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Modeling and Illustrating Requirement Prioritization in Public E-Service Development From a Value-Based Perspective

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Abstract: A major problem in e-service development is the prioritization of the requirements of different stakeholders. The main stakeholders are governments and their citizens, all of whom have different and sometimes conflicting requirements. In this paper, the prioritization problem is addressed by combining a value-based approach with an illustration technique. This paper examines the following research question: How can multiple stakeholder requirements be illustrated from a value-based perspective in order to be prioritizable? We used an e-service development case taken from a Swedish municipality to elaborate on our approach. Our contributions are: 1) a model of the relevant domains for requirement prioritization for government, citizens, technology, finances and laws and regulations; and 2) a requirement fulfillment analysis tool (RFA) that consists of a requirement-goal-value matrix (RGV), and a calculation and illustration module (CIM). The model reduces cognitive load, helps developers to focus on value fulfillment in e-service development and supports them in the formulation of requirements. It also offers an input to public policy makers, should they aim to target values in the design of e-services.

Keywords: public e-services, public e-service development, requirement prioritization, requirement domains, values, goals, illustration, requirement fulfilment

1. Introduction

For more than twenty years, governments have worked hard to introduce e-government initiatives that allow work to be carried out electronically at all levels. Unfortunately, as many as 80% of e-government projects have failed (Heeks, 2006;Ng, 2009). One reason for their failure implicates stakeholders' involvement and engagement (Berander, 2005). Whilst researchers are still discussing the reasons for failure, governments' use of IT has nonetheless increased at a rapid pace; for example, the share of individuals in the Euro area using the Internet for interacting with public authorities increased from 37% in 2008 to 46% in 2013 (Eurostat, 2014). This means that the development of tools for citizen–government interaction is crucial for governments as well as for citizens. The development and launching of public electronic services (hereafter called e-services) has grown rapidly (Goldkuhl & Röstlinger, 2010; Eurostat, 2010). An e-service is an interactive, content-centered and Internet-based customer service that is driven by the customer and integrated with related organizational support processes and technologies to strengthen the customer-provider relationship (De Ruyter et al, 2001). In relation to the public sector, the idea is that citizens should always be able to reach government agencies through the Web and should also be served by them (Goldkuhl, 2007).

E-services can be classified in various ways; they can be informative, communicative, horizontal, vertical and transactional (Layne & Lee 2001; Jayashree & Marthandan, 2010). No matter the level of sophistication, e-services are developed in order to fulfill at least two major purposes. Firstly, e-services can benefit service providers (public administration) by automating a part of the administrative job; thus, they can speed up services, which results in cost savings. Secondly, e-services can benefit service users (businesses and citizens) by giving them an opportunity to interact with the public authorities, who are then able to meet their needs at any time, quickly, cheaply and easily (Vassilakis et al, 2005). We relate the first purpose to efficiency and the second to effectiveness. We define efficiency as a "better way of doing what we currently do" and effectiveness as "doing it well, getting the desired effect or result" (EU, 2010a).

Theoretically, in e-service development, the needs of both service providers and service users are taken into consideration, as they are both main users of the e-service. In practice, though, when developing an e-service, service users with their needs and expectations tend to be excluded from the development phase; instead, development becomes rather more public administration oriented or even technology oriented (Vassilakis et al, 2005; Affisco & Soliman, 2006).

The most important aspect of e-government projects is that citizens are well served and satisfied (Anthopoulos et al, 2007); otherwise, an e-government solution cannot be considered a success. In this case, citizens will return to other, traditional channels for government interaction, and the expected benefits for the agencies involved will not be met. There are even examples of major e-service development projects that have led to e-services which were not used at all (Heeks, 2006; Gauld et al, 2010). Thus, there is a need to strengthen the citizens' perspective during the development process in order to create successful e-government in a holistic sense (Axelsson et al, 2010; van Velsen et al, 2009).

Citizens are seen as the main target group of an e-service as they are its users. As tax payers, they are also the main investors. However, it is a mistake to focus too much on the needs of service users and forget about an organization's internal needs. Public organizations administrate e-services on a daily basis and are, thus, also a major stakeholder. Focusing only on the service users' needs and expectations might result in an e-service which is not efficient. Wimmer (2002) claimed that there is a need for a holistic approach which strongly aims to focus on people's roles and cognitive needs within a one-stop government system. Emphasis is placed on active user participation, where citizens, employees, managers and members of firms contribute with their specific knowledge and requirements to develop a system that fits their needs, rather than a technical system to which people have to adapt.

The process of collecting, organizing and selecting requirements is called requirement analysis. This process is as old as the Information systems domain. During the last decades various approaches have gained interest from analysts and researchers (Shawla et al, 2014). One traditional strand of approaches have focused functional requirements (e.g. Rossi, 1996; Ceri et al, 2000).Together with the proliferation of the object oriented method paradigm, there has accordingly been a hausse for object oriented requirements analysis. During the latter part of mentioned decades, there has been an increasing interest for goal based analysis e.g. Mylopoulos et al (1999) and Castro et al (2000) (Shawla et al, 2014). Value based analysis has been rare just like the systematic use illustrating techniques to analyse and prioritize requirements.

In cases where a project has many stakeholders and many requirements, there is a need for requirement prioritization (Berander, 2005; Firesmith, 2004). Evidently, all requirements in a systems development project are not equally important to all stakeholders. When designing an information system, different requirements have to be weighed against each other. The process of prioritizing requirements is a delicate one, and there is a need for methods and tools to support decisions in this matter. Requirement prioritization, in practice, is often informal (Lehtola et al, 2004) or non-existent (van Velsen et al, 2009), and takes numerous approaches, e.g. Firesmith (2004), Wiegers (1999) and Mead & Stehney (2005). Value-based approaches put forward by Azar et al (2007) and Heindl and Biffl (2005) aim to reduce the differentiation between requirements by eliciting the values that are inherent in different requirements. Bekkers & Moody (2011) showed the importance of visualization in e-government, especially for communication with citizens. Danielson et al (2007) proposed an approach that is based on decision support algorithms. This approach did not aim to take decisions, but rather to illustrate priorities by ranking them. This current paper's main aim is to show that a mix of a value-based and illustration approach is viable. Such a mix would combine form and content, and would, thereby, highlight (illustrate) the values that are actually promoted when various requirements are promoted.

Alternative approaches can be used to fulfil various stakeholders' needs. The approach put forward in this paper is heavily influenced by the so called Scandinavian approach, also labelled "Participative Design" (Gregory, 2003) which stresses users influence in the systems development process. A similar approach is "The collaborative approach in e-service development (EU, 2010b) which is focusing "participation of all" (EU, 2010b:10). Both approaches are addressing both citizens and civil servants. In the approach of this paper citizens and civil servants (as representatives of government) are both identified as important stakeholders whose requirements are highlighted and analyzed.

To summarize, the research question of this paper is: How can multiple stakeholder requirements be illustrated from a value-based perspective in order to be prioritizable? The objective is to present a value-based model for organizing information that is relevant for requirement prioritization in e-service development projects. The long-term aim of this model, which is relevant to policy makers, is to present appropriate information to support improvements in government efficiency and create more effective services

for citizens. The short-term aim, which is relevant to practitioners, such as e-service developers, is to provide a basis for effective requirement prioritization.

According to studies by, for example, Ancarani (2005) and Magoutas et al (2007), research on the quality of e-services is in its infancy. Thus, there is still a need for further investigation on this topic. To date, research has focused on the broad launching of public e-services rather than emphasizing quality in use of e-services (Goldkuhl & Röstlinger, 2010). Likewise, when evaluating e-services, the focus is often on efficiency. The EU benchmarking of e-government success that has been carried out on projects since 2000 does not take effectiveness into consideration as much as efficiency (United Nations, 2010). Thus, there is a need for further investigation within this context. We believe that our model has implications for public policy making with regard to target values and the reduction of cognitive load when developing e-services.

The paper is organized as follows. After the introductory part central concepts are discussed in the theory section. After the method follow sections of research method and results. Finally we discuss the results and draw some conclusion.

2. Theory

In this section we present relevant theories as a basis for formulating a model of e-services requirements.

2.1 Requirements, goals and values

Requirements are the described needs that a system should contain in order to fulfill stakeholders' expectations (van Lamsweerde, 2009). These requirements can be influenced not only by stakeholders' needs, but also by their different technological requirements, and, requirements applied for legislative and economical reasons. An example of a user requirement is: "The system should provide extended possibilities for reserving premises compared with the existing situation".

Requirements are used as a basis for changing a problematic situation in an organization into a state that the organization strives for as a goal. A goal can be interpreted as a value indicator of what an organization wants to achieve (Goldkuhl & Röstlinger, 2005). A goal could be: "The system should offer the opportunity to reserve premises 24/7".

Whilst goals can be achieved, values merely indicate the direction to be taken. People hold values in the form of attitudes and feelings; they show what is important to them through their opinions and their beliefs on how needs and expectations can be fulfilled (Hedström, 2007). According to Bannister (2002), values are normative characteristics or modes of behavior that individuals, groups or organizations hold to be right or at least are better than other characteristics or modes of behavior. Furthermore, Bannister (2002) claimed that all members of an organization have values that lead both individuals and organizations to seek good outcomes which meet or comply with these values. For example, in terms of e-services, a citizen-related value could be effectiveness, whilst another value, related to public organizations, could be efficiency. In a certain situation, there are often many identified values, some of which may be opposed to each other (Hedström 2007). Typically, the values of effectiveness and efficiency can come into conflict. Since this study focuses on the contradictory relationship between these two values, they are regarded as being of greatest importance when defining a set of values for e-services.

The identification of requirements is the result of a process of negotiation, where different actor groups hold and promote various, and sometimes conflicting, goals and values, which influence the design and evaluation of an IT artifact. These requirements are exposed to negotiations during the development process. Some values are prioritized, become accepted and finally form part of the new IT system, while others are neglected. Therefore, it is important that values relating to information systems are recognized as having an influence on design choices. It is also important to evaluate the systems' outcomes after their use (Hedström 2007).

2.2 Requirement domains in e-service development

Since this paper is about requirement prioritization in public e-service development, we carried out an inventory of relevant models to find any relevant aspects. The outcome is an inventory of three models that target e-service development and thereby identify categories that are relevant to our objectives. From these

models, we generated five domains. Table 1 below shows how the five domains correspond to the categories of models.

Table 1: Model correspondence into five requirement domains

Domains	Wimmer (2002)	Vassilakis et al (2005)	Grönlund (2000)
Citizens	Individual citizens	User culture barriers	Users
	Groups and society		
Government	Employees of authorities and governments	Administrative barriers	Organisation
	Social and cultural practices	Social barriers	
Technology	Technical and information systems	Technological barriers	Technology
Economy			Economy
Laws/ regulations	Norms and laws	Legislative barriers	
	Moral and ethics		

Below we give a more detailed presentation of the five requirement domains:

Citizens. The citizens are the target group of any future e-service as they will be its main users. Citizens affect the development of an e-service through their needs and expectations (Axelsson et al, 2010). Consequently, if an e-service is to be successful, it is vital that its content is adapted to meet citizens' needs. Value concepts such as accessibility, usability, and efficiency are important from the citizens' point of view (Anthopoulos et al, 2007). A concept which is also important from the citizens' perspective is the effectiveness and usefulness of the e-service; in other words, how useful the e-service is considered to be by citizens compared with similar services on offer (Grönlund, 2000). An e-service that does not fulfill citizens' expectations is considered to be a failure (Anthopoulos et al, 2007).

Government. According to Grönlund (2000), government and citizens are the most significant players within the context of e-services. They are also the dominant actor in e-service development, where e-service development tends to be government oriented (Axelsson et al, 2010). The government domain consists of the service providers, who - as administrators - are also a target group of e-services. In order to provide efficiency within the public authority, e-services often require reorganization and integration within the different organizations that make up that public authority (Vassilakis et al, 2005). Thus, during the development of an e-service, there are organizational requirements that have to be taken into consideration.

Technology. Since e-services are based on technology, several technological issues need to be taken into account. One problem is related to choosing the right technology in relation to e-services, e.g. web platforms, distribution channels, required functionalities, and competence requirements (Grönlund, 2000). These choices of technological requirements influence both governments and citizens. Therefore, the technology domain is easily connected to the domains of government and citizens.

Whilst security is a value and encryption a requirement, both have to be given serious consideration when developing an e-service. According to Vassilakis et al (2005), the level of security is related to the citizens (end-users). High security levels need end-users to have a significant level of expertise. Another technological value is performance, which might affect the citizens when the system provides complex or large volume data submission forms in combination with slow Internet connection. Hence, infrastructure plays a central role with regard to the time it takes to exchange data between citizens and the public authority when using a specific e-service.

The deployment of complex e-services requires cooperation between more than one public authority. Sometimes, third parties are involved, such as banks (Vassilakis et al, 2005). Technical requirements are second order requirements, since they are the result of citizens' and governments' requirements; at the same time they are the means for the aforementioned requirements to be achieved.

Economy. Unlike private organizations, where resources come from "below", public organizations get resources from "above" (Hoff, 1992). The domain of economy equals an investment that affects the development of an e-service. Investments are typically made with a budget in mind, and a larger budget is most often gained for political rather than economic reasons or those related to service quality levels (Grönlund, 2000). Indeed, the economy plays a central role in e-service development. Access to an appropriate budget is vital if an e-service is to be implemented and launched, and all system requirements are to be realized so as to fulfill stakeholders' needs and expectations. Thus, the values of this domain are closely related to the value of a balanced budget.

Laws/regulations. Decision making in the public sector has the force of law; unlike private sector organizations, which deals with voluntary customers, the public sector deals with citizens, (Bannister, 2002). According to the Swedish Government (2004/05), citizens have to be served equally. Additionally, it is stated that IT can promote and strengthen democracy and human rights and also fulfill political values such as growth, full employment, regional development, democracy, justice, life quality, equality, transparency, efficiency in public administration and social sustainability. These are values that cannot be neglected in e-service development in the public sector.

Whereas the above laws have to be followed strictly, there are also some regulations that are provided as guidelines and are thus optional. Most regulations relate to accessibility and usability, but there are also other regulations that are related to policies about technical matters, such as the technologies to be used for the integration of e-services into the official websites of public authorities (Hagström, 2007). Other regulations relate to the types of technologies that should be used or avoided during the development of e-services. (Vassilakis et al 2005).

Internationally, there are policy frameworks that affect public e-services: Digital Agenda is an EU policy framework for "strategy to help digital technologies, including the internet, to deliver sustainable economic growth" (EU, 2010a).. With regard to accessibility issues in e-services and public websites, the Web Content Accessibility Guidelines (WCAG) also explains how to make web content accessible to disabled people. Finally, the Swedish government provides guidelines on how to gain more efficiency and offer better service through public sector websites and e-services (Verva, 2008). As these are only guidelines, it is up to each public authority's internal policy to decide whether or not to follow them.

In Table 2 below, we summarize the values stated in the previous sections.

Table 2: Domain-related values

Domains	Related values
Citizens	Accessibility, usability, simplification, effectiveness and usefulness.
Government	Efficiency
Technology	Security, performance
Economy	Balanced budget
Laws/regulations	Equal service to citizens, full employment, regional development, democracy, justice, life quality, transparency, equality, efficiency in public administration and integration.

2.3 Prioritization

Most software projects have more potential requirements than can possibly be realized within the given time and cost constraints. Prioritization helps to identify the most valuable requirements from this set by distinguishing the critical few from the trivial many (Berander, 2005). The challenge is to select the "right" requirements so that all different key interests, technical constraints and preferences of the critical stakeholders are fulfilled, and the overall business value of the product is optimized.

Prioritization can be carried out in various ways; for example, it could consider the importance of a particular requirement, the eventual penalties of not taking some requirements into account, the costs involved, the time needed for development and implementation (related to costs), any risks that might appear, and volatility. Volatility refers to the fact that business requirements can change: legislative changes occur or requirements become clearer during the software lifecycle. Thus, in practice, prioritization takes into account multiple factors, and not just one of those mentioned above (Berander, 2005).

In this study, we merely aim to provide a basis for prioritizing measures by organizing and illustrating the requirements of different stakeholders and domains, as shown above. When domains and requirements are organized and illustrated, any decision taken is more firmly grounded in the consideration of all aspects involved.

2.4 Illustrations

An illustration is a form of visualization, where the goal is to show what is "inside data". In our case, an illustration is considered to be an external representation and abstraction of a real world phenomenon, which is related to a human internal representation of the same phenomenon. External representation can be transformed by internal representation, and vice versa (Zhang, 1997). The general aim of an illustration is to reduce cognitive load (Korakakis et al, 2009). In an educational experiment, illustrations such as diagrams, allowed students to process information using fewer working memory elements than would have been the case if they had been presented in an equivalent text-based format. Thus cognitive load was reduced (Carlsson et al 2003). Illustrations are also used for organizing text and information into a coherent structure in order to help humans interpret them (Mayer & Gallini, 1990). Figure 1 below represents the consequences of prioritization in terms of how well the requirements of the domains are fulfilled. By selecting and organizing the domains and values in a figure such as this, the participants have to relate the external with the internal representation. The illustration also represents the project participants' discussions about the degree of fulfillment regarding the values of domains.
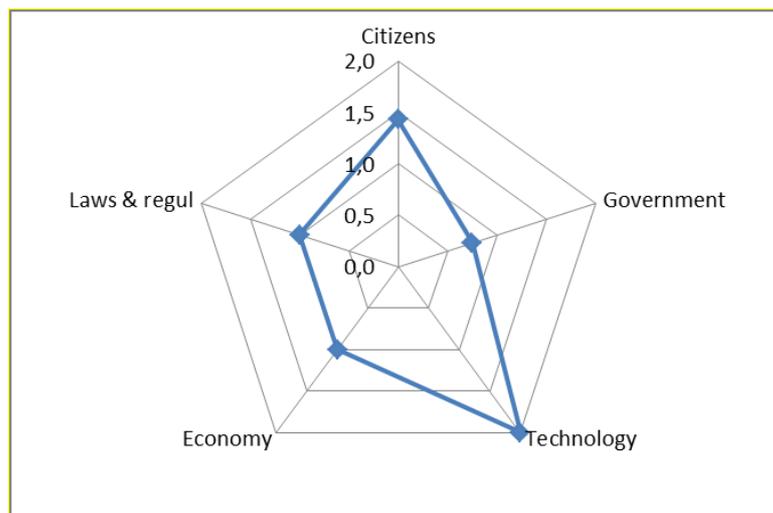

Figure 1: Illustration of the relationship between domains and values that influence e-service development

2.5 e-service development (notation example).

The above model (Figure 1) illustrates the relationship between the domains and requirement fulfillment, where the distance between the center of the graph and the label of the domain represents the degree of

value fulfillment. Zero means that no requirements related to this domain are fulfilled, and 2 means that all requirements related to the domain are fulfilled. The illustration technique is elaborated further in Section 4.

3. Research method

We chose to use a qualitative research approach, because our aim is to understand the social phenomena (Patton, 1980) associated with requirement prioritization. Requirement prioritization is deeply qualitative and basically interpretive because data collection and analysis are carried out through the interpretation of interviewees and documents (Walsham, 1995).

In our case study, data collection was carried out through interviews and document studies. The case itself is a project to deliver an e-service for premises reservation and subsidy application that is to be implemented in Örebro municipality, Sweden. We have chosen a fairly simple e-service, but since the number of requirement domains is not affected by the size of a development project, a simpler case makes it easier to see the nuances and characteristics when analyzing the requirements.

The case study was carried out as a post facto study of the development of an municipality e-service that had already been launched. We identified the municipality's goal as the introduction of the e-service and also identified the requirements needed for the fulfillment of the needs and expectations of the different stakeholders. This was achieved through document studies and interviews.

Interviews were conducted with key municipal personnel within the project such as IT project managers, the e-service system administrator and other people with responsibility for the municipality's web systems. The purpose of the interviews was to acquire detailed information about how the development of the e-service had been carried out. The conceptual framework presented above was used as a basis for the questions posed during the interviews, which covered aspects of the requirement domains.

The interviews were semi-structured and included questions about the development of the e-service, the ways in which the interviewees proceeded in order to come up with the requirements of the e-service and their actions to prioritize the different needs. Additionally, there were questions about the difficulties they experienced during the project, the way in which they managed to adjust the e-service so that it was in line with the municipality's web portal, and the regulations they followed regarding user accessibility. Finally, the interviews included questions about how user accessibility and usability was achieved. In addition to data gathered from interviews, the municipality provided vital documentation that related to the e-service, such as information about requirement specifications and goals.

All together, the documents and interviews gave us a rich picture of the e-service development process, with a focus on the way in which the various requirements were met. The results of the case study, which are described below, were analyzed by applying the tentative theoretical model of requirements domains. This allowed us to elaborate on the model. Our analysis was carried out as follows. Firstly, requirements, goals and values were identified and characterized with reference to the requirements domains. An iterative process was used to refine (1) the table relating to requirements, goals and values, (2) the tables for calculating requirement fulfillment, and (3) the graphs for illustrating requirements fulfillment for values, domains and goals. This refinement process was carried out until the graphs were considered suitable for illustrating the various relationships. These tables and graphs are presented in the next section. Figure 2 below, shows the methodological activity flow of the study.

In order to verify and refine the technique, metrics, and procedures used for illustration, we have tested our outline twice in a project management course at Örebro University in which the requirements of a real-time student/teacher feedback service were identified and prioritized. The course is a five weeks fulltime course and as assignment the students are expected to (in groups of four) design a project plan. The mandatory tasks are to:

- Describe strategy
- Describe vision, objective and scope
- Propose project organization including roles, responsibilities and time plan
- Identify stakeholders
- Carry out a feasibility study to identify stakeholders' requirements, technological requirements, legal requirements and financial requirements

- Prioritize requirements using the approach proposed in this paper
- Define project deliverables
- Design a risk plan
- Reflections on the use of the tools used in the project

After the submission of the assignment we interviewed the students groupwise about their experiences of the prioritization module. We asked straightforward questions about what problems they experienced and how they dealt with those problems. We also asked in what way, if any, the technique helped them to prioritize requirements.

Further on we studied the documentation the students have provided to see how the groups had used the technique.

The first test resulted in a refined graph technique, metrics and an additional module for specifying conditions for requirement fulfillment. Most of the refinements were also implemented in documentation for the original case (except the conditions module). The refined graph technique was also used during the second test.
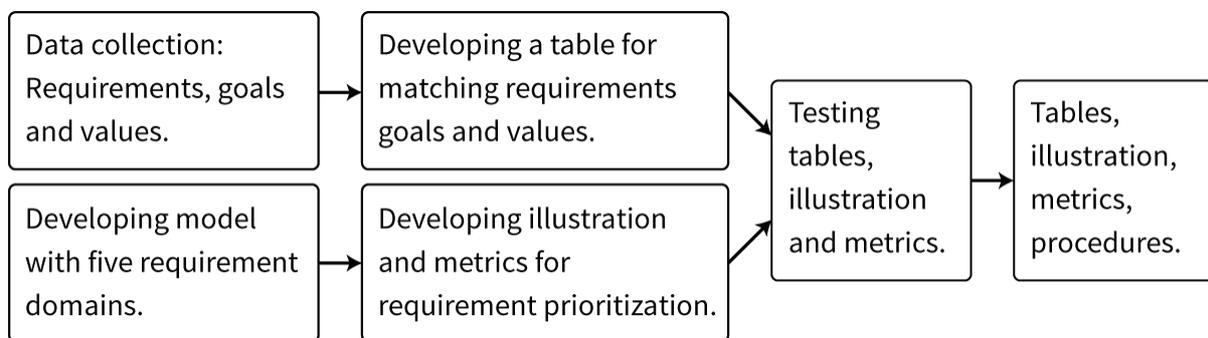

Figure 2: The process of developing a value-based illustration of requirement prioritization

4.   Result

4.1 Goals

The case study focused on an existing e-service (as described above) that targeted sports clubs in the region. Before the introduction of this e-service, the premises were booked by phone and applications for financial subsidies were sent by regular post. The purpose of the e-service was to simplify the management of the financial contribution and to make the internal organization work more efficiently. (Ottosson & Rapp, 2006; Wåhlander, 2008). The goals that the municipality wanted to achieve by offering this e-service are stated in Table 3 below.

Table 3: E-service organizational goals, as formulated in the specification (Ottosson and Rapp, 2006)

Goal	Organizational goals
o1	Higher service level for citizens and clubs through better access and more opportunities to see available slots and events.
o2	Improved facility booking system.
o3	Timesaving on handling of financial contribution and facility reservation.
o4	Fewer telephone calls, making it possible for the handling officer to undertake other responsibilities/duties.
o5	Improved quality of information through its correct storage.
o6	By connecting the reservation system to the security system of the facilities, it is possible to give access only to the person who has reserved a specific facility for a specific time slot.

Table 4: E-service effect goals as formulated in the specification (Ottosson and Rapp, 2006)

Goal	Effect goals
e1	To make it possible for associations/sports clubs to see available facilities and book these facilities through the Internet.
e2	To make it possible for individuals to pay via e-banking or invoices.
e3	To offer a function where sports clubs will be able to submit their desired training hours.
e4	To make it possible for associations/sports clubs to see their reservation history and upcoming reservations.
e5	To share access keys and codes for access to the facilities.
e6	To offer a searchable registry of associations/sports clubs, where the associations/sports clubs themselves will be able to change their stored information.
e7	To make it possible for sports clubs to apply for financial contribution online.
e8	To simplify the handling of financial contributions by offering direct update information online.
e9	To offer lists of upcoming events.

The e-service was developed and finally launched after a number of quality tests were made by the municipality and the regional sports association of Örebro County.

4.2 Matching requirements, goals and values

Many requirements were stated during the development process. Table 5 presents a sample of the accepted requirements, which have been grouped according to the five identified domains. The requirements were collected through the review of the requirements specification document. The prioritized requirements are presented without any prioritization order. In the table, goals are allocated to the requirements and values are derived from goals.

It is evident that the requirements tended to focus on the functionality of the e-service. It is worth noting that the requirements in favor of the citizens dominated in comparison with requirements that relate to the government and technical aspects. The municipality of Örebro has given serious consideration to its citizens, accepting all requirements that relate to the citizens' domain, and thus aiming to make the e-service as effective as possible. As the project leader stated: "We must design the service so that it will be used by the organizations, otherwise the work burden will increase instead of decrease".

4.3 Requirement relationships and prioritizations

According to the system administrator, the objective of the introduction of the e-service was to achieve government efficiency. Efficiency would be achieved by reducing the workload of the employees working in the organization and by administering reservations and financial subsidies. As for the citizens themselves, their aim for effectiveness would be achieved if they were provided with a service that could be used at any time of the day, in an easy way and with quicker response times. In order to achieve efficiency and effectiveness, many goals were mentioned, including: offering a higher service level to the citizens, improved booking facilities, time savings in administration, system integration, a better quality service, opportunities for citizens to pay online, the provision of functions for scheduling and applications for financial subsidies, and making more information accessible to the citizens.

Such goals are achieved by fulfilling a range of requirements stated by the citizens, who act as service users, and the municipality, which acts as the service provider. These requirements take the form of the needs and expectations that they have on the system. In some cases, there is also pressure on technology to fulfill some

of those requirements. Such requirements as online payment and system integration have been stated by citizens, businesses and civil servants for their own benefits. However, these requirements need a technological input if these goals are to be fulfilled.

Table 5: Sample of requirement prioritizations (goal references, see Table 2) (NES means "not explicitly specified").

Domain	Requirement	Goals	Values
Economy	Restriction to a limited budget	NES	Sound finances
Laws and Regulations	To abide by the following laws:Education act, public administration act, local government act, secrecy act, personal information act, principle of public access to official documents	NES	Binding law - democracy
	To follow sections 4 and 5 of the Verva (2008) guidelines regarding accessibility	NES	Accessibility regulations
Citizens (Sample)	Access to previous service cases and information about their status.	e4	Accessibility
	Access to help functions	NES	Usability
	Access to FAQ, news, glossary and external links	NES	Usability
	To be able to see the upcoming events	e9	Effectiveness
	To be able to search for sport club information	e6	Effectiveness
	To make it possible to apply for financial subsidies	e7, e8	Effectiveness
	To be able to see the reservation at each sports facility	e1	Effectiveness
Government	The system administrator will have access to an interface through which they can handle and control the e-service and its parameters	o1, o2, o5, o6	Efficiency
	To be able to update and add information on any page of the e-service	o6	Efficiency
	To file and store compiled information in the municipality's data media.	o6	Efficiency
Technology	To be able to validate automatically all data entered by the user.	o3, o4	Integrity
	To be able to handle multiple users and any risk of "time schedule collisions"	o1	Integrity

When a number of requirements need to be fulfilled to achieve pre-stated economy goals, and when restricted by a limited budget, requirement prioritization is more imperative than ever. Apart from economic issues, there are also legislative issues that affect the development of e-services. Laws and regulations put forward requirements during the development of e-services that often have to be accepted; although in some cases, guidelines do not have to be followed strictly.

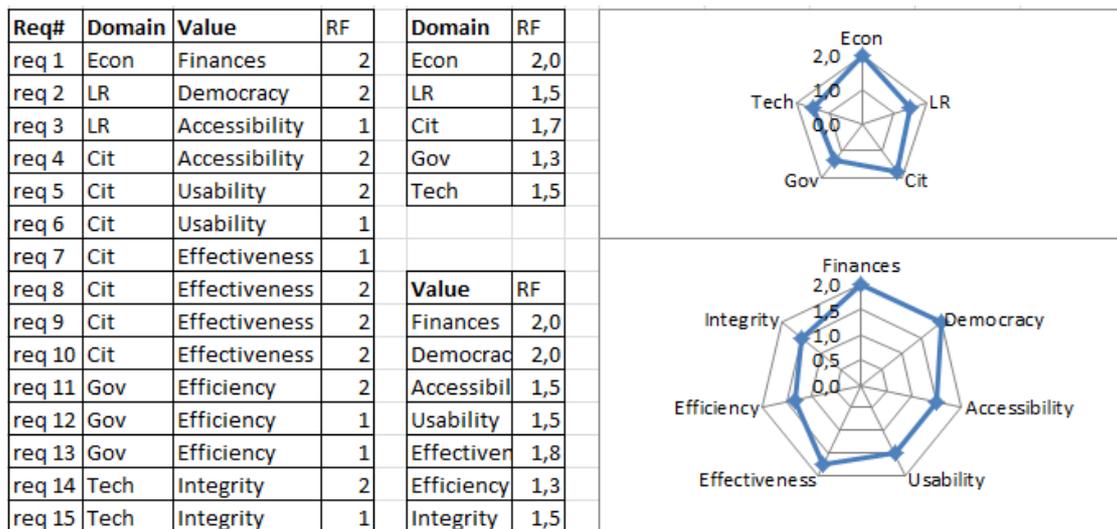## 4.4 Calculation and illustration of requirement prioritization

At the beginning of the project, one of the requirements was to integrate the e-service with other internal systems and also, if needed, to connect with external systems such as banks. The developer of the system was not able to accomplish this requirement because the system was already developed and such adjustments

would not be easy from a technical point of view. Nonetheless, the developer made an offer to develop a new e-service from scratch, which would include all requirements. However, the municipality did not have sufficient budget at its disposal; thus, it decided to continue with the old system and reject the integration requirement.

Regarding the requirements that relate to the laws and regulations domain, it is interesting to note that the municipality chose only to follow sections 4 and 5 of the Verva (2008) guidelines. Even though these guidelines are optional, they should have been followed more strictly. The municipality's accessibility and usability expert evaluated the e-service according to the guidelines relating to accessibility and usability, and found the e-service to be defective. As reported by the expert, the e-service included a number of scripts and tables that are forbidden to be used in accordance with the Verva (2008) guidelines, as they counteract user accessibility.

In order to assess the differences in requirement prioritization we added a calculation phase where stakeholders in the project group can assign a value to each requirement where 0=not fulfilled at all, 1=partly fulfilled and 2=fulfilled. If all stakeholders assign 0 to a certain requirement the total value assigned is 0 and vice versa if all stakeholders assign 2. If there are different opinions among the stakeholders the assigned total value is 1. The requirement can also be partly fulfilled for other reasons; for example, where some of the accessibility guidelines were followed but others were not. For the original case we have reconstructed assigned values. For the test case actual values were assigned.

In Figure 3 the assigned values are in the left matrix. In the two middle matrixes the average values are calculated for domains and values. To the right: the graphs visualizing the average degree of fulfillment for domains and values.

Req#	Domain	Value	RF
req 1	Econ	Finances	2
req 2	LR	Democracy	2
req 3	LR	Accessibility	1
req 4	Cit	Accessibility	2
req 5	Cit	Usability	2
req 6	Cit	Usability	1
req 7	Cit	Effectiveness	1
req 8	Cit	Effectiveness	2
req 9	Cit	Effectiveness	2
req 10	Cit	Effectiveness	2
req 11	Gov	Efficiency	2
req 12	Gov	Efficiency	1
req 13	Gov	Efficiency	1
req 14	Tech	Integrity	2
req 15	Tech	Integrity	1

Domain	RF
Econ	2,0
LR	1,5
Cit	1,7
Gov	1,3
Tech	1,5

Value	RF
Finances	2,0
Democrac	2,0
Accessibil	1,5
Usability	1,5
Effectiven	1,8
Efficiency	1,3
Integrity	1,5

Figure 3: Assigned values for requirement fulfillment, calculated degree of fulfillment and graphs visualizing fulfillment (RF = Requirement Fulfillment).

The matrixes and graphs are developed in MS-Ecel®, which make them interactive and open to simulation.

All useful functionality requirements that were accepted during the prioritization procedure resulted in a higher RF (requirement fulfillment) value. If accessibility and usability issues had been given more serious consideration, the value would have been even higher.

The economic aspects that restricted the integration requirements from being accepted decreased the technology RF. The fewer technological advantages the system has, the lower the RF value becomes for the technological values. The lower technology RF also influenced the government RF: less integration implies that the government is charged with more manual work, which results in increased work load, increased risk of error, increased risk of redundancy and increased risk of provision of the wrong information to the citizens. Thus, as a result, lack of integration might also affect the citizen RF as there might be a risk of accessing the wrong information and a risk of increased service time. However, since the usefulness of the e-service is higher

than the usefulness of the traditional version of the service,the citizens may well still prefer the e-service (as it is still better than the traditional service on offer), regardless of the above integration disadvantages.

Despite the restricted budget and the requirements prioritization dilemma, it is essential to note that the municipality took its citizens and their needs seriously, regarding them being very important and valuable for the acceptance of the e-service. This also resulted in the success of the e-service.

As for this paper, the actual case is less interesting than the discussions about values; namely, whether or not they are fulfilled, and whether they can be represented firstly by relating requirements to goals and values, and secondly by manipulating the graph, with respect to the fulfillment of goals. This way, the evaluation of goal-fulfillment is mediated via the model. And it is, of course, also possible to generate a goal fulfillment graph.

Furthermore, by using this model, it is easier to identify the most important requirements. If there is an acceptance of a requirement that affects several goals, it results not only in a high RF value, but also contributes to higher RF values for other domains and values. A requirement that affects more than one RF value is considered an important requirement that has to be prioritized.

The main benefit of the model is the reduction of the cognitive load while considering the consequences of prioritizations. The original list of requirements, goals and values was much more extensive than the sample in tables 3 and 4. The model makes it easier to keep all variables in mind, while analyzing consequences.

4.5 The test

When we studied the outcomes of the test prioritization at Örebro University, we found that some groups had used the tables and graphs in a quite meaningful way, defining stakeholders and values and assigning values of requirement fulfilment that made sense. Other groups submitted a shallow analysis where it was hard to say from the documentation in what way it actually helped them to prioritize.

The interviews showed that the discussions about what values the requirements fulfilled, made the project team more aware of the overall aim with the specific requirements as well as the projects as a whole. Negative was that it was difficult to assign goals and values. The reason that goals were difficult to assign was that the project documentation was poor. In the project model used, it was mandatory to define goals (just as in the Örebro municipality case). When the goals were not defined, the prioritization made the team aware of the missing goals. The reason that the values were hard to assign was that the requirements were not well enough specified. All interviewed teams had to iterate to get the requirements specified in such a way that it was clear what values were fulfilled when the requirement was fulfilled.

5. Discussion and Conclusions

In this section, we answer and discuss the research question: How can multiple stakeholder requirements be illustrated from a value-based perspective in order to be prioritizable?

5.1 Conclusion

The answer to the research question is presented in the form of two contributions.
- The e-service domain model. The model presents the five domains of requirement prioritization: government, citizens, technology, economy, and laws & regulations. The origins of the domains are presented in Table 1.
- The requirement fulfillment analysis tool (RFA). The tool consists of two main parts. Part A is the requirement-goal-value matrix (RGV), see Table 5. The matrix supports the activity of relating requirements, goals and ultimately values for each of the five domains. Part B is the calculation and illustration module (CIM) see figure 3. The RFA relates to the domains of requirement prioritization: government, citizens, technology, economy, and laws and regulations via their inherent values.

The module will reduce cognitive load and support developers by helping them to focus on value fulfillment in e-service development and support them in formulating requirements. It will also provide input to public policy makers should they wish to aim for target values in the design of e-services.

5.2 Discussion

To break down complexity is to make it intellectually comprehensible. This is the very foundation for systems development and its methods. Börje Langefors, a pioneer in information systems analysed complexity in information systems already in the 60's (Langefors, 1966). Langefors (2001) describes this: "Complexity is the property of being a thing that can only be perceived piecewise. Thus, to understand a complex thing as a whole, we have to study it as a system; that is we have to study the system formed from the perceptible pieces through analysis of the interrelations among those pieces". An e-service like the one described in the paper is an information system and information systems are abstract and complex, accordingly in need of complexity break down.

Developers have to deal specifically with and prioritize all identified requirements. In the process from requirement to graph developers have to match and classify requirements, goals and values. The process supports the elaboration of the specifications of the requirements. This way it is not possible for a project team to postpone or procrastinate any requirement just because it is cumbersome to take a decision about its priority if the fulfilment is difficult to assess. It will still be visible and open for discussion. If there are different views on whether a requirement is fulfilled, partially, completely or not at all, it is of course possible to produce more than one graph illustrating different scenarios and present them to the project management. In case of a discussion the arguments behind the prioritization must be made explicit and thereby contribute to divide the e-service into pieces, in the spirit of Börje Langefors. In the case we studied at Örebro municipality, the prioritization was implicit. This does not mean that the final design was wrong, but it means that decisions were taken without explicit and documented support. As for the illustration aspect, the literature study (Zhang, 1997; Korakakis et al, 2009) supports the idea of alternative representations in the form of illustration as something that makes people understand a certain phenomenon. The graph is an illustration that serves to reduce the cognitive load by presenting only those pieces of the complex system relevant for prioritization.

In order to develop an e-service and fulfill the values related to the domains, governments have to consider which requirements they should prioritize and how their choices affect all stakeholders. By using the model presented in this paper, governments can obtain a multiple perspective view on the domain and illustrate visually how the acceptance or rejection of each requirement affects the e-service. Additionally, the model supports governments in identifying the most important requirements, and supports the prioritization of them, helping to develop an e-service that is as close to the required values as possible.

The model also supports the formulation of assessable requirements. Berander (2005) mentioned such important requirements as importance, costs, development time, risks and volatility, all of which need to be formulated in such a way that they are assessable with regards to fulfillment. For example, if risks are included as a requirement, the project group will have to perform a risk analysis in order to assess that requirement.

It is also important to note that the illustration technique was only tested in three cases in this study. During the second test, we found it necessary to specify conditions for unfulfilled requirements (not presented in this paper). Thus, it will certainly be necessary to improve and refine the model. The proposed model cannot replace the subjective element of assessing requirement fulfillment; however, it can be reduced by the formulation of requirements in a strict way. One important effect of the model is an awareness of how requirements are formulated. The main advantage is that the model fuels discussions about values, domains and goals when discussing requirements.

In the public sector, the context of e-services is complicated. It is also clear that requirement prioritization cannot be carried out according to only one prioritization aspect. In order to get as high value fulfillment as possible, multiple prioritization aspects have to be taken into consideration. With the use of the model, which simulates various options, governments can increase their awareness of which goals and values are fulfilled when various requirements are met. It is particularly important to highlight the citizen domain and to consider carefully the effects of prioritizing efficiency on the effectiveness values of citizens. The success of any e-service is well connected to citizens as they are its users. If citizens are not satisfied and return to an older, more traditional version of the service, the result will be a failed e-government project that boasts neither efficiency nor effectiveness, and wasted economic resources.

The aim of the model is just to illustrate how requirements are fulfilled. Decisions are taken by the assigner and project management. The technique is meant to stimulate discussion about prioritization and any

circumstance related to that. The arguments for how requirements, domains, goals and values belong together are claimed by the members of the project team and not integrated in the model.

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