WHAT IS THE RIGHT SERVICE? A MULTI-CRITERIA DECISION MODEL BASED ON 'STEP'

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Abstract: Together with the diffusion of the Internet both private and legal persons have designed a wide variety of information intensive services. At the same time, concepts and methods have been developed to facilitate the description, discovery, composition, and consumption of these services. However, the selection of the right service still represents a major problem for consumers, since policy-, reputation- or trust-based selection techniques often do not lead to the desired results. In this paper a multi-dimensional service selection model - including social, technological, economic, and political considerations - is presented that can help service consumers in this sketchy and complex task.

1 INTRODUCTION

Providers of information intensive services still face many problems in regard to the collaboration with globally distributed business partners. High demands on service accessibility and reliability, lack of widely accepted standards for service definition and orchestration, complicated pricing models as well as language problems are some of the reasons why the global provisioning of services has not yet become commonplace (Schroth, 2007).

Different connotations and meanings for the term 'service' exist in distinct disciplines such as information systems, business administration or computer science (Baida, Gordijn, and Omelayenko, 2004). In this paper we use the term service as "the application of specialized competences (knowledge and skills) through deeds, processes, and performances for the benefit of another entity or the entity itself" (Vargo and Lusch, 2004). By that definition a wide range of possible manifestations of services are opened, for example: tangible (products) and intangible services; automated, IT-reliant and non-automated services; customized, semi-customized and non-customized services; personal and impersonal services; repetitive and non-repetitive services; and services with varying degrees of self-service responsibilities (Alter, 2008).

With respect to information intensive services the Organization for the Advancement of Structured Information Standards has defined the Unified Service Description Language (USDL) in order to help service providers describe technical and business-related properties. In contrast to the former Web Service Description Language (WSDL), which focused on a pure technical characterization of the service concept, USDL includes information about the participants, interaction between these parties, a delineation of the service level and pricing and legal as well as functional aspects. These service descriptions can then be published in public or closed community repositories, service registries, or the provider's website in order to enable consumers to discover the offered services. According to Alter (2007) there is still the need for negotiated commitments, under which the service may be delivered many times. Flexibility, quality, and thoroughness of negotiated mutual commitments is thus a key determinant of whether long term service agreements will fully meet the consumers' needs (Cullen et al., 2005).

Consumers on their part, may they be individuals, groups or organizations, thus have to define (or at least have an idea of) what their exact business needs are. This may be driven from an inside-out perspective, e.g. derived from the

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corporate strategy, or from an outside-in perspective, e.g. induced by market trends. Once the requirements are clear, a consumer has to find services which may satisfy the identified needs. In doing so, a consumer may refer to search engines and software agents, rely on professional service brokers or word of mouth. However, the key challenge for consumers is not discovery, but selection. In accordance with Sreenath and Singh (2004) the key issue is that in most instances, service descriptions are given from the perspective of providers and do not necessarily include information relevant for the consumers. The selection of a particular service may not only be motivated by the best technical features or the lowest price, but by multiple criteria such as cultural fit or ethical and legal aspects (Krishna et al., 2004). Nevertheless, matchmaking mechanisms or algorithms for selecting information intensive services (e.g. Maximilien and Singh, 2004; Yu et al, 2007) still mainly rely on technology-oriented criteria.

Due to the increase of the number of available services offered on vendor websites, service registries, or electronic marketplaces, we see a necessity of having an informed approach for service selection that also takes business, cultural, and legal considerations into account. It is the aim of this paper to address the problem of service selection in a holistic manner by defining a multi-dimensional decision model. To this end, the paper is organized as follows: after this introduction, we first provide an examination of the related work on general service selection techniques and discuss their suitability with respect to information intensive services. In the section that follows, we describe potential criteria for service selection for each of the mentioned dimensions. Subsequently, the decision-making procedure is presented and illustrated by means of a comprehensive case study. Finally, we present some concluding remarks and offer some suggestions for future research.

2 RELATED WORK

There is a wide range of research conducted in the field of service discovery and selection. Comparing and categorizing these works is not an easy job as one service is not like another and the measurement, especially of the quality of a service, is not trivial either.

In order to establish a semblance of order in our literature review, we focused on service selection and on information intensive services. First, we defined ‘service discovery’ as the process of finding and retrieving services that fulfill the wanted functionality, whereas ‘service selection’ refers to the process of choosing one service among several with adequate functionality on the basis of different criteria. Over the further course of this paper we focus on the latter. Second, services vary in their complexity. Kugyt (2005) places services on a spectrum between ‘professional services’ on the one extreme and ‘mass services’ on the other. Professional services are characterized by a formal relationship, the importance of the service for the overall welfare of the customer, a high customization, the importance of a critical judgment, and a centering on people. Mass services are on the contrary: in other words, there is no formal relationship, no importance of the service for the overall welfare of the customer, no customization, no importance of a critical judgment, and the services are equipment-based (cf. Collier and Meyer, 2000, Ettenson and Turner, 1997). In this article, we will concentrate more on professional services, which we call ‘complex services’, and which we basically understand as information intensive services. We refer to simple services or commodities as mass services. With this background, several techniques qualify for a more detailed appraisal, including heuristics, policy-based approaches, reputation- and trust-based selection techniques, multi-criteria decision analysis, UDDI-extensions, and ontology-based preference modeling approaches.

An optimal service can only be selected if an optimal service actually exists as well as a strategy to find it (Gigerenzer, 2007, p. 86). If this is not the case, *heuristics* can help in choosing services that are good enough. Gigerenzer (2004) provides an overview of fast and frugal heuristics, which stop the search immediately if a factor allows it. The factors need to be retrieved in order of their importance. This has the advantage that a fast and frugal tree only has $n + 1$ leaves whereas a full tree has 2^n leaves, which can make a full tree computationally intractable. Heuristic approaches for service selection are described, for instance, in Menascé et al. (2008 and 2010). Heuristics are useful for service selection problems, where no optimal solution exists or where finding the solution is too expensive or even computationally intractable. They are less suitable for multi-criteria decisions and may have some weaknesses if the selection decision is made by a human. One weak spot is the base-rate fallacy, which is the finding that “people are relatively insensitive to consensus information presented in the

Table 1: Techniques for complex service selection.

Service Selection Technique	Pro	Contra
Heuristics	Fast / cheap / often good enough / suitable for simple service selection	Unsuitable for multi-criteria or multi-person decisions
Policy-based	Considers preferences and limitations of the requestor	Translation of policies (to make them machine readable) is complex and time-consuming
Reputation-/ trust-based	Decision can be based on own and others' experiences	Long time to build up reputation- and trust community / potential of manipulation of evaluations
Multi-criteria decision analysis	Accommodation of multiple criteria, facilitation of participation, simple and intuitive character	Lengthy duration of the process / boost of effort with increasing number of criteria
UDDI-extensions	Monitoring the performance, safety, and price of services	Limited focus: overemphasize on technical aspects / quality information and service data are separated
Ontology-based preference modeling	Automatically interpretable / ability to automatically derive new relationships between concepts of your ontology	Difficulties in mapping ontologies / big effort to define an ontology

form of numerical base rates" (Brehm et al., 2005, p. 108).

Similar to heuristics are *policy-driven approaches* for service selection, which are based on the specification of non-functional requirements coded in a Quality of Service (QoS) policy model (Yu and Reiff-Marganiec, 2008). The QoS policy model contains the service requestor's policies like preferences and restrictions. Policy-based approaches are outlined, for instance in Janicke and Solanki (2007) or Liu et al. (2004). Just like for heuristics one disadvantage is the difficulty in translating non-functional criteria to allow computation. The formulization of non-functional criteria is time-consuming and tricky, as the criteria have to be formulated as numbers or in another format. In principle, policy-based approaches could be applied for basic service selection as well as for a complex one.

Policy-based approaches – like most approaches for services selection – select the service on the basis of information provided by the service provider and try to match this information with the service requestor's selection criteria. Yet, a major difference of *reputation- and trust-based selection techniques* is the introduction of a trusted third party. Reputation- and trust-based selection approaches are genuinely meant for service selection, while most other approaches can also be used – or are indeed even designed – for service discovery. Some literature is summarized in Yu and Reiff-Marganiec (2008), of which Wang and Vassileva (2007) and Galizia (2007) can be recommended for further reading. The advantages of these approaches are that they can be used for any arbitrarily complex service and that non-functional requirements like legal issues, reliability, or availability parameters can also be incorporated into the selection process. On the downside, there is no real deployment of this approach in the real world yet due its high complexity (one service is not like another) and the enormous amount of time needed to establish a "trust and reputation"-community. Another drawback is the potential of manipulation of evaluations.

Another kind of service selection is *multi-criteria decision analysis*, which qualifies for numerous and possibly conflicting evaluations. Multi-criteria decision analysis methods are particularly well suited for complex service selection, for which several criteria need to be judged. Multi-criteria decision analysis methods include Analytic Hierarchy Process (AHP) and its successor Analytic Network Process (ANP), goal programming, and weighted product or sum models. The AHP is, for example, used for a QoS-based web service selection in Wu and Chang (2007). It is also applicable as a decision support model for managers to understand the trade-offs between different criteria by group properties and thus structuring the decision (e.g. Handfield, et al., 2002). Advantages of the AHP include the support of both subjective and objective criteria, the accommodation of multiple criteria, the facilitation of participation, and its simple and intuitive character. A disadvantage might be the lengthy duration of the process.

Universal Description, Discovery and Integration (UDDI) is a directory service that provides a mechanism to register and locate web services. The UDDI repository basically consists of three components: the white pages (similar to a phone book, which gives information about the service providers supplying the service), the yellow pages (similar to the "Yellow Pages", which provide a classification of the services), and the green pages (which are used to describe how to access a service and which control the congruency between the service provider's offers and the requestor's needs). While standard UDDI can be used for service discovery, *UDDI-extensions* aim at supporting service selection. Seo et al. (2005), for example, propose the introduction of a quality broker in the

service-oriented architecture between the service requestor and the UDDI repository. The quality broker monitors the performance, safety, and price of services, which are registered in the UDDI repository. Yu and Reiff-Marganiec (2008) also assess UDDI-based approaches for service selection and come to the conclusion that there are two disadvantages: (1) information about the quality and service data are separated, and (2) there is no extensible service quality model, i.e. the selections are limited to few predefined criteria. Another weakness of this approach is its limited focus: there is an overemphasis on technical aspects while e.g. legal aspects are neglected.

Other ways of service selection are *ontology-based preference modeling approaches*. In computer and information science, "an ontology refers to an engineering artifact, constituted by a specific vocabulary used to describe a certain reality, plus a set of explicit assumptions regarding the intended meaning of the vocabulary words" (Guarino, 1998). Adopting this definition implies two important premises: (a) the ontology is specified in form (syntax) and content (semantics), and (b) the ontology is appropriate to represent a consolidated world-view of a delimited domain (pragmatics). Consequently, for service selection, the selection criteria of a service requestor are formalized with semantic vocabulary and a domain structure for the classification. For example, Sutterer et al. (2008) describe user profiles including their preferences in an ontology. García et al. (2010) define a preference ontology for service selection and ranking. Yu and Reiff-Marganiec (2008) model the service requestor's preferences and use this ontology model as criteria for service selection. This approach makes it possible to define weights for the preferences either by the service requestor or by the system to handle emergent behavior. An advantage of this ontology-based preference modeling approaches is that it is automatically interpretable by machines. A bunch of advantages stem from the functions reasoning, inference, and validation, which basically means that you are able to automatically derive new relationships between concepts of your ontology. Still, major disadvantages are the difficulties in mapping ontologies and the effort to define an ontology and to keep it up to date.

As mentioned before, in our literature review we focused on service selection for information intensive and compared several selection techniques. (Table 1). A good comparison of service selection methods is also presented in (Yu and Reiff-Marganiec, 2008) on the basis of seven requirements for web service selection approaches, which are: model for non-functional properties, hierarchical properties, user preferences, evaluation of preferences, dynamic aggregation, automation, and scalability and accuracy.

As summarized in Table 1, all discussed service selection techniques have advantages and disadvantages. While heuristics might be the easiest and most convenient method for simple service selection, we consider multi-criteria decision analysis - and in particular AHP – as a superior technique for complex service selection. One major drawback of AHP is its lengthy process. However, once set-up, the process can be automated and several software tools are available to support the decision process. The application of AHP for service selection is not new and has been adopted for many different settings (e.g. selection of ERP vendor or communications service provider, cf. Wei et al., 2005). With this paper we want to extend the current field of application and show how AHP generally can be applied for decision-making in the complex area of information intensive services.

3 CRITERIA FOR SELECTING INFORMATION INTENSIVE SERVICES

The selection of the right information on intensive service involves the balancing of a series of multi-dimensional and often interrelated aspects. The STEP (Social, Technological, Economic, Political) approach, also referred to as PEST (Peng and Nunes, 2007), STEEP (second 'E' stands for 'Environmental', Voros, 2001), or PESTLE ('L' stands for 'Legal', Warner, 2010), offers a proven, integral framework for guiding a complex decision-making process. A general assumption is that not only directly assignable effects, such as the price or defined service levels, but also external or indirect circumstances, such as the image of the service provider, or cultural fit with the company, are also likely to influence organizational investment decisions. To identify these influencing factors and get a 'satellite view' for a holistic choice, the decision-making process is based on four dimensions: technological, social, economic, and political. In order to identify the most relevant decision criteria for selecting information intensive services, our literature review adheres to this classification and thus can be designated as 'concept-centric' (Webster and Watson, 2002).

3.1 Technological Dimension

The main focus of service selection is often more or less limited to the technological dimension and a great part of current service selection techniques mainly uses QoS-metrics (e.g. Maximilien and Singh, 2004; Tian, et al., 2003) as a basis for decision-making. In particular under the label of QoS, characteristics of technological usability as a basis for service selection have been widely discussed (e.g. Liu, et al., 2004; Zeng, et al., 2003). Because QoS is defined and measured in different ways, we do not want to rehash a discussion about the subject, but rather focus on the three major concepts of usability as defined by the International Organization for Standardization (ISO-9241).

The first central concept to render usability is *efficiency*, which is commonly referred to as the level of resources consumed in performing a specific task. In regard to information intensive services, efficiency can be quantified by a service's processing time (throughput), response time (latency), or capacity (guaranteed performance).

Effectiveness is the second fundamental concept for quantifying the quality of a service. According to Rengger et al. (1993), effectiveness is comprised of two aspects, namely the number of tasks the user completes and the quality of the goals the user achieves (output). With respect to the quantity, the scalability of a service is of major importance, since it represents a service provider's capability of increasing his capacity and ability to process more service consumer requests, operations, or transactions in a given time interval (W3C Working Goup, 2003). In regard to quality, criteria such as robustness (the degree of quality provided even in the presence of invalid, incomplete or conflicting inputs), reliability (the ability to perform a service under the stated conditions for a specified time interval), integrity (consistency of information and processing), and timeliness (actuality of information and punctuality of provision) can be used as units of measurement.

Finally, the service consumer's *subjective satisfaction* with using the technology is another inherent concept for service selection. From a technological point of view, satisfaction or perceived usefulness of the rendered service is positively influenced by its ease of use (Wixom and Todd, 2005). For example, this might be assessed by inspecting a service's integration possibilities (e.g. integration into regular tasks), adaptability (e.g. possibility to readjust service levels), or exception handling.

3.2 Social Dimension

QoS-metrics are often restricted to characteristics of technological usability (as described in the previous sub-section) and do not consider social aspects for service selection. No matter where information intensive services are used – be it business-to-business or business-to-consumer - concepts such as trust (e.g. Billhardt, et al., 2007; Liu, 2005), reputation (Ding, et al., 2008; Wang, et al., 2009) and cultural fit (Javalgi and White, 2002) play an important role in decision-making.

The concept of *trust* as basic principle for establishing business relationships and social phenomenon has been widely investigated in the past years (e.g. McEvily, et al. 2003). According to Castelfranchi and Faclone (1998), trust can be gained by the service provider's competence, disposition, persistence, as well as the belief on his dependence, cooperation willingness, and self-confidence. Reference points for assessing the trustworthiness of a service provider of an information intensive service are, for instance, a transaction history (Manchala, 2000), a sociability index (Smoreda and Thomas, 2001) or a competency index (Hu, 2010).

Another concept that is central from a social perspective is *reputation*, which generally can be defined as the "public's opinion about the character or standing (such as honesty, capability, reliability) of an entity" (Wang and Vassileva, 2007). Like trust, it is based on the long-term experiences that the different service consumers have made when collaborating with a particular service provider. However, in contrast to trust, which can be allocated on different levels (e.g. trust in the service itself, trust in the service provider), reputation is merely focused on a private or legal person and thus can be independent from a service offer. In this sense, not the quality of the service is in focus, but the quality of the service provider. Useful means to ascertain the reputation of a service provider could be a rating history (Maximilien and Singh, 2004) or the electronic word-of-mouth in online platforms (Hennig-Thurau, et al., 2004).

Although several studies report a significant interrelation between culture and user interaction (e.g. Birukou, et al., 2007), the concept of *cultural fit* is often neglected in service selection techniques. Reasons for this are probably the difficulty in capturing 'culture' in tangible terms as well as the diversity of divergent understandings that are attributed to this concept. In a broad sense, culture can be conceived as a collective phenomenon that is

manifested in several ways such as by common symbols, heroes, rituals, values, and practices (Hofstede and Hofstede, 2005). For instance, Forest and Arhippainen (2005) discovered that there is a considerable difference in the way how Finish and French users interact with IT-based services. Consequently, it can be assumed that cultural differences play an important role when selecting a particular service. In order to include it in the decision-making process for selecting a service, it must be narrowed down to concrete conceptions such as for example linguistic affiliation (e.g. does the service provider support all the different languages that are spoken in the company), professionalism (e.g. does the service provider certify a certain capability level), philosophy (e.g. does the service provider share the same values with respect to specific subjects), or business conduct (e.g. does the service provider apply the same or similar standards to business transactions).

3.3 Economic Dimension

In QoS policy models, the price is often the only economic criterion for service selection (e.g. Liu, et al., 2004). However, especially in the context of information intensive services, not only the costs, but also the benefits of utilizing the service (instead of accomplishing the required output on one's own or resigning) are important.

With respect to *costs*, a differentiation between non-recurring costs, ongoing costs (the price typically is a combination of both) as well as switching costs is needed. Non-recurring costs are, for instance, the purchase of a commercial software license, payment of a registration or activation fee, or one-time investment costs for infrastructure and training in order to effectively using the service. On the other hand, exemplary ongoing costs are subscription fees, utility-based maintenance and support costs, or user-based cost additions for using special service characteristics. Finally, when changing a service provider, switching costs must be considered, too. According to Farrell and Klemperer (2007), switching costs may be transactional (e.g. returning of equipment), contractual (e.g. exit fees) as well as search and learning costs (e.g. retraining of employees). In addition, psychological, emotional, and social costs may incur.

Considerable research is available on how to assess the economic *benefits* of IT; however, it is less common to specifically study them in relation to information intensive services. Following Mirani and Lederer (1998), advantages may occur on a strategic (e.g. enhanced customer relations), informational (e.g. improved decision-making), and transactional dimension (e.g. money savings or productivity increases).

3.4 Political Dimension

Although having an exceptional great impact on the final decision, political considerations are often neglected in current service selection techniques. One reason for this is that a wide mix of issues must be addressed, which usually makes it difficult to replace human intervention through programmatic means such as UDDI-extensions or QoS-algorithms. Accordingly, different stakeholders might be involved (Chatterjee and Webber, 2004). Among other considerations, the concepts of *dependability* and *regulatory compliance* play a major role.

Unlike the technological connotation of dependability, which generally uses this term to describe the trustworthiness of an IT-system based on its availability, reliability, safety, integrity, or maintainability (Avizienis, et al. 2004; Wang and Vassileva, 2007), we rather associate the service consumer's subservience to a particular condition of a service provider's offer with it (commonly referred to as lock-in). In the context of information intensive services this might come to light when a service provider's market power is high enough to circumvent the compatibility or interoperability of a service by proprietary characteristics or to enforce additional obligations. Not least, a service should be also assessed whether it is capable to comply with national and/or international regulations (e.g. standard services directive) as well as with the own needs for privacy protection.

4 DECISION-MAKING WITH AHP AND STEP

The Analytical Hierarchy Process (AHP) was devised by Saaty (1980) and became one of the most – or even the most – prevalent model for multi-criteria decision-making. The AHP provides a framework for solving multi-criteria decision problems based on the relative importance of the criteria assigned to each criterion in achieving the overall goal (e.g. Handfield, et al., 2002). The AHP technique is particularly suitable for multi-criteria and also multi-person decision making, in which subjective managerial opinions are present. The advantages of AHP over the other methods (cf.

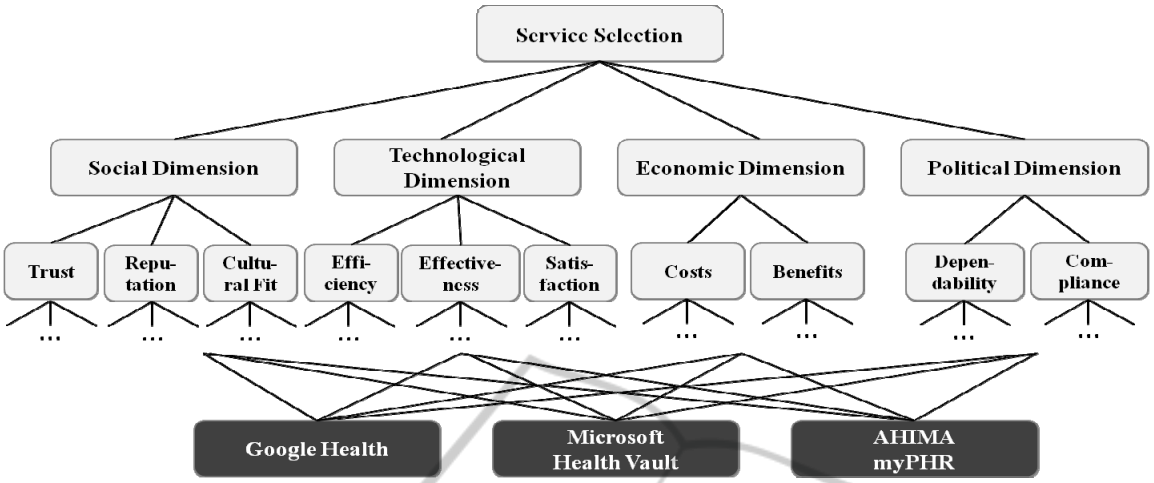

Figure 1: A Multi-Criteria Decision Model based on AHP and STEP.

section "Related Work") are: its applicability in vast variety of different areas (e.g. Golden, et al., 1989; Handfield, et al., 2002), its reliance on easy-to-get managerial data, its ability to reconcile inconsistencies in managerial perceptions, and the existence of various software tools (Handfield, et al., 2002).

We describe the basics of the AHP technique in a four step approach (on basis of Handfield, et al., 2002; Saaty, 1980; Wu and Chang, 2007), but as our approach suggests suitable sub-criteria, we mainly focus on the second abstraction level (for detailed information on the other levels please refer to Saaty, 1980). Indications therefore are discussed in the previous section. In order to exemplarily explain the AHP and especially the second abstraction level, the illustration is based on the example of personal health records (PHR) as we think that the choice of a suitable PHR is complex and includes many technical (e.g. provision of interfaces to mobile devices, security and accessibility mechanisms, etc.) as well as non-technical considerations (e.g. credibility of provider, benefits of electronic vs. paper-based health records, etc.). However, our proposition is applicable to a wide area of domains. As basis for this comparison we chose three exemplary services: Google Health (GH), Microsoft Health Vault (MHV), and AHIMA my Personal Health Record (myPHR).

1st Step: Construction of the hierarchy: All stakeholders can jointly construct the AHP hierarchy, for instance, physically in a workshop or over the Internet, e.g. on a Wiki (Wu and Chang, 2007). The AHP hierarchy typically consists of three or four levels (can be extended to more levels, if applicable): the goal (service selection), the relevant criteria (cf. "STEP"), the relevant sub-criteria (as introduced in the previous section), and the alternatives to be evaluated (in this example: GH, MHV, and myPHR; cf. Figure 1). The decision makers need to agree on and describe the characteristics of the components in the hierarchy.

2nd Step: Pair-wise comparison and estimation of priorities: The stakeholders need to determine a priority for each alternative (Step 2.1) and each criterion (Step 2.2). The priority is a numerical measurement of the power of a node in relation to the other nodes on the same level and with respect to the node(s) above it.

Step 2.1: Priorities of Alternatives: Each alternative is pair-wise compared to all other alternatives with respect to all related sub-criteria and assigned weights, which reflect the relative intensity of importance. The decision makers can (among other variants) use a scale from 1 to 9: 1 being equally important, i.e. the two criteria contribute equally to the objective and 9 referring to favoring one criterion extremely over the other one; Example, cf. Table 2).

Table 2: Alternatives compared with respect to TRUST.

GH	5	MHV	1	Wrt TRUST GH is fairly favored over MHV
MHV	1	myPHR	7	myPHR strongly more trusted than MHV
myPHR	4	GH	1	myPHR is moderately more trusted than GH

There should be some evidence for the judgment and weighting: the evidence could stem from, e.g. past experience or the use of trial versions. The weights are then transferred into matrices for each sub-criterion: for each pair-wise comparison, the

number that represents the greater weight (of a pair-wise comparison) is directly rendered into the matrix, whereas the reciprocal of that number is transferred to matrix instead of the smaller number. Then, for each sub-criterion priorities are calculated for the alternatives by mathematically processing the matrices. The estimation of priorities can be accomplished in many ways (Table 3).

Table 3: Priorities of alternatives with respect to TRUST.

	GH	MHV	myPHR	Priority
GH	1	5	1/4	0.24
MHV	1/5	1	1/7	0.07
myPHR	4	7	1	0.69

Saaty (1980) recommends using a normalized eigenvector approach, which is a proven method for estimating the priorities (Golden, et al., 1989). Other approaches are discussed, for instance, in Choo and Wedley (2004). Software tools can take over the task of the calculation.

Step 2.2: Priorities of Sub-Criteria: The same procedure is applied to get the priorities for the sub-criteria. That is to say, the sub-criteria are first pair-wise compared with respect to their super-criterion/criteria (cf. connecting lines between sub-criteria and criteria) and relative weights assigned. The weights are then transferred to matrices, from which the priorities for each sub-criterion are extracted.

Step 2.3: Priorities of Criteria: The same process as for the sub-criteria is applied to the criteria, resulting in one matrix that depicts the comparison of the criteria with respect to the goal, the service selection decision. Out of this matrix relative weights are calculated.

Step 3: Calculation of the weight of each Alternative with respect to the goal: In this step the weights are multiplied and summated. The priorities of the alternatives are multiplied with the priorities of the sub-criteria and with those of the criteria, which results in the overall priorities of each alternative with respect to the goal. The priorities of each alternative with respect to the goal are summated over all criteria.

Step 4: Decision-Making: In accordance to the AHP method, the alternative with the highest sum should be chosen: that is the alternative with the highest overall priority with respect to the goal. For example, if a priority of 0.38 is calculated for GH, 0.11 for MHV, and 0.51 for myPHR, the service myPHR should be selected.

5 CONCLUSIONS

The decision on selecting the right information-intensive service should be made in a holistic manner. However, we realized that the technological dimension tends to be overemphasized. Therefore, we suggest a multi-dimensional decision model for complex service selection that dynamically assigns relative importance to the social, technological, economic and political dimension. Even if a service may be ever so suitable from a technical perspective, it may be ruled out due to a legal issue. Another usual shortcoming is the limited perception of different decision criteria. For instance, economical considerations tend to be incomplete by focusing too much on single issues such as the purchase of a license, or the payment of a registration or activation fee. A complete cost-benefit ratio can offer valuable clues for complex service selection. For this reason, we devised a framework for relevant second level criteria: social (trust, reputation, cultural fit), technological (efficiency, effectiveness, satisfaction), and economic (costs, benefits), and political (dependability, compliance).

Advantages of the method include the accommodation of multiple criteria, the facilitation of participation, the provision of a model to learn from, to debate about, and to present to others, as well as its simple and intuitive character and its mathematical rigor. On the downside, the technique can lead to a lengthy process, in particular if further abstraction levels are added. To ensure a target-aiming decision making process, one needs to be careful not end up with an information overload. The proposed method is therefore most suitable for the selection of complex services with sweeping consequences, e.g. if the service is very expensive, if the service cannot be changed later on or if many processes depend on the services. For a simple service selection, heuristics may be the method of choice as it the cheapest and fastest way to come to a decision that is good enough. Future work should be directed to automate repetitive decision-making as good as possible. Still, it should be noted that automated decision-making and the suggested method is no substitute for clear thinking! The actual process of the analysis can support the decision makers in organizing and representing their thoughts, but only clear thinking can prevent them from an information overload and support them in quick decisions.

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