Process Design Theory for Digital Information Services

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Abstract Information services transfer information goods from a creator to a user. Information services have three design aspects, i. e. content, value, and revenue, and their design has an evolutionary nature, i. e. that information gained in the service's usage stages is part of their (re)design efforts. The literature abounds of fragmented insights for information services design. This article gives a literature review of methods and techniques that are useful in the representation and analysis of the above-mentioned aspects for each evolving step of information service design. The article also describes several scenarios for information service design projects. These insights have considerable consequences for information services design practices and a list of topics for new design theory research is given.

Keywords: Information services; Information service development; Networks of expertise

1 Introduction

Numerous information services – also named information brokers, infomediaries or information intermediaries – have been established to intermediate between producers and consumers of information [30]. We identify four classes of information services:

1. Corporate web-sites. These websites help to communicate certain messages to an audience, while keeping full control over content and property rights by the website owner. Such websites may be customer support websites [18] or they may be content-business (like publishers) of their own [31].
2. Content aggregators serve interest groups to find and compose their own information goods on their specific area. An example is the www.hornplayer.net,

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which has only little information about itself, but has many internetlinks for French horn enthusiasts. Such website also may be integrated in a so-called webring (see www.crickrock.com), by which it is easy to switch to thematically related websites.

3. Community builders provide ways of community building by meta-data processing. An example here is www.YouTube.com which allows members of the community to share meta-data on music and so help develop communities of people with common interests.
4. Data integrators aim at the consolidation of data from different sources by a common data standard or ontology. For this purpose the semantic web community tries to realize solutions [2] and W3.org.

Information services, like any service, need a viable business model, processes and infrastructures for 1) acquiring, aggregating, displaying, processing, creating and delivering *content* according to client needs, 2) delivering additional *use features* to increase opportunities of data use and contribute to the value experience for information service, and 3) realizing a stream of *revenues* for the information good supplier and the information service owners [3, 22, 25, 317). Therefore, we identify three design aspects, i. e., content, value and revenue.

Information systems design processes aim at detecting information system needs and translating these needs to a new working system via a set of design steps, so-called design layers [23]. The information systems literature identifies here at least requirements identification and analysis, and the (detailed) design of solutions. More modern views on information systems development also include the development of a prototype and its evaluation as part of information system design activities, especially in cases of high ambiguity and complexity of understanding the requirements [1, 13, 15]. Also problem analysis, as a step before the actual requirements steps is regarded as a key activity. The e-business literature (i. e. information services are a class of e-business) has refined requirements analysis in two steps, i. e., business modeling (who wants to deliver what to whom under what conditions) and process modeling (what set of activities and in what sequence do actors exchange values and information) [9, 26]. Given the three design aspects and the mentioned design steps, Fig. 1 summarizes the design space

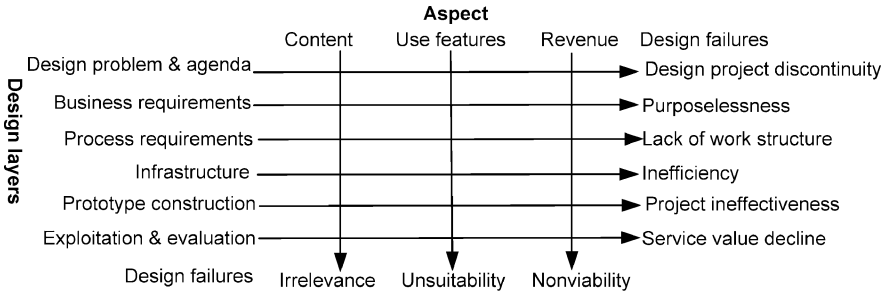

Fig. 1 Design space and performance criteria for information services

for information services and we anticipate on possible consequences of failing in each design activity.

2 The Research Problem

As many information services have cost coverage problems, have poor levels of (content) maintenance, or ceased to exist soon after an initial success, it is apparent that it is not self-explanatory how an information service should cope with these challenges [19, 20, 22, 30]. The large amount of design options and the lack of theory for information services design make information services design challenging. Consequently, this paper aims to fill in part of this theoretical gap by contributing to a design theory, i. e., "… a prescriptive theory based on theoretical underpinnings which says how a design process can be carried out in a way which is both effective and feasible" [28, 37]. Such design theories consist of "… an integrated prescription consisting of a particular class of user requirements, a set of system solutions (…), and a set of effective development practices" [15, 180].

Markus et al. [15] and Walls et al. [28] distinguish between product-oriented and process-oriented design theories. Product-oriented design theories focus on features of the end product; i. e. provides meta-requirements and meta-designs that help to solve classes of problems and create classes of artifacts [28, 42]. Requirements consist of specified goals or solutions for a problem. For an information service this implies the specification of the content, use features, and revenue mechanisms that are needed to make the service effective as intermediary between content suppliers, information goods consumers, supportive service providers, and sponsors. A meta-design for information services describes the set of components (i. e. databases, organizational structures, and information technologies) and relations between them, according to which (sub)systems for information services can be designed. Product-oriented design theories require kernel theories that explain which requirements are most suitable for a certain situation or certain actors and that explain what components may be most useful, how they can be related in a system, and why they meet the requirements. As part of design theories, product-oriented design propositions empirically link meta-requirements to meta-designs. If the design propositions are incorrect, any design built according to this design theory will show mismatches with agreed requirements.

A process-oriented design theory prescribes kernel theories, design methods and research propositions with regard to the process of design. Following information systems design literature [10, 23, 29] information systems design requires a few steps from abstract understanding to concrete solution. These steps are named design layers, and range form abstract notions of a system (the mission and business model) to its realization in an infrastructure for organizational processes consisting of databases, organizational support, and technical means [17]. The business process model is an operationalization of a business model to concrete

service actions. Knowing these actions enables a designer to select appropriate infrastructure means to facilitate these processes.

For accomplishing a design process, designers may use specific *methods and techniques* for representing and analyzing their impressions related to each design layer. They also need *design scenarios*, i. e., prescriptions of how their design work has to evolve from start to finish, where different sequences among the layers and aspects may be taken, in one sequence or through iterations.

This article aims at contributing to a design theory on basis of a literature review. Fragments of a design theory for information services are given by authors from different disciplines (especially economics, knowledge management, and information systems). Because of space limitations here, we will only present elements for the design *process* theory, and because this is a literature study, we will not discuss process design propositions, which need empirical evidence. This literature review will answer two questions 1) What methods and techniques are useful for each layer in an information service design process, and 2) What design scenarios can be prescribed for information service design processes?

3 Process-Oriented Kernel Theories

Section 2 discussed two dimensions of design processes, i. e., methods and techniques to be used in each layer, and the scenarios that place design activities in a 'proper' work order.

The design layers can be executed by using different methods and techniques for each layer (e. g. [23]). We identify the following layers: problem and agenda setting, business and process requirements identification and analysis, design of the infrastructure, construction of the prototype, and exploitation and evaluation. Exploitation and evaluation, although often falling outside the scope of the design process, are regarded as an essential element in information services design, because it is extremely difficult to know in advance what the actual needs of the information market are. The client group is geographically often dispersed (sometimes all over the globe), and consequently a market analysis in advance may be too superficial [1]. The development of a system for monitoring client needs is therefore a critical design layer [18]. Consequently, we split the exploitation design (e. g., selecting key performance indicators and ways of analyzing the performance data) from the actual evaluation and feedback.

We believe that besides of process-oriented methods & techniques and design scenarios, a designer needs information from several design product-oriented sources of the body of knowledge. This results in a sequence of design layers with theoretical needs as given in Fig. 2.

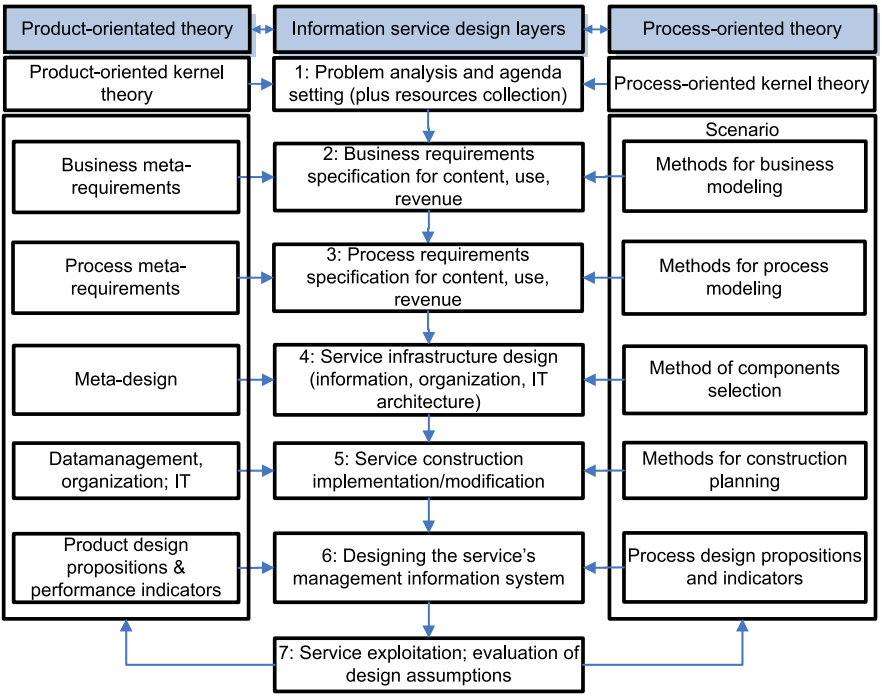

Fig. 2 Steps in an information service design project with design theoretical needs

4 Methods and Techniques for Information Service Design

This section mentions methods and techniques for each layer of Fig. 2.

Layer 1: Problem analysis and agenda setting. A well known lesson of all IS development projects is that before it starts it must be clear that the project has sufficient support from key stakeholders. This implies that a *stakeholder* identification is required and that each stakeholders needs must be well analyzed, i. e., it should become clear that a sufficient large collection of stakeholders have similar positive opinions about the project so that they will supply the resources needed for the project. A *causal analysis* of what would happen if the problems are not solved by an information service is an important tool for communicating about the problem with stakeholders [8]. Such a causal model also helps to scope the project by stating what causes will be part of the project; i. e., in most cases not all causes can be solved or treated by an information service. The stakeholders can have an important say in the priorities of what will be coped with and what the actual goal variable must be.

Layer 2: Business and process requirements specification. Because information services are intermediaries between stakeholders (i. e., suppliers, users, sponsors,

and support providers), the existence of an information service depends on its ability to enable value exchanges between these stakeholders, which result in sufficient satisfaction for all to be members of the business network. Consequently, the kernel theory for information services at the business level is value nets [9, 24]. The *business requirements* can be represented in a business model, which is a (explicit or tacit) business proposal for all actors involved in an information service. Some actors deliver or collect content, user features, and revenues, and some of these are required and others are optional for a successful service. Thus, a viable information service thus must have a business model that specifies what stakeholders have to deliver what in return for what, and this business model must realize sufficient means to (at least) cover the costs of the information service [6]. The E3Value method can be used to test if the business requirements are met for all relevant stakeholders [9]. Sponsors are often important for realizing information services [30] but attempts of services to raise advertising incomes may result in clutter costs, which are fictive prices for the consumers [5].

Layer 3: Process requirements specification. Regarding the *process requirements*, an information service delivers content, facilitates content use, and collects revenues. These processes are interlinking mechanisms between the network actors. Three core processes interlink the activities of the actors:

1. Ordering and delivering, which can be content logistic or content transformation. Content logistic activities consist of acquiring, storing, and delivering of content. Content transformation improves content value on top of what the supplier delivered to the service by modifying the information good's representation level (reducing overload) and its conceptualization (reducing cognitive distance and misunderstanding). The related process models are named content service models. These service models and can be presented by content-user interactions.
2. An information service may deliver use content facilitation to its customers via delivering content interaction means or meta-information (e. g. quality indicators) about the content [27]. To know what interactions have to be supported, use support models can be created by use case and tasks descriptions.
3. Transaction processing compensates suppliers and external use facilitators and collects funds to cover the service's costs by applying rules concerning quality demands and performance [25]. The related process models we name transaction processing models. A good transaction processing model also works explicitly with the revenue rules stated in the business model, i. e. that it accesses client bank accounts when there are contracts that say that this is allowed. This must of course be defined very precisely in terms of prices per content and use units, use measuring mechanisms, and billing procedures.

Layer 4: Service infrastructure design. For the infrastructure layer, knowing the process activities will facilitate the determination of the informational, human, and

information technical means. For the design aspect (content, value and revenue) different models are needed. For content we have to describe the data precisely in data structures and entity relation diagrams. For content interactions, we need to specify interfaces, which intersect content and use. For the use aspect, we need activity diagrams as further elaborations of use cases, which next can be used to denote relevant IT applications and their relation in an architecture model (e. g. [12]), organizational tasks and their relations in an organization chart. For revenue we need to formalize the payout rules, and we need data collection mechanisms to find out if certain payout rules should be activated.

Layer 5: Construction of prototype. In the construction stage, the content aspect is covered by a database model and an actual set of data. The use aspect consists of use and user support applications, acquisition and filing software. This is an implementation of the previously mentioned systems architecture. The organizational chart is further realized by hiring people and task allocations. Finally the revenue aspect is realized by payment systems and by logging/measuring systems.

Layer 6: Designing the service's management information systems. Such a design activity involves the definition of performance indicators, the specification of methods and tools for the analysis of performance data, and the specification of ways how the resulting *behavioral* insights can be used for feedback. With respect to indicators, the use of log data may be essential. Any kind of market research, for instance, gives a too superficial and expensive feedback to the designers [1]. To be effective here, a log information collection and organization mechanism is needed, named the log information architecture [1]. Transaction log analysis mostly requires substantial data cleaning before it can be actually done [11]. The current literature on informative web-performance has delivered a few interesting performance measures as well. For instance Palmer [18] has developed and validated the following measures: Download delay, organization/navigation, information/content, interactivity, and responsiveness. Yang et al. [31] identify and validate five measures, i. e. usability, usefulness of content, adequacy of information, accessibility, and interaction.

Layer 7: Exploitation and evaluation. The exploitation and evaluation layer aims at insights that might help improve the service by:

1. Behavioral analysis through (log) data collection and analysis of actual use and performance of the service.
2. A logical reflection about how the design process actually has evolved and if everything which has been created in each layer is consistent with other steps. Reviewing here of the kernel theories, requirements, infrastructure design, and actual realization in the prototype can result in important insights for design theorizing.

The layers and their methods and techniques are summarized in Fig. 3.

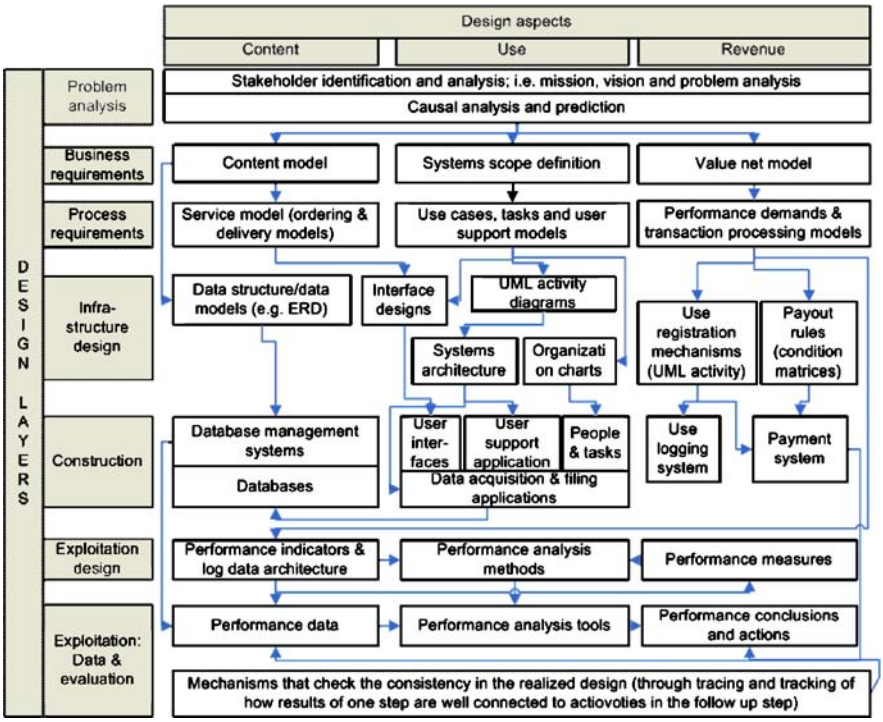

Fig. 3 Grouping of relevant methods and techniques for information service design

5 Design Scenarios

The information systems discipline has addressed design strategies intensively, particularly for the design *layers* [23]. Several authors have proposed 1) top down business-led approaches, 2) bottom up approaches, or 3) business and information process based approaches (see e. g. [7]). These approaches also have been incorporated in information systems development methodologies. For instance the top down approach has been advocated by the BSP methodology. The *aspects* of design have been emphasized by [23], and implemented in modern views on the design of information systems [21]. Probably most of the current information services design efforts have started from the content aspect, as a way of improving communications with their audience. This is manifest from attempts of, e. g., newspapers to regard their internet versions as a simple shoveling of their paper version's content [19]. It has become clear to internet newspaper designers that the Internet offers them additional opportunities to serve their readers, and new ways of distinguishing themselves from others. This may result in a more use-features focused scenario. A key point in a revenues driven scenario is the opportunities that the internet version may give for extra incomes from advertising or subscrip-

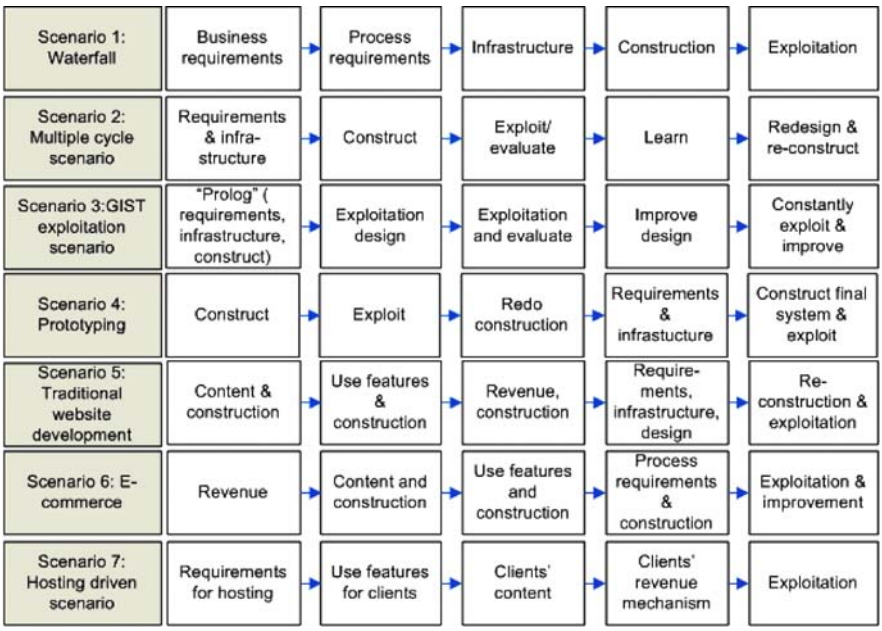

Fig. 4 Seven design scenarios for information services

tions. Likely, the sequence of design actions taken in a design scenario is dependent on which stakeholder is leading in the design project. In information services design, therefore, a project may be mainly driven from the content-side (supplier, or customer is leading), the revenue side (the information services management is leading), or the use value side (driven by the interests of the subcontractor, the sponsor, or the customer).

Because we have three design aspects and seven design layers, theoretically a huge number of scenarios may be possible, when we assume that each intersection of aspects and layers need to be taken at least once in a design scenario. Each aspect or layer also may be executed in parallel sets, increasing the possible number of scenarios even more. Because of space limitations but also because the presented scenarios are closest to current theory, we only describe seven scenarios here: four scenarios that differ on the sequence of layers, with two extremes i. e. the waterfall approach and prototyping and two related scenarios described in the literature [1, 13], and three scenarios that take respectively content, use, and revenue as it initiation object of analysis. See Fig. 4 for an overview.

1. The waterfall scenario. Business models in fact are never complete, so such a scenario in its purest sense is difficult to find. Nevertheless, there are examples where an information service provider wants to fully consider what it wants to deliver, to whom, what the clients want, and who pays before going to any further process and infrastructure. An example is the publishing industry, which actually responded rather late on the opportunities that the Internet gave them. The reasons for these hesitations have not been the technology, but rather the business model.

They had to answer the question of how they could earn money if the entrance barrier on the Internet is so low and how they can safe-guard proper management of the intellectual property so that quality and pay-outs can be guaranteed [22].

2. Multiple cycles scenario [13]. Although Lindgren et al.'s study is not explicitly about information services, but about competence management systems, their work is very relevant here. They mention that they started to develop a competence management system with a number of Swedish companies, but that the exact requirements for such a system were not clear, and some of the aimed at requirements were organizationally and socially not acceptable. Consequently the first prototype they made was aiming too much at managerial control over personnel, resulting in non cooperative behavior of the employees, which resulted in the delivery of incorrect data or no data at all to the competence management system. These were hard lessons, and only two of the initially six companies decided to give it a second try using better description of the content needed by distinguishing between three types of competence, and by assigning more ownership of the system to the people it concerns (i.e, the employees). This system became a success. This may be a feasible scenario when the actual design errors can be detected, although it may be quite risky, because the errors also may block any motivation of trying again.

3. GIST [1] describes the GIST scenario as gather, infer, segment, and track. Their approach is based on the assumption that informative website often have very diverse and heterogeneous clients. In such situations one can best follow a marketing-like approach, which focuses on the ability to learn from client behaviour. Therefore the requirements and infrastructure design layers are kept very short, and a working service is delivered as soon as possible. Key thing is to develop performance indicators, collect data (client behaviour logs) and analyze these to find new business opportunities (e. g. new market segments which can be served much better with rather limited resources). GIST therefore mainly focuses on what we call "exploitation". The authors demonstrate by a case study in the financial service sector, that such a strategy can be commercially extremely rewarding. The authors also plead for optimizing information services with regard to abilities to permanently learn from client behaviour, and therefore exploitation design is key to information services success.

4. Prototyping. The prototyping scenario is similar to the multiple cycles scenario and GIST in the sense that:

1. It assumes that not all requirements can be know in advance, which implies that at least two cycles are needed to find the real requirements.
2. It assumes that the best way of finding requirements is the construction of a prototype.
3. Prototypes have to be evaluated by use(r) data of any kind (maybe surveys, or log data).
4. After several cycles, the insights gained to the systems requirements may be only marginal, and consequently the system design can be handed over to the system builders.

But, once the system is build it can be put in production and only marginal maintenance may be needed. Consequently, prototyping is mainly a requirements analysis approach. This results in less flexibility than the GIST method. For some information services with a very stable structure and context (e. g. corporate websites and product information services) this may be the best approach. For information services with high diversity in content, use, and clients (e. g. websites with frequently developing services like in the music and financial service industry), prototyping is probably not effective and GIST is more useful.

5. *Traditional website development.* This strategy focuses on delivering more value for customers from improved interactions with an existing content-base. Because the business strategy is never ended and difficult to specify, this design scenario starts with what is possible to realize at the business, process and infrastructure levels. This is typical for the exploratory way of the development of electronic newspapers and information services, which have huge and interesting collections of content and have to think about all kinds of opportunities to improve their exploitation. Interesting example here is LexisNexis (www.lexisnexis.com) which offers all kind of customized data packages and related use features for private or business purposes.

6. E-commerce. Currently, paying content per unit of delivery is often not considered, because this may result in rather high administrative costs. Micropayment systems (MPS) though have been developed to reduce these costs, as MPSs enable the financial handling of many small transactions (e. g. less than 5$ per unit) by collecting all the transactions and processing these transactions in a certain period at once. This results in rather low transaction costs per unit traded. Some companies that trade MPSs are also in the business of internet services and content management systems, which indicates that they even may try to aggregate content for creating business for the MPSs.

7. Hosting. This strategy focuses on owners of internet and cablenet infrastructure which organize use features (software, internet access, security etc) for their clients, so that the clients can build their own websites. Hosting is mostly done using a content-blind approach [14], although in the context of mobile internet the internet providers do currently organize content and define the requirements, use options, delivery processes and business model. A trend to open mobile internet recently started (see http://www.3g.co.uk/PR/July2005/1694.htm). Software owners can specialize on solving information search and use problems on the Internet, and also enable full hosting of their clients' websites (for instance Google and yahoo). The competition between these providers is clearly one of who has the best use features (and the winner will take most of the advertising incomes).

6 Conclusions and Further Research

We stated the following research questions: 1) What design process can be prescribed for information service design projects, and 2) What methods and tech-

niques are useful for each step in an information service design process? The answers to these questions have been given in Sect. 4 and 5 and Fig. 3 and 4 summarize the findings. With respect to question one, it is also important to note that information services design mostly requires incorporating construction (like in prototyping) and even involves exploitation activities. This implies that design validation and improvement of information services is not only a logical activity (through tracing of decisions made and checking consistencies in design) but also an empirical research activity. With respect to question two, we want to note that a huge number of design scenarios can be identified along the aspect and layers of the information service design space. Very likely though, several of the possible scenarios will not be suitable, but we leave the discussion about their suitability to further research.

This paper has some other limitations, which should be addressed by future research:

1. We have not discussed the product-oriented design issues (i. e. the meta-requirements and meta-designs of information services), it is unlikely that these would not have any effect on our outcomes, because each method or technique is just a means to reach some goals, and in information systems design not the methods should be the goals themselves, but the concrete substantive designs should be the goals.
2. We have also not discussed design propositions. The specification of concrete design propositions is essential to validate this research. Several propositions are possible with regard to methods and techniques and project scenarios. The propositions may be stated in terms of the effectiveness and efficiency of the methods and techniques chosen for each cell in Fig. 3. More fundamentally, the design space framework (Fig. 1) could be subject for (empirical) research. For instance one may question the classification of aspects and design layers and argue for alternative structures or more or less subdivisions. These choices have large consequences for views on design projects' execution and management.
3. With respect to the design scenarios, we only presented seven scenarios. Many more scenarios may be possible, and empirical research may be valuable in finding a better classification of scenarios and for discovering what scenarios may be most useful or applicable in certain information markets or information exchange networks.

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