with Professor Mussio, they have come to appreciate his original approach to the design and development of interactive systems, which always paid attention to users' language, notation, and system of signs. The research the authors have carried out in the past with Piero Mussio on meta-design and end-user development has stimulated the work described in this paper.

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¹ Let us notice that in this paper the term “service” is used with a more general meaning with respect to the term “web service” (http://en.wikipedia.org/wiki/Web_service).

Italy, which promoted the use of web communication with citizens since the early years of web technology. The Brescia Municipality currently provides several G2C services on its website (<http://www.comune.brescia.it>) and, due to the increasing importance that these services are assuming not only for citizens but also for administrative employees, the municipality is interested in making the process of G2C service creation more efficient and effective.

The development of e-government services is now in the hands of the Computer Science department of the Brescia Municipality, because it requires programming skills that can hardly be found outside this department. However, only administrative employees, as experts of government procedures, possess the know-how to structure and characterize a given service. To develop such services, several interactions are thus needed between software developers and administrative personnel, not rarely affected by misunderstandings and ambiguities. This situation witnesses once again the communication gap that often affects the interaction between different stakeholders [4,5].

To cope with this problem, we propose an approach to e-government service development that adopts a meta-design perspective [6] and capitalizes on concepts and ideas deriving from the end-user development (EUD) area [7]. Our aim is to create the socio-technical conditions that allow administrative employees to act as unwitting e-government service developers [8]. Indeed, administrative employees, although expert in the government domain, are usually neither expert in information technologies nor motivated to learn them [3,9]. At the same time, they feel at ease with software systems only when these systems adopt interaction styles consistent with the software applications they commonly use in their work and daily practices, e.g. word processors, spreadsheets or browsers. Therefore, our final goal is to design a software environment that could foster employees' participation in service development, without asking them to acquire additional competencies in information technologies.

In this paper, we conceive meta-design as a human-centered approach, being based on the analysis of the different perspectives of the stakeholders involved in service creation and usage—municipality employees, citizens, software developers and human–computer interaction (HCI) specialists. This analysis leads to obtain different informal and semi-formal service descriptions, from which we have derived a *meta-model* of e-government services. On the basis of this meta-model, we have designed and developed an interactive software application that supports municipality employees in creating an instance of the service meta-model, namely a *service model*. The service model can then be properly interpreted by a web-based application to generate the service pages to be used by citizens.

Our meta-design approach is described with reference to the development of G2C services for reserving appointments at various counters of the Brescia Municipality. We demonstrate the feasibility of the approach by presenting the resulting application for service creation and discussing the results of an evaluation carried out with six employees from different municipality departments who usually provide assistance to citizens through their counters.

The paper is organized as follows. Section 2 reviews the background and related studies that have been inspiring for the present work. Section 3 provides a classification of e-government services, focusing on those services provided by the Brescia Municipality, and discusses some emerging needs. Section 4 introduces a multi-faceted description of services while Section 5 explains how such a description guided us in the definition of a meta-model of e-government services. Section 6 illustrates the characteristics of the EUD environment developed to support administrative employees in creating instances of the meta-model. Section 7 presents the system at work during the creation of a service for the Public Education sector of the Brescia Municipality. Section 8 discusses the method adopted for system evaluation and the results obtained. Finally, Section 9 concludes the paper.

2. Background and related work

In the development of current interactive systems, including e-government services, a variety of aspects must be taken into account: (i) the technologies involved; (ii) the interaction experience one would like to provide users with; (iii) the mental model that users have of their tasks; and (iv) the domain competencies necessary to develop useful and pertinent applications. These different perspectives are usually expressed by using different languages, notation, and systems of signs thus giving rise to communication gaps among the different stakeholders cooperating in the design of interactive systems (design level) and between systems and their end users (use level) [4,5].

To cope with this problem, a variety of approaches have been proposed over the years. We mention in the following the most influential for our work.

2.1. User-centered and participatory approaches

User-centered approaches [10,11] to interactive system design have been initially proposed to bridge the communication gap occurring at use level. User-centered design may involve consultation with users to acquire knowledge about work activities, procedures, standards, users' habits and needs. User involvement is obtained by means of questionnaires, meetings, interviews, and user tests. Some of these techniques can support, for example, task analysis and specification with the purpose of providing a logical description of what users want to accomplish with the interactive system [12]. User-centered design can also be supported by design rationale methods, which aim to create documentation about decisions made by designers showing also the reasons that underlie decisions themselves [13]. However, various experiences suggest that this passive role of users in system design is not always sufficient to meet user requirements, but there is the need to give users a voice, allowing them to participate actively in the design of interactive systems [14].

Participatory design approaches [15] suggest a more active involvement of end users throughout the system design process. According to these approaches, an interdisciplinary design team is usually set up by including representative end users and HCI experts, beyond software analysts

and developers. Each expert in the team is a stakeholder who owns specific knowledge, a particular aspect of the knowledge crucial to designing the interactive system, but not sufficient per se. In this scenario, the communication gaps occurring at design level among the different stakeholders, due to their different cultural backgrounds, experience, and views of the problem at hand, become crucial. To fill these gaps, traditional participatory design approaches adopt scenarios [16], use cases, checklists or prototypes as design tools [17].

2.2. End-user development at design and use time

Recent participatory design approaches capitalize on the adoption of end-user development techniques to make the owners of problems in charge of developing their software artifacts not only at the design time, but also during their usage.

EUD-Net – the network of Excellence on End-User Development funded by the European Commission during 2002–2003 – defined EUD as “the set of methods, techniques, and tools that allow users of software systems, who are acting as non-professional software developers, at some point to create or modify a software artifact” [7]. EUD leads to transfer to end users part of the activities traditionally carried out by software developers, such as software design, implementation, customization, and adaptation at use time. EUD techniques proposed in literature range from simple system parameterization, to component-based [18,19] and model-based [20] approaches, up to programming-by-example and programming-by-demonstration methods [21–23] and visual programming techniques [24,25].

In many situations, however, end users are not able to adapt systems themselves, whilst experts of the domain are required to be involved in system development and adaptation, thus performing a sort of EUD at design time. This case represents what Carmien and colleagues call a “multi-tiered proxy design problem” [26], where (i) end users are not capable of, or not interested in, articulating what they want or need; (ii) communities who are able to articulate what should be designed (i.e. domain experts) are not the same communities who are able to create the needed technologies; and (iii) communities who know how to develop technical systems are usually unable to offer this service directly to end users without the help of domain experts. This occurs for example in the MAPS project [26], which aims to provide a simple, PDA-based device that prompts instructions to support a person with cognitive disabilities in the accomplishment of her/his daily tasks. This prompting system can be developed by caregivers (usually family members) by means of a simple editing tool that does not require any programming skills.

Piero Mussio, to whom this special issue is dedicated, identified and explored the multi-tiered design problem in many application domains, from biology to medicine, from geology to mechanical engineering. In 1992, Mussio et al. proposed a bootstrap approach to the design of interactive systems for liver study [27]. In that approach, an interactive system was conceived as a hierarchical set of computerized *logbooks*, namely digital versions of

paper-based archives that the physicians used to record their data and activities. The hierarchy of software environments reflected the traditional organization of scientific and technical work environments, where senior scientists or technicians usually prepared the work environment in which less qualified people were required to operate. Visual programming environments for supporting electroencephalogram tracing interpretation in biomedical laboratories were then developed following the bootstrap approach. These environments were designed by adopting visual languages that recalled concepts and notations of the considered domain [28] and by proposing the architecture of a Biomedical Information Management System (BIMS), which, contrary to a traditional User Interface Management System (UIMS), “delegates the definition of the dialogue to the users themselves” [29, p. 290].

The idea of structuring an interactive system as a hierarchy of software environments, where senior domain experts carry out development activities by creating software artifacts for their colleagues, has been subsequently explored and refined in the works about the so-called *software shaping workshops* (SSWs) [5]. In the SSW approach, the hierarchy has been structured in three levels: (i) the *meta-design level*, where software engineers create customized workshops to be used by other experts in the design team; (ii) the *design level*, where HCI experts and domain experts use customized workshops created at the upper level to cooperate in the design, implementation, and validation of workshops for end users; and (iii) the *use level*, where end users cooperate to perform their tasks (such as a medical diagnosis or a mechanical engineering design activity) through workshops created at design level and customized to their needs, culture, and skills.

2.3. Meta-design and meta-modeling

An important issue addressed by the SSW approach is the concept of meta-design, which is also the design paradigm proposed by Fischer and Giaccardi for the development of complex systems that can evolve with the contribution of end users [6]. However, in the SSW approach, the methods and technologies to be used at the meta-design level of a SSW hierarchy were not explored adequately. In this paper, we propose a structured approach to e-government service development that starts from a suitable meta-designing activity.

By commenting on the concept of meta-design introduced in [6], Sutcliffe and Mehandjiev said that end-user development can be regarded as a two-phase process, the former being designing the design environment, the latter being designing the applications using the design environment [30]. For instance, in the MAPS project, software developers design the design environment for caregivers who in turn create the prompting systems for people with cognitive disabilities [26]. In a similar way, we focus on the development of the design environment to be used by administrative employees to create e-government services for citizens. In both cases, the two-phase process advocated in [30] is followed.

The meta-design approach proposed in this paper is based on a meta-modeling activity. This idea is not totally new. For instance, in [31,32] a meta-modeling approach to end-user development of web-based business applications is proposed. In these works, the meta-model is developed as an abstraction of many different business applications, which are described uniquely according to a software engineering perspective. In this way, the developed EUD system requires end-user developers to learn the syntax of a language that seems too much computer-oriented for people who do not possess any knowledge of programming languages.

By contrast, our meta-design approach develops a meta-model from the different stakeholders' perspectives, thus playing the role of boundary object [33]. A boundary object is interpreted by each stakeholder from her/his perspective, but nevertheless represents a means to coordinate and align [34].

In the case of e-government service development, we create the meta-model by abstracting from the different stakeholders' descriptions of services, thus obtaining a boundary object that can guide the design of the EUD environment supporting administrative employees in creating e-government services in an easy and natural way. Other approaches to modeling e-government services have been proposed over the years, such as those based on ontologies [35,36]. However, although semantically more powerful, such approaches generally consider the software engineers' point of view in service creation, while neglecting the other points of view, and particularly, the role administrative employees may have in the creation and maintenance of e-government services.

3. e-Government services

Electronic service delivery (ESD) usually refers to providing government services through the Internet or other electronic means [37]. With ESD, federal, state, province and local government agencies may interact with citizens and organizations (business and other government organizations) to satisfy their many and various needs. Particularly, ESD provides a way to deliver services (e.g. paying taxes or requiring papers such as passports or driver's license) directly to citizens, without requiring them to go to a government office. The provision of high quality services is one of the key actions of the i2010 eGovernment Action Plan of the European Union (EU) [38]. Whilst among the priorities of the EU Action Plan 2011–2015 there are actions focused on sustaining user empowerment, as well as on increasing efficiency and effectiveness of administrations [39].

3.1. Classification of e-government services

The last benchmark assessing the supply of 20 common government services in 32 European countries was issued in 2010 [1]. It adopted a scoring framework based on a five-level sophistication model of e-government services that includes the following levels: (1) *Information*: the public agency website provides only information about the service and how it is supplied; (2) *One-way*

interaction: the public agency website allows citizens to download the form to request the service, the filled form can then be sent to the agency by means of traditional channels; (3) *Two-way interaction*: the public agency website allows citizens to start the service supply, e.g. fill in the service forms and submit them through the website; (4) *Transaction*: the government service is supplied completely on the website, possibly including its payment; and (5) *Targetization/Automation*: the government service is pro-actively provided to citizens, based on a previous registration of an event or citizen's profile.

The benchmark established that Europe has achieved an average sophistication maturity level between levels 3 and 4, with a significant increase with respect to the results of previous assessments. However, the benchmark also reported that, even where e-government services are provided, the majority of EU citizens (58%) are reluctant to use them. From these data, the last EU e-government Action Plan concludes that "there is clearly a need to move towards a more open model of design, production and delivery of online services" [39, p. 3].

In this paper, we propose a new approach to service design and development that capitalizes on the role and activities of administrative personnel. The final goal is again to improve the quality and effectiveness of resulting services offered to citizens and businesses.

3.2. e-Government services in a local municipality

We focus here on the e-government services provided by the Brescia Municipality belonging to levels 3 and 4 of the sophistication model.

These services have been further classified by domain experts and software developers working at the Brescia Municipality according to the following goal-oriented characterization: (i) front-office reservation; (ii) tax payment; (iii) document request; (iv) document submission; and (v) enrollment in courses or schools.

Such services have been implemented according to a form-based metaphor. For example, the service for booking appointments at the general registry office is implemented in the municipality website as a 5-step process including the following steps: (1) counter selection; (2) date selection; (3) time selection; (4) input of personal data including appointment topics; and (5) summary of inserted data and confirmation. In each step, citizens are provided with a form, which contains a limited number of widget types for data insertion (text fields, radio buttons, combo boxes and check boxes).

As shown in Fig. 1, in each form, a section placed on the right side of the screen visualizes the steps performed, the step under execution, and the remaining steps; whilst, on the bottom, a message summarizing the choices made in previous steps is reported. More specifically, Fig. 1 shows a portion of the web page during the booking of an appointment at the general registry office while the 4th step is under execution: the citizen has just inserted her personal data and selected the appointment topic; on the basis of the selected topic, the system suggests the citizen the papers needed for the appointment.

PRENOTAZIONE SERVIZIO ANAGRAFE

DATI PERSONALI

Compilate il modulo seguente, inserendo i vostri dati. I campi contrassegnati da asterisco [*] sono obbligatori. I dati forniti saranno trattati nel rispetto della Legge 675/96 (trattamento dei dati personali e privacy).

Informazioni personali dell'utente

Cognome*:

Nome*:

Data di nascita (gg/mm/aaaa)*:

Telefono*:

Email:

Argomento dell'appuntamento

Argomento*

Documenti da presentare

- documento d'identità
- Partita IVA
- iscrizione alla Camera di Commercio
- codice fiscale

Note (ad esempio: indicare se non si parla italiano):

Sto prenotando presso: **RESIDENZE - BROLETTO**: cittadini comunitari
 Sto prenotando un appuntamento per il giorno venerdì 20 maggio 2011 alle ore 11:30.

- SELEZIONE DELLO SPORTELLO
Scelta dello sportello presso cui prenotare l'appuntamento.
- GIORNO DELLA VISITA
Scelta del giorno in cui si desidera prenotare la visita.
- ORARIO DELLA VISITA
Scelta dell'orario in cui si desidera prenotare la visita.
- ➔ DATI PERSONALI
Raccolta dei dati anagrafici e dettagli sul tipo di servizio che si desidera prenotare.
- RIEPILOGO DATI
Riepilogo dei dati inseriti dall'utente.

Fig. 1. The 4th step of the service for appointment reservation at the Brescia Municipality.

The form-based metaphor has proved to be quite adequate to the heterogeneous population of potential users, due to its low cognitive burden and because it reminds the traditional interaction with paper-based forms. Actually, online forms are the most frequent interaction style offered in the e-government field, as also witnessed by the EU-project DIADEM (Delivering Inclusive Access to Disabled and Elderly Members of the community) [40].

3.3. Emerging needs in e-government service development

Personnel of the Computer Science Department of the Brescia Municipality are currently in charge of developing e-government services. Since G2C services are usually characterized by a recurring structure, their creation generally leads to implement very similar programs. In the past, software developers proceeded by replicating and adapting the code of another service, whilst nowadays they execute several configuration operations through a homemade configuration system that carries out automatically almost all the coding activity. However, the core problem is that only administrative employees, as experts of government procedures, possess the know-how to structure and characterize a given service. Moreover, employees often express new requirements for their services, which must be directly implemented by software developers. To obtain

the necessary configuration parameters and correctly understand the requirements for building the new service, several interactions between software developers and administrative personnel usually take place, due to the communication gaps that often arise and that must be progressively clarified. There is the need for a new perspective on service creation, which goes beyond the simple transfer of domain knowledge from employees to software developers.

To satisfy this need, the idea is to make administrative personnel directly responsible for the creation of online services by using a suitable software tool. However, a hurdle to this new work practice is the resistance of employees to service creation if they must acquire skills alien to their daily work and expertise [9]. As a consequence, traditional techniques foreseen in the end-user development literature are not suitable to our end-user developers' profile, being, at present, too much computer-oriented. On the contrary, we need to provide administrative personnel with an EUD environment that fosters their progressive change in mindset and culture [6,41]. Such an environment should require a low cognitive burden and should support employees' best practices, being centered on the employees' idea of service creation in the paper-based world, rather than on the idea of "creating a program" as the other EUD techniques are generally based on.

To cope with this problem, we have adopted a meta-design approach structured in two main phases:

1. meta-modeling of e-government services: this is a bottom-up activity that, starting from the analysis of existing services, aims at defining an abstract service description that catches the “essence” of an e-government service by abstracting from its software implementation, the interaction experience it offers and the mental model that administrative employees associate with it;
2. development of an EUD environment for administrative employees: this is a top-down activity aiming to design an EUD system that allows employees to create instances of the abstract service description without being aware of that. These instances are actually descriptions of programs implementing online services that can be automatically generated through a proper interpretation of the descriptions themselves.

The following sections deepen these bottom-up and top-down phases.

4. A multi-faceted description of e-government services

This section addresses the first phase of our meta-design approach, by analyzing in particular the stakeholders' profile and capturing their different points of view on e-government services. The goal of this activity is to achieve a multi-faceted description of services that could be used to define an effective meta-model of services (see Section 5) to be exploited in the second phase of the work (see Section 6).

4.1. Stakeholders' profile

The stakeholders involved in our case study are the following: (1) the *citizens*, to whom e-government services are offered; (2) the *administrative employees*, who are required to actively participate – as experts of the government domain – in G2C service creation through a proper EUD environment; (3) the *HCI experts*, who are in charge of designing the interaction experience offered by such an environment, suitable to the administrative employees; and (4) the *software engineers*, who should finally develop such an environment satisfying the requirements established with the other stakeholders.

Since the profiles of HCI experts and software engineers are quite standard and well known, we prefer to dwell upon the characteristics of the other classes of stakeholders.

The profile of Brescia citizens refers to a high variety of people who may access the website of the Brescia Municipality for service supply. Their age can vary in a wide range, as well as their education, cultural background and software technology knowledge. Most of them are accustomed to interact with e-commerce sites or social networks; therefore, when asked to use a web application, these users look for an interaction experience that recalls the one offered by the systems they know. In general,

given the high variety of the citizen profile and the importance of the goals that e-government services usually pursue, a careful attention should be paid on the usability of such services. Citizens expect to be guided throughout the process until task completion, without being overwhelmed or confused by the system. Usually, these users need clear and simple explanations during the interaction with each web page; furthermore, they would like to move back and forth in the site easily, without losing the work already done or the data just inserted; finally, citizens must be prevented to make irreparable errors or mistakes, otherwise, they will probably give up using online e-government services.

As to administrative employees' profile, government agency employees are expert in different administration issues, and have different competencies, skills, and cultural background. Most of them are female, their age ranges approximately from 20 to 60 years old, and they do not usually hold a high education degree. They are usually acquainted with web browsers, word processors, spreadsheets and other similar office applications, but complain when they are charged by software systems with house-keeping activities. Additionally, they are not very motivated to participate in web content authoring that requires them to learn software technicalities [9].

4.2. Stakeholders' perspective on online services

Each stakeholder – citizen, employee, HCI expert, software engineer – has her/his personal view on e-government services, which includes only the details the stakeholder is interested in [42].

A citizen usually describes an interactive system in natural language, possibly making reference to some screenshots of the system for a better explanation and indicating the possibilities for her/his actions. For example, let us consider again the service for reserving appointments at the general registry office, a possible description of this service from the citizen's point of view is the following²: “To obtain an appointment at the general registry office I should fill my data in these pages by proceeding step-by-step. I must first select the office where I would like to be received and then select the button ‘next’ to reach the page [screenshot with step 2] that allows me to choose the date of the appointment. Then, I must select the button ‘next’ again, in order to reach this new page [screenshot with step 3] where I can find all the time slots available for booking appointments in the selected date. Once the time slot has been chosen, I must go to the next page [screenshot with step 4], which requires all my personal data and the appointment topic. I am obliged to fill in fields ‘surname’, ‘name’, ‘date of birth’ and ‘phone number’, since they are indicated as mandatory. When the topic of the appointment is selected, the system shows in this area which papers are necessary for the appointment. Then, I must click ‘next’ again and reach the confirmation page [screenshot with step 5] where

² For the sake of readability, we assume that an English version of the service is available.

I can see all data inserted in the previous steps and send my request”.

An employee describes an e-government service using natural language as well, but s/he prefers focusing on the kind of data to be acquired and the procedures to be carried out to supply the service. An example description referred to the same example discussed above is the following: “I must first know the date and time when the citizen would like to be received. However, my office is open only on Monday and Wednesday and only in the morning from 10 to 12, therefore I can accept only appointment requests that satisfy these constraints. Then, I must acquire some citizen’s personal data: name, surname, place and date of birth, tax code, which must be coherent with the other data. I prefer also knowing the appointment topic in advance, so I can prepare myself. On the basis of the appointment topic, the citizen must bring some papers with herself/himself”.

An HCI expert, instead, analyzes an interactive system in terms of the interaction experience offered to its users, thus, in our case, focusing on the service metaphor and interaction style offered to citizens. As HCI experts, we have discovered in the given service some typical interaction design patterns adopted in web sites. More precisely, with reference to the Tidwell’s HCI pattern collection [43], we recognized the following patterns: “wizard”, “fill-in-the-blanks” (or “form”), “visual framework”, “center stage”, “sequence map”, “go back one step”, “disable irrelevant things”, “choice from a small set”, “interaction history”. The same patterns are adopted in all e-government services currently available on the Brescia Municipality website and in many other world-wide government websites, as witnessed in [44,45]. For example, the study reported in [45] highlights that the pattern “wizard” corresponds to an interaction pattern recurring in 80% of e-government applications, as well as the patterns “form” and “sequence map” (called “advancement box” in [45]).

Finally, a software engineer usually adopts a formal or semi-formal specification, such as a Unified Modeling Language (UML) diagram, to describe an interactive system. In our case, the software developer of the service described above provided us with a high-level class diagram that described the main classes of the software program implementing the service. As an example, in this specification, the class “reservation” was used to synthesize the type of service at hand, the class “step” was used to organize a service in a

limited number of chunks, and the class “control” to denote the different widgets to be used in each interaction step.

5. A meta-model for e-government services

The analysis of the above perspectives allowed defining a service meta-model [42]. It describes the main concepts of an e-government service, which can be interpreted and specialized by the different stakeholders according to their personal point of view.

The meta-model has been specified by means of an XML schema. A portion of its graphical representation is illustrated in Fig. 2.

The main role of the meta-model has been to drive the development of the EUD environment, by making clear the structure of the file that this environment should generate. Actually, the description of a specific service is an XML document, namely an instantiation of the XML schema, which must be properly interpreted by a suitable web application to generate the online service for citizens.

As one can notice in Fig. 2, a *service* is structured as a sequence of one or more *step* elements, each one corresponding to a web form through which (i) employees usually ask for the information needed and (ii) citizens provide the information required. This conception of a service as a sequence of steps is, indeed, in accordance with the conceptual separation of the different kinds of data to be acquired (by the employee) and to be supplied (by the citizen). It is also compliant with a simple guided interaction, satisfying the wizard interaction pattern, and with an implementation that represents both services and steps as software objects (as in the specification provided by software developers).

A *step* is in turn a sequence of one or more *requests* to the citizen on behalf of the employee, and in some particular case it may call a *substep*, not foreseen a priori and depending on input data, which includes a sequence of requests as well.

A *request* includes an element *instructions* that contains instructions to guide the citizen while answering the request itself and an element *information* used to store additional information for the citizen.

Then, it is composed of one or more items that describe the data chunks the citizen has to input. To this aim, the

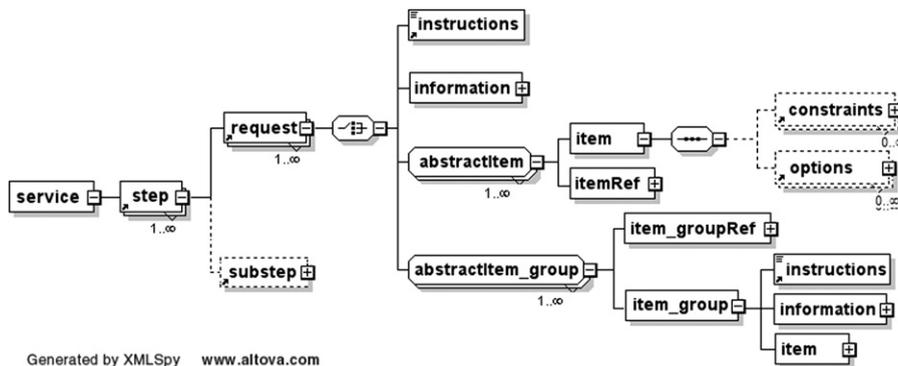


Fig. 2. A graphical representation of the service XML schema.

special element `abstractItem` has been introduced: it can be specialized as either the element `item` or the element `itemRef`. Similarly, to deal with groups of data items, the special element `abstractItem_group` has been defined to denote either the element `item_group` or `item_groupRef`. Elements `item` and `item_group` are used to represent input data effectively, while `itemRef` and `item_groupRef` are used to indicate references to data already provided by the citizen and included in the XML document. Additionally, elements `item_group` and `item_groupRef` are defined recursively on `item` and `itemRef`, respectively.

The element `item` has some mandatory and optional attributes: for example, `label` must be assigned the value of the data label to be visualized to citizens, while `type_input` may potentially characterize the data to be acquired as a name, surname, date, taxcode, etc., in order to identify the procedure for its validation. Each `item` in turn may include zero or more `constraints` for the generation of data to be visualized, such as for example all dates and times available for booking appointments. In other cases, an item can be specified as a set of `options` to be shown to the user for selection, such as for example the topic to be discussed during the appointment.

For the software engineer a request is an object referring to other objects (item or group of items). Whilst the HCI expert conceives a request as a set of text fields, combo boxes, check boxes, radio buttons, namely the virtual entities [5] to be used for visualizing and acquiring a single item or multiple items related each others.

6. A visual interactive system for instantiating the service meta-model

Starting from the abstract service specification previously described, this section illustrates the second phase of the approach, which concerns the development of an EUD environment that enables administrative employees to unwittingly implement e-government reservation services.

In order to design a suitable visual language for the environment, the employees' work practice has been analyzed. We have adopted scenarios and use cases to gather and describe employees' activities and needs; then, we have iteratively designed the conceptual and physical model of the system by using mock-ups and HCI design patterns.

During the requirements analysis, we analyzed the existing employees' work practice when a traditional service is supplied: they usually had a set of drafted forms (paper or electronic-based) to be adapted and combined to create new forms to be filled in with the required information. Based on this analysis, we assumed that the activity performed by employees may require again managing and interacting with sets of forms to be composed and/or adapted according to the service requirements. The environment for e-government service creation has thus been conceived as a service itself providing employees with an interaction experience similar to that offered to citizens by online services, including editing content, selecting content from available choices, pasting content from other sources.

To organize the EUD environment as a set of forms, a general six-step structure for front-office reservation services has been defined and taken as reference.³ To define step 1 ("Date selection"), the employee has to define all the parameters for generating a form allowing the citizen to choose the date of the appointment. Step 2 ("Time selection") is created similarly, by defining the parameters necessary to generate a form where the citizen can choose the appointment time. Defining the "Personal data" step (step 3) means deciding which kinds of personal data the employee would like to request to the citizen. Step 4 ("Topics and notes") allows the employee to define a step where s/he can request the citizen to choose or communicate a discussion topic and eventually provide some notes for preparing the appointment. Step 5 ("Other data") can be used by the employee to create further and specific requests, which have not been considered in the other steps yet. Finally, creating the step "Summary and confirmation" (step 6) means deciding which kinds of information requested to the citizen in the previous steps must be summarized before appointment confirmation.

The employee is required to create a service by choosing the steps that make it up and defining the parameters for each step. The most frequent order of steps is suggested by the system, but it can be changed by the employee at her/his own pace. Some steps, such as step 1, are mandatory; whilst others, such as step 5, are optional. The system is in charge of checking the presence of mandatory steps.

Fig. 3 shows a screenshot of the EUD environment with superimposed indications referred to the main parts of the interface (the system is in Italian, according to the end users' profile). The employee decides which step s/he would like to create by selecting one of the buttons in the steps toolbar. In Fig. 3, the employee is creating the step "Giorni di erogazione" (date selection) by filling out the fields in the working surface (structured as a form according to the analysis of employees' work practice) with the constraints on the possible dates to be chosen for appointments. The contextual help on the left provides the employee with indications on how to interact with the environment. When s/he is satisfied by her/his definition, s/he can select the button "OK" and a new step of the service under construction will be added as a selectable widget in the summary section on the right, where each step can be recalled for further modification. In this interface area, the employee can also delete a step by clicking the corresponding wastebasket or modify the step order by changing the sequence number of steps through the related combo boxes.

In summary, we have developed an EUD environment able to guide employees in defining steps, requests, items, etc., which characterize the service to be supplied. However, employees are not forced to write any XML code, neither to know the underlying meta-model, but they can just follow their usual way of reasoning and operating

³ After a discussion with a group of municipality employees and software developers, we decided to remove the counter selection step, being it conceptually external to the creation of a specific service.

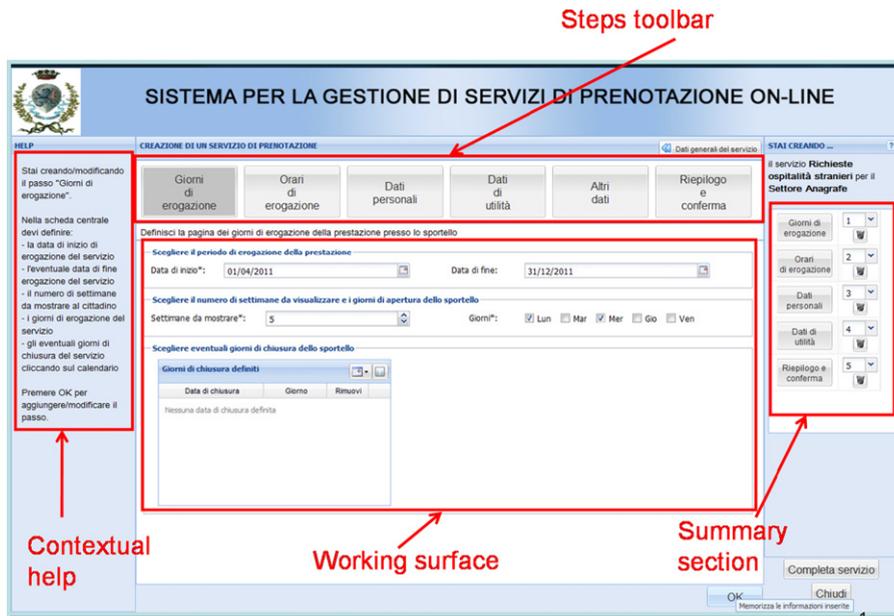


Fig. 3. The EUD environment for creating reservation services.

when a new G2C service has to be supplied. The interaction with the EUD environment determines the progressive generation of an XML document, corresponding to the service under creation.

7. The system at work

In this section we illustrate the activities carried out by an employee to create an e-government service with our EUD environment and the resulting service for citizens. The output service is shown by presenting both its internal representation (XML document) and its external visualization as a sequence of web forms.

The example presented in this section describes how an employee working at the Public Education Office of the Brescia Municipality, who participated in the evaluation (discussed in Section 8), used the system to create a front-office reservation service for families with young children. In particular, the employee created the “Centri ricreativi estivi” (“Summer recreation centers”) service. This service should allow families to reserve an appointment at the Public Education Office to know and choose the possibilities for children assistance in summertime.

The employee logged in the system and started creating a new service by assigning the name “Centri ricreativi estivi” to the service. Then, she selected the steps to be created, starting by defining the date selection step. As Fig. 4 shows, the user established a discharge period for the service from April 18, 2011 to June 24, 2011. She then indicated that three weeks should be visualized, that the office is open on Monday and Friday, and that Monday April 25 is holiday.

When the user selected the “OK” button in the right-hand corner of the form, the system adds the XML fragment shown in Fig. 5 to the document under construction. It corresponds to the creation of the step for date selection

with the above parameters. The element *step* is used (according to the XML schema in Fig. 2), including an element *request*, which includes, in turn, the element *instructions*, whose content (in Italian) asks to choose the day when the citizen would like to be received, and an element *item* including one element *constraint*. This element states the service discharge period with two elements *date*, the open weekdays (elements *day*), an holiday (a further element *date*) related to an open weekday through the attribute *ref_day*, and the number of weeks to be visualized (element *number*).

Then, the employee created the step for time selection, by setting the parameters for time slots as follows: appointments last 20 min each, Monday has an associated time slot from 8.00 to 13.00, and Friday has a time slot from 13.00 to 18.00. A screenshot illustrating the creation of this step is shown in Fig. 6, while the corresponding XML description is reported in Fig. 7.

The XML description of this step describes the constraints for the generation of time choices, according to the established appointment duration and time slots, and referred to the week days in which the office is open. Therefore, here the element *item* includes two elements *constraint*. Each *constraint* element states the duration of appointments (element *duration*) and the time slot (elements *time*) related to an open day chosen in the step for date selection. Such open days are referred by means of the element *dayRef*.

When the XML fragments shown in Figs. 5 and 7 are interpreted by the service generator, the forms shown in Figs. 8 and 9, respectively, are visualized to the citizen. As one can notice, only three weeks, each with the two open days, are visualized in the step for date selection (Fig. 8), with the time slots for each day indicated within parentheses. Monday April 25 appears disabled since it was specified as an holiday. All the possible appointment

Fig. 4. The employee is creating the step for date selection.

```

<step name="Data dell'appuntamento" description="Scelta del giorno in
cui si desidera prenotare l'appuntamento" n_step="1">
<request goal="information" id="r1">
< instructions>Scegli il giorno in cui desideri essere ricevuto tra
quelli presenti nella casella sottostante
</instructions>
<item type="input" id="datum0" label=""
mandatory="yes" choice="single" >
<constraint id="v0" name="period">
<date id="d0" name="start" >18/04/2011</date>
<date id="d1" name="end" >24/06/2011</date>
<day id="g0">lunedì</day>
<day id="g1">venerdì</day>
<date id="d2" name="closure" ref.day="g0">25/04/2011</date>
<number id="n0" format="int" role="n_week">3</number>
</constraint>
</item>
</request>
</step>

```

Fig. 5. XML fragment modeling the step for date selection.

times are shown in Fig. 9: they are computed not only on the basis of the specification reported in Fig. 7 (e.g. appointment duration) but also on the basis of the citizen's selection (in this case, Friday April 29, 2011).

The "Topics and notes" step was then created by the employee to establish different topics to be discussed during appointments, along with papers needed. The employee then created the step for personal data acquisition. He chose to ask name, surname, tax code, address, cellular phone, identity card as mandatory data, and home phone as optional datum. Let us notice that the employee, in this case, did not follow the usual order of step creation implicitly suggested by the steps toolbar, but she decided to create the "Topics and notes" step before the "Personal data" step. The employee then passed directly to the summary and confirmation step, where she required to present the citizen with the following summary data: personal details, date and time of the appointment and topic to be discussed.

On the basis of the definition of the last step, the citizen sees a web page similar to that shown in Fig. 10.

8. System evaluation

The EUD environment has been evaluated with a group of real users to gather qualitative feedback on the usability and usefulness of the application.

The environment developed in this project represents an important innovation in the government domain. Indeed, to the best of our knowledge and according to the software developers working at the Brescia Municipality, software applications that transfer service creation to administrative employees, following their competencies and skills, do not exist on the market yet. Therefore, our aim was mainly to understand if the application was perceived as a useful support to municipal employees to carry out their daily work. In our evaluation, we also tried to understand if the application correctly reflects the employees' mental model about reservation services and to collect hints for future application improvements. To this end, two evaluation techniques have been adopted: a direct observation with think aloud and a questionnaire.

In the following, the details on the evaluation method and the results obtained are provided.

8.1. Method

Six employees (all females) participated in the evaluation of our EUD environment. Their age ranges from 30 to 60. Five of them hold a secondary school degree, whilst the last hold a Master degree in Law. Three employees work at the Brescia Municipality, and more precisely one works at the Press Office, another at the Public Education Office and the third one works at the Public Relations Office. All these offices provide online services on the Municipality website, so as to support employees in managing appointments with

Fig. 6. The employee is creating the step for time selection.

```

<step name="Orario dell'appuntamento" description="Scelta dell'orario
in cui si desidera prenotare l'appuntamento" n_step="2">
<request goal="information" id="r2">
<instructions>Scegli l'ora in cui desideri essere ricevuto tra
quelle proposte nella casella sottostante
</instructions>
<item type_input="time" id="datum1" label="Orario"
mandatory="yes" choice="single">
<constraint id="v1" name="timeSlot">
<text id="t0" role="slotName">Mattino</text>
<duration id="n1" format="int" role="duration">20</duration>
<dayRef ref_day="g0" />
<time id="ora0" role="startSlot">8:00:00</time>
<time id="ora1" role="endSlot">13:00:00</time>
</constraint>
<constraint id="v2" name="timeSlot">
<text id="t1" role="slotName">Pomeriggio</text>
<duration id="n2" format="int" role="duration">20</duration>
<dayRef ref_day="g1" />
<time id="ora2" role="startSlot">13:00:00</time>
<time id="ora3" role="endSlot">18:00:00</time>
</constraint>
</item>
</request>
</step>

```

Fig. 7. XML fragment modeling the step for time selection.

citizens more effectively. The other three employees that participated in the evaluation work at the Municipality of Pumenengo (within the Brescia District), which does not offer online services to its citizens yet. Two out of three employees work at the Registry Office and one at the Tax Office.

Six different tasks, personalized according to each test participant's job, have been prepared and submitted to the employees as realistic work scenarios. As an example, the employee at the Tax Office received the following scenario⁴: "You must create a service for reserving an appointment at your office for the renewal of a tomb burial grant. In

particular, you should provide the general data of the service and then define the steps that you think are necessary to request citizens all useful data. The steps can be defined in any order, so you should choose which is the most suitable order of steps in this case. After steps definition, you should complete the service and close the application".

Each test was carried out separately for each participant and was performed at her usual work place. A notebook with the application already open in its initial state has been used to conduct the evaluation. An introduction session was carried out before the test to illustrate the employee the goals of the application and show her a complete operation cycle concerning the creation of a service devoted to Italian citizens who would like to reserve an appointment at the Registry Office.

Then, the prepared scenario was submitted to the employee, by explaining her that she would have been observed during task execution. The employee was reassured that she was not under examination, that she was free to make observations and comments on the strengths and weaknesses of the application and that no time limit existed to finish the test. Furthermore, the employee was asked to describe loudly what she had been doing and to fill out, at the end of task execution, a brief and simple questionnaire.

The questionnaire (translated in English and reported in Appendix A) was submitted to participants to investigate their opinions about the easiness of the interaction with the application, the clarity of interface contents and messages, and the usefulness of the application. The questionnaire included eight questions: four questions required closed answers in a scale, whilst the remaining required, beyond the answer in the scale, also an answer explanation.

8.2. Results

During the direct observation with think aloud, test participants commented positively on the easiness of the

⁴ The scenario was written in Italian. It is translated here in English for the sake of paper readability.

CENTRI RICREATIVI ESTIVI	
1) DATA DELL'APPUNTAMENTO	1) DATA DELL'APPUNTAMENTO Scelta del giorno in cui si desidera prenotare l'appuntamento
Scegli il giorno in cui desideri essere ricevuto tra quelli presenti nella casella sottostante	2) ORARIO DELL'APPUNTAMENTO Scelta dell'orario in cui si desidera prenotare l'appuntamento
<input type="radio"/> lunedì 18 Aprile 2011 (dalle 8:00: alle 13:00) <input type="radio"/> venerdì 22 Aprile 2011 (dalle 13:00 alle 18:00) <input type="radio"/> lunedì 25 Aprile 2011 (dalle 8:00: alle 13:00) <input type="radio"/> venerdì 29 Aprile 2011 (dalle 13:00 alle 18:00) <input type="radio"/> lunedì 2 Maggio 2011 (dalle 8:00: alle 13:00) <input type="radio"/> venerdì 6 Maggio 2011 (dalle 13:00 alle 18:00)	3) INFORMAZIONI DI UTILITÀ Raccolta di dettagli sul tipo di servizio che si prenota
	4) DATI PERSONALI Raccolta dei dati personali del richiedente
<input style="border: 1px solid black;" type="button" value=" << Indietro "/> <input style="border: 1px solid black;" type="button" value=" Avanti >> "/>	5) RIEPILOGO DATI Riepilogo dei dati inseriti dall'utente

Fig. 8. The service web form for selecting the appointment date.

CENTRI RICREATIVI ESTIVI	
2) ORARIO DELL'APPUNTAMENTO	1) DATA DELL'APPUNTAMENTO Scelta del giorno in cui si desidera prenotare l'appuntamento
Scegli l'ora in cui desideri essere ricevuto fra quelle proposte nella casella sottostante	2) ORARIO DELL'APPUNTAMENTO Scelta dell'orario in cui si desidera prenotare l'appuntamento
<input type="radio"/> 13:00 <input type="radio"/> 13:20 <input type="radio"/> 13:40 <input type="radio"/> 14:00 <input type="radio"/> 14:20 <input type="radio"/> 14:40 <input type="radio"/> 15:00 <input type="radio"/> 15:20 <input type="radio"/> 15:40 <input type="radio"/> 16:00 <input type="radio"/> 16:20 <input type="radio"/> 16:40 <input checked="" type="radio"/> 17:00 <input type="radio"/> 17:20 <input type="radio"/> 17:40 <input type="radio"/> 18:00	3) INFORMAZIONI DI UTILITÀ Raccolta di dettagli sul tipo di servizio che si prenota
	4) DATI PERSONALI Raccolta dei dati personali del richiedente
<input style="border: 1px solid black;" type="button" value=" << Indietro "/> <input style="border: 1px solid black;" type="button" value=" Avanti >> "/>	5) RIEPILOGO DATI Riepilogo dei dati inseriti dall'utente

Fig. 9. The service web form for selecting the appointment time.

interaction and on the flexibility of the application in general.

Employees of the Brescia Municipality appreciated the idea of having a tool that could directly support them in the creation of reservation services, thus avoiding the need of transferring their requests to someone else, with the risk of incomprehension.

The employees working at the Municipality of Pumenengo appreciated very much the usefulness of the application, also because their agency does not offer online services at all. Indeed, at the moment, several citizens arrive at the municipality offices at any time during the day and without the necessary papers, and thus they are often asked to come back again.

CENTRI RICREATIVI ESTIVI

5) RIEPILOGO DATI

Di seguito è mostrato il riepilogo dei dati che hai inserito nelle fasi precedenti. Se tutti i dati sono corretti premi il tasto Conferma, altrimenti torna indietro e correggi dati.

Giorno scelto: venerdì 29 Aprile 2011

Orario scelto: 17:00

Dati anagrafici del richiedente

Nome: Daniela

Cognome: Fogli

Codice fiscale: FGLDNL70B61G970F

Argomento scelto per l'appuntamento: isee

1) DATA DELL'APPUNTAMENTO

Scelta del giorno in cui si desidera prenotare l'appuntamento

2) ORARIO DELL'APPUNTAMENTO

Scelta dell'orario in cui si desidera prenotare l'appuntamento

3) INFORMAZIONI DI UTILITÀ

Raccolta di dettagli sul tipo di servizio che si prenota

4) DATI PERSONALI

Raccolta dei dati personali del richiedente

5) RIEPILOGO DATI

Riepilogo dei dati inseriti dall'utente

Fig. 10. The service web page summarizing the data inserted by the citizen.

During the task execution many observations about the various phases of service creation have emerged, also providing hints for improving the application. Let us see some of these observations:

1. In the creation of the “Date selection” step, the holidays should be already pre-loaded in the system, so to relieve employees from carrying out the additional tasks of selecting them from the calendar. Moreover, employees asked for adding Saturday as a further open weekday.
2. In the creation of the “Time selection” step, some employees complained that they had to insert time slots separately for each day, whilst a unique command to select the same time slots for more than one open weekday could be useful. Employees then commented positively on the fact that the system assists them entering consistent information; indeed, the information set in steps for dates and times are kept by the system always consistent: for example, the user can define the time slot for a week day not selected in the step for defining available dates, and the information about the open week days is automatically updated in that step.
3. The form for creating the “Personal data” step has been very appreciated for the easiness of selecting the requests and making them mandatory or optional. The functionality for creating personalized requests has been considered very useful as well, also for the possibility of creating lists of options associated to such requests. To improve this phase, most employees suggested to enrich the set of pre-defined requests. More precisely, the possibility of providing different sets of pre-defined requests according to the different offices has been discussed.

Table 1

Users' answers to the post-questionnaire.

	U1	U2	U3	U4	U5	U6
Q1	Very	Enough	Very	Very	Enough	Very
Q2	Very	Enough	Very	Very	Very	Enough
Q3	Enough	Very	Very	Very	Very	Enough
Q4	Enough	Enough	Very	Very	Enough	Enough
Q5	8	9	9	10	9	9
Q6	9	8	10	10	9	9
Q7	10	9	10	10	9	9
Q8	Very	Very	Very	Very	Enough	Very

4. Finally, the employees suggested to modify the step “Topics and notes” by improving some visualization features.

Employees judged positively also the general features of the application, such as: the role of the “OK” button in each step to partially save the work done; the summary section on the right to (1) control and manipulate the step order and (2) recall step content for possible modifications. However, some employees suggested to extend the environment so as to create multi-language services.

The answers provided in the questionnaire confirm the positive impact of the application on users (see Table 1). Questions from Q1 to Q4 received answers between “enough” and “very”, with a prevalence of “very”, confirming the user appreciation for the usability of the EUD environment, which supports employees in creating online services through a visual language tailored to their work practices. An average value equal to 9 was assigned to Question Q5, thus showing that the buttons in the central bar correctly reflect the mental model that

employees have of reservation services and of related information to be requested to citizens. The lowest score to this question was equal to 8, since the office where the participant works (Press Office) deals with different data with respect to those of other offices. The summary section in the right-hand side of the screen has been judged very useful (Question Q6, with average value equal to 9.2); beyond the comments provided during the direct observation, some employees said that the step summary makes the employee sure of what she has defined. The employees declared to be willing to use the application in their daily work (Question Q7, with average value equal to 9.5), since it adequately assists an employee in creating and specifying all steps of an online reservation service. Finally, as far as Question Q8 is concerned, the application has been judged very useful for developing online services, due to its adaptability to the needs of the different offices.

9. Discussion and conclusions

In this paper, we have described our approach to empower administrative personnel to create web-based G2C services. The analysis of existing services from the different stakeholders' points of view led us to define a meta-model of e-government services and to develop an EUD environment for service creation.

The activities of creating a meta-model for a software application and designing a suitable EUD environment according to the meta-model can be regarded as two phases of a meta-design approach to end-user development, which, in our opinion, could be applied also outside the e-government domain. The general goal of the approach is not only to technically facilitate software artifact creation, but also to promote and possibly improve existing best practices, thus increasing end-user developers motivation and engagement in end-user development activities.

The evaluation of the EUD environment with employees of the municipalities of Brescia and Pumenengo shows that the system could be well accepted by its users, thanks to its usefulness and good level of usability.

We are currently improving the EUD environment on the basis of the feedback received. At the same time, a web-based back-office application is under development: it will be able to access data inserted by citizens during the usage of services and present the necessary information to employees, possibly different from those developing services, who must effectively deal with appointments. This application should complete the "software package" supporting the whole workflow for reservation services.

Then, a more extensive set of experiments will be carried out with administrative employees of different municipalities within and outside the Brescia district, in order to gather all necessary indications for transforming the package into an engineered product.

Accessibility aspects of services will be also considered in the new version of the application. Indeed, the EUD environment should support employees in creating web applications compliant with guidelines for accessibility

[46,47], so that "no citizen is left behind" [38, p. 4]. This is a very important goal, necessary to follow the principle of inclusive e-government.

Then, an extension of the approach will be investigated, in order to support employees to create further classes of e-government services. To this end, we are reviewing, on one hand, the meta-model to include specific aspects related to level 4 (Transaction) and level 5 (Targetization/Automation) services, and, on the other hand, the development of an environment capable of generating specialized EUD environments for the different service classes. This "meta-meta-design" approach is inspired to the ideas promoted by Piero Mussio since the early 19s [27] to his last works [5,8].

Finally, we would like to apply the approach here proposed in other contexts, such as business process management and systems for knowledge sharing, with the aim to demonstrate that, although the EUD environment discussed in this paper apparently addresses a very specific problem, the overall approach is general enough to be applied to a variety of application domains.

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Appendix A. Post-questionnaire

This questionnaire aims to gather observations and suggestions related with the application for e-government service creation. Please fill in the questionnaire with all the information required. Thanks for your collaboration!

- Q1. Do you think that the application is easy to use?
 No Not much Don't know Enough Very
- Q2. Do you think that contents are clearly disposed on the interface?
 No Not much Don't know Enough Very
- Q3. Do you think that the messages appearing when the mouse cursor is over some buttons are useful?
 No Not much Don't know Enough Very
- Q4. When you used the application, was it always clear what you had to do?
 No Not much Don't know Enough Very
- Q5. How much, from 1 to 10, the buttons in the central bar reflect your idea of reservation service and related information to request to the citizen?

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

Why? _____

Q6. How much, from 1 to 10, is the step summary on the right-hand side useful?

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

Why? _____

Q7. How much, for 1 to 10, would you be willing to use the application in your activity?

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

Why? _____

Q8. Do you think that the application could be useful to encourage the development of online services of your Municipality?

No Not much Don't know Enough Very

Why? _____

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