Improving Usability of e-Government for the Elderly

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Abstract: Our research focuses on the question of acceptance of current e-government systems by elderly users. It describes how such systems should be designed and offered for this user group in order to provide an acceptable alternative to offline processes. In order to answer our research question, the research was structured into three phases along the development model of the ISO 9241-210. This enabled to identify not only the main factors of acceptance, but also the expectations of elderly users. Our research was conducted in parallel in Germany and Hungary in cooperation with the Fraunhofer FOKUS, the Federal Ministry of Interior, the Bundesdruckerei and the Corvinus University Budapest. The first phase provided results about the expectations and previous experience of the users with e-government systems. Our goal was to acquire information about the general experience of the age group with interactive applications so that a suitable test environment could be selected in the second phase of the research. The results made it possible to select an application in the second phase, which was used as a model in the remaining phases. The selected application was the AusweisApp of the electronic ID card. This was tested with 75 participants and a control group consisting of 20 students of the Humboldt-University. The obtain results allowed us to develop a generalised solution, the IGUAN guideline. This guideline makes a standardised approach to the usability improvement process possible. It contains the special requirements of elderly users, and a catalogue of criteria, which helps to develop an application in line with the set requirements. The third phase of our research was used a proof of concept for the IGUAN. The guideline was evaluated and tested with an iterative prototyping. The successful completion of this phase indicates that the IGUAN can be used to measurably increase the acceptance of e-government systems by elderly users. We could therefore demonstrate that improvements in the interface make e-government application possible which are perceived useful and easy to use by elderly users. These improvements will measurably increase the user motivation and experience. This can however only be achieved with a structured design process, and requires a framework which takes the requirements of the elderly users into account.

Keywords: e-Government, usability, acceptance, guidelines, ASQ, usability testing, structured approach, GUI improvement

1. Introduction

Electronic government was created on the example of e-business, or electronic commerce. It is essentially the evolution of the transformation of the public sector, which, as a process has been on-going for several decades, but only reached its critical mass in the last decade. The use of IT in public administration and other branches of government (including parliaments and the judiciary) as support systems, has reached a high level in many industrialised countries, but there was almost no political interest in this on-going and almost invisible process of modernisation of the government for a long time. Although the idea itself provides great opportunities for improving government processes and interaction on the G2C level, the basic concept of electronic government remains vague. The main problem, which can be still seen, is that decision makers try to base the underlying idea of e-government on concepts based on experience with e-commerce. This may misdirect the attention of governments when trying to gear services for innovation. E-government systems are somewhat different. The underlying technology of e-commerce and e-government systems is analogous, but premises are very different. A difference with a major impact on the system design is the question of the targeted customers. E-commerce systems have a customer base with clear boundaries. E-government systems have to be offered for all members of the population. Fragmentation of the users is not an option. This issue is one of the key factors, which has to be considered, when working with e-government system. This is therefore one of the main elements, which determined the direction of our research.

The essential difference between offline government and a fully electronic governance, is the goal to reach the ultimate efficiency in processes not only to speed up the exchange of information, but also to create a system which is considered effective by the users, the citizens and businesses. This increase in efficiency can be directly translated into the speed of process execution. Apart from efficiency, another aspect of electronic government, which needs a new approach, is the user-friendliness. Interfaces can contribute to the complexness of the system or help the user by easy access. This issue is not a trivial task; it needs a very

different approach in user interface design than any other software. The most difficult but also most important characteristic for this is the narrowing the "digital divide" (Mehra, 2004) to a minimum for the users. This might prove to be a challenge with the complete population as the target audience, even greater than any technical, privacy or security aspect of the systems. This can be translated into the general acceptance of the applications, which combined with the least experienced cohorts of the population, the elderly, will become an imperative factor in electronic government of the future. Additionally, e-government theoretically offers the prospect for identical service quality independently from time, location or age. This ubiquitous access to governmental services would have measurable advantage! In the midst of the current demographic trends in Europe, it would give the elderly an uncomplicated way to access to governmental services and enable these cohorts to be one of the strongest benefactors of electronic services. Contrasting to this, systems have not been designed with these users in mind until recently, and even today, elderly are not considered as prime candidates, with system developers and designers hard to convince otherwise. Decision-makers see the endeavour as questionable before understanding the impact of future demographic changes the governmental infrastructure. These premises made it apparent that the utility of e-government for the ageing population warrants a deeper research project, which should focus on this essential population group. Other research projects have also shown that the use of e-government can be promoted to older people (Righi, et al., 2011). Additionally, papers also describe the strong correlation between usability and acceptance for older users (Fisk, et al., 2009).
We selected therefore a model which took these results into account and united this with a user-driven approach to determine the requirements of the target group. The basis of our model is the ISO 9241-210 (International Organization for Standardization, 2010) development cycle.

Merging this into the hypotheses describing the user behaviour and the technology acceptance of the elderly enabled to extend the model to better represent our target group and to specify the application environment. This allowed the creation of a hybrid model based on the ISO 9241-210 activity diagram, describing the tasks of the research.

2. Acceptance of electronic government by the elderly

This phase formed the basis of our research, and was designed to give an overview about the requirements and the fundamental issues of the target group. The data gathering for this was based on deep interviews and standardized questionnaires. This step also includes a technology overview, which was fundamentally a generalized expert analysis of the currently offered electronic government systems in Germany, Hungary and on European level.

The systems used in the interviews in this step have been created on a purely theoretical basis, with no actual application serving as a basis. This decision was essential, as any functional system might have influenced the test group with actual and real problems, which consequently would create falsified data based on a single system. This made an analogous approach in both countries possible and centred the scenarios around a theoretical system, which would give the elderly several advantages through improved service quality and efficiency. Along this idea, a theoretical "retiree-card" application was specified, which was based on the concept of typical German university student ID. The scenarios for the research step were constructed around the request procedure for this card and featured the four maturity levels of electronic government systems declared by the European Commission. The data was acquired by the means of a standardized questionnaire, which included multiple questions about the acceptability of the targeted system. The number of participants was 25 for Hungary and 45 for Germany, with a median age of 69.5 years.

The choice of Hungary as a comparable test environment to Germany was made on multiple premises: The e-government distribution, the Internet penetration and the demographic structure. The centralised approach to e-government in contrast to the federal system of Germany enabled an evaluation of multiple governmental procedures in a similar environment. The selection of Hungary was also made possible by the knowledge of the Hungarian language. A further aspect, which enabled a deeper view on the e-government usage, was the scepticism of the users with e-services, which was observed by Abramson and Morin (Abramson & Morin, 2003) in Hungary. An example for this is the low usage of the electronic tax declaration by citizens, especially by the elderly (Inforum, 2008).

The results of Eurostat e-government usage panel (Eurostat, 2011) also support the selection of the two countries. Although it does not create separate data records for different age cohorts in E-government usage, the data in figure 1 visualises the similarities in acceptance.

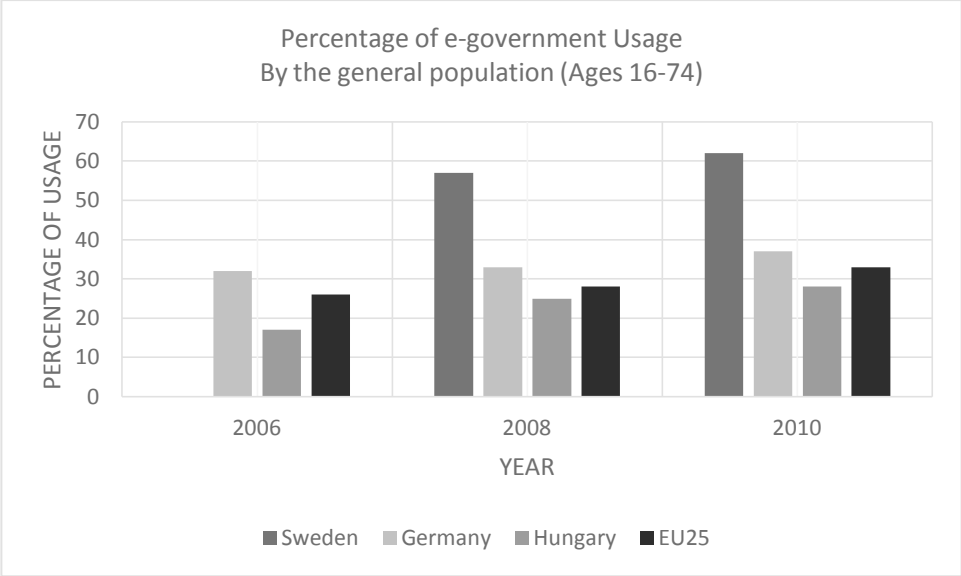

Figure 1: E-government Usage by the general population (Source: Eurostat 2011)

A further question when dealing with e-government services is the complexity of the integrated electronic components. The maturity model for e-government systems created by the European Commission can illustrate this increasing complexity and development of e-government solutions. (Fig. 2) We used this maturity level based model for the different systems, enabling the easy and proven assessment of electronic services, thereby creating a framework for the research and an option to compare systems with different components and goals.

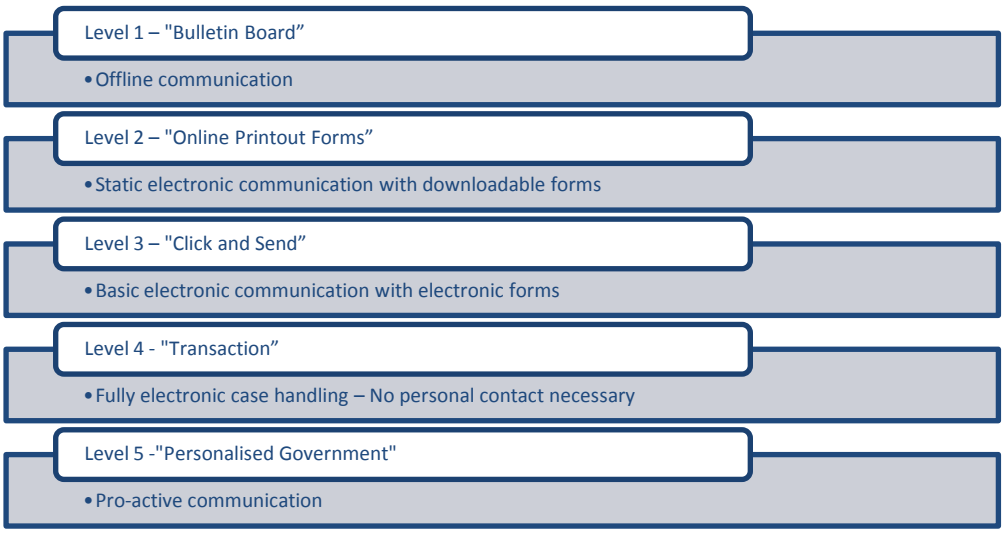

Figure 2: Maturity levels of e-government solutions (Source: European Commission, 2011)

This approach guaranteed that the users were confronted step-by-step with more and more electronic components and were not overwhelmed by new concepts, which might have created refusal or other sudden and uncontrolled changes in the attitude of the test candidates. The results from the different levels analysed in accordance with the maturity model of the European Commission support the theory, that there is a

threshold in the acceptance of electronic government and probably other systems for these cohorts. The results support that that younger elderly seem to theoretically approve electronic government systems, which offer electronic components up to level 3. Level 4 systems were somewhat more controversial, but even such systems were acceptable for about half of the younger test participants in both countries. Older citizens might not accept present systems beyond level 2; interactive systems seem to encourage a fear of new technology and fuel disapproval in about 50% of the tested participants.

In the subsequent step, the technology available was analysed to create an overview of the available systems, which could serve as a platform for further research.

The acceptance of the levels was measured with a standardised questionnaire, consisting of three standard questions of the ASQ method, shown in the previous section, based on the research by J.R. Lewis (Lewis, 1991) at IBM. We have modified the method for the use with the scenarios, as the basic framework places its emphasis on multiple choice grading. This was not deemed effective in case of scenarios based on multiple maturity levels. A simple yes or no answer gave sufficient data for the assessment of the basic user needs at this level. Later in the research, multiple level grading was introduced as it provided a finer distribution for the results.

In addition, the standard ASQ questions were accompanied with supplementary queries, needed for a deeper understanding of attributes unique to e-government. This procedure can be seen in figure 5.

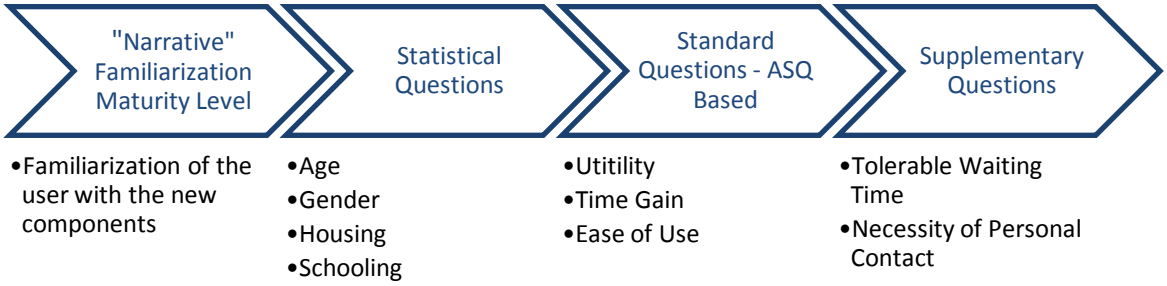

Figure 3: Model of the interview procedure

The three main aspects of the ISO 9241 – efficiency, utility and effectiveness – link the standard with the ASQ, leading to comprehensive and reproducible results. Utility in the ASQ is consistent with utility in the ISO 9241. Ease of use is consistent with effectiveness and time gain is consistent with efficiency. The final ISO 9241-210 was not yet available at the time of the design of the model in late 2009; therefore, some details of the final standard could not be employed. This is also the main reason for the use of the older ISO 9241 and ISO 13407 standards at this stage of our research.

Before the questionnaire, the participants were familiarised with the scenario by a short verbal introduction consisting of the narrative overview. This was followed by the relevant questionnaire. This was repeated for each maturity level with the relevant narrative part and then the questionnaire. The standard questions were asked for each maturity level. The supplementary questions were asked at the relevant maturity levels, thereby creating a deeper understanding of the user experience of highly advanced systems. This was followed by the socio-demographic questions, consisting of age, gender, housing, schooling and previous experience with e-services. The interviews were based on a standardised questionnaire consisting of multiple questions arranged into two distinct groups:

- Standard questions, based on the ASQ method
- Supplementary questions for the socio-demographic query

The answered questionnaires were analysed and evaluated in order to visualise the theoretical acceptance of e-services for elderly users. The theoretical acceptance was calculated from the three ASQ questions by assigning one or zero for positive or negative answers. The theoretical system was considered as accepted if the three scores were positive for the user.

3. Specify Requirements

The results gathered from the first step enabled to identify a system, which could serve as test platform for further research. This system had to maintain the following criteria defined on the basis of the ISO 9241:

- *The system had to be user-centred, with a service offered for citizens in a G2C configuration;*
- *The context had to be relevant for elderly citizens and independent from language, nationality, social, educational or cultural background to make a cross-cultural study possible;*
- *The quality of the system had to be of a level not to disrupt the tests through incompatibilities, system crashes or other software problems;*
- *The complexity of the selected service required to be of a certain level. Only systems with medium or high complexity can adequately simulate the usability problems for a later successful generalisation;*
- *A further requirement was the openness of the application to serve as a platform for the iterative system development;*

These criteria led to the selection of a system, which was in line with the efforts of the European Union to create a single Pan-European Identification Solution (Atkins, 2004), and concluded in the selection of the new German eID System, which was introduced in Q3 2010 to the general population in Germany. The client system called "AusweisApp" was therefore used as a basis for every subsequent step of the research. The data collection in this phase of the project was centred on the hypothesis that the system had to be usable for a wide array of citizen to government (C2B) interaction.

4. Methodology

The main objective of the tests in the second phase was to gather data about the usability of systems in an everyday environment with the users of the selected cohort. The tests were therefore based not only the scenarios, but also backed-up by methodology designed for the assessment of the user experience and verified by analogous studies. To completely understand the users' previous familiarity with comparable computer systems, a complex analysis of the experience on an individual level was needed. (Maeda, 2007) This was based on the CLS (Computer Literacy Scale) developed at the Chair of Engineering-Psychology at the Humboldt-University Berlin. (Sengpiel & Dittberner, 2008) This model can assess the computer literacy of the user precisely through a series of questions, creating a matrix from typical tasks on a computer. The tests have been conducted in parallel in both countries to assess the general usability of such systems on a European level. This unique set-up enabled a broader understanding of the special requirements when dealing with elderly users. The tests groups were recruited from community college courses specially offered for the elderly, and from basic computer courses offered by senior leisure centres in Berlin, Potsdam and in metropolitan area of Budapest. Test candidates recruited with this process possessed basic computer skills. Users without any previous experience with computer would not use e-government applications, as long as any other alternative is provided by the state. Additionally, the tests with computer illiterate users might not provide usable results as these participants would first need to learn the basic concepts of computers before any tests can be done. According to Scherer (Scherer, 2008), this causes the users to focus on the problems of the physical user interface, which is leading to results which are not measurable in case of a software usability analysis. The CLS was followed by the scenario based user tests, which supplied information about the problems the users were facing with actual systems. The direct usability of the system was measured by the problems encountered. The encountered problems, which were categorised earlier, were counted while testing the users. When encountering a problem, users were encouraged to complete the scenario after assistance from the test leader.

The ownership of Internet capable devices, computer, tablet or smartphone was also asked to assess the Internet habits. Additionally a number of questions were set up to gather information about the computer experience and usage of the candidates. This was used to create a broader picture about the experience of the cohort. The actual tests with the "AusweisApp" were conducted according to the data gathered in the 1st phase, and made up the main part of the user tests. They were performed with a "thinking-aloud" method to document the accomplishment of the tasks. The mouse movements on the screen were captured by screen-capture technology. A direct audio or video feed of the tests was not captured, as it would have highly complicated the set-up by creating the need for strict privacy agreements. In addition fear from misuse of

privacy relevant data would have made the recruitment process extremely hard to almost impossible for the tests in this case. This deficit was compensated by the application of the RSME (Rating Scale Mental Effort) developed by Zijstra (Zijstra, 1993). The users were asked to indicate the effort they needed to complete the tasks. This enabled, combined with the observations through the "thinking-aloud" method, an overview over the user behaviour in the scenario. During the scenarios, the number of external assists needed was recorded and categorized. The seriousness of the problem was characterized by the frequency (F), the impact (I) on the successful competition of the task and the persistence (P) between individuals. The score (S) of a problem was created with the function (1) and based on Nielsen and Loranger. (Nielsen & Loranger, 2006)

$$\boldsymbol{S = (F * I * \sqrt{P})/\sqrt{10}}$$

The impact of the problems was classified on a scale of three, with minor issues as one and problems with critical outcome for the success of the task with three.
Additional data was acquired by the after scenario questionnaire (ASQ) which was adapted for these user tests. The three questions, which the ASQ is based on, were modified according to the results from the 1st phase, thereby contributing to the comparability of the results. The ASQ itself was based on the work of Lewis J.R. (Lewis, 1991)

"*I am satisfied with the ease of completing the tasks in this scenario.*"
"*I am satisfied with the information and consider this system useful.*"
"*I am satisfied with the amount of time it took to complete this scenario*"

The answers were provided through five intervals from strongly disagree (1) to strongly agree (5).
The ASQ method was selected for the evaluation as it is proven and complies with the ISO 9241. The three main aspects of the ISO 9241 – efficiency, utility and effectiveness – link the standard with the ASQ, leading to comprehensive and reproducible results.

5. The Test Setup

The test environment has been set up for three different iterations of the user evaluation. A pilot-test with a small number of candidates was essential to verify the test equipment and the scenarios. This was conducted with identical premises as later tests. The usability laboratories of the Fraunhofer FOKUS were used for the pilot-tests and for the test runs in Germany. The eight volunteers for the test-run were recruited from the best possible candidates (20-30 year old university students), who had theoretically the highest previous experience with similar systems and would easily accomplish the set out tasks, thereby verifying the measurability and utility of the scenarios. A second run on the finalised setup with additional volunteers also provided reference data for the later tests with the actual test candidates. The control group, consisting of students enabled to set up the ideal course of usage by gathering information on the behaviour of the ideal users. This data was later used as a basis for the tests to be able to create a comparison between older and younger participants and also to have an insight on the complexity of the usability deficits of the system. The methodology used for the trials was identical to the actual tests with the target group. This enabled a merger of the data from the different test runs.
The tests were conducted in Germany and Hungary with a sum of 75 test participants. We used an identical approach for the validity of the results.

Table 1: Results from the ASQ for the 1st scenario

N=95	Ease of use	Utility	Time
Germany N_G=45	1.71	3.36	2.02
Hungary N_H=30	1.97	3.27	1.77
Control Group N_C=20	1.1	3.14	1.4

The main issue, which caused the high number of medium and critical problems, was the structure of the application. This has also been observed by other papers (Wandke & Jörn, 1999), and is described as one the main reasons leading to critical problems of the users. This is caused by the low previous experience, which has a high impact on the use of an interface (Maeda, 2007).

The large number of critical problems, which have often led to an abort of the process, is however alarming and visualises the deficits of the GUI. Only the comparably highly experienced users of the control group accomplished the scenario mostly without critical problems encountered. It is desirable to create an interface, where critical problems are not encountered, as these can cause severe distress for the users and lead to negative motivation through failures and disappointment.

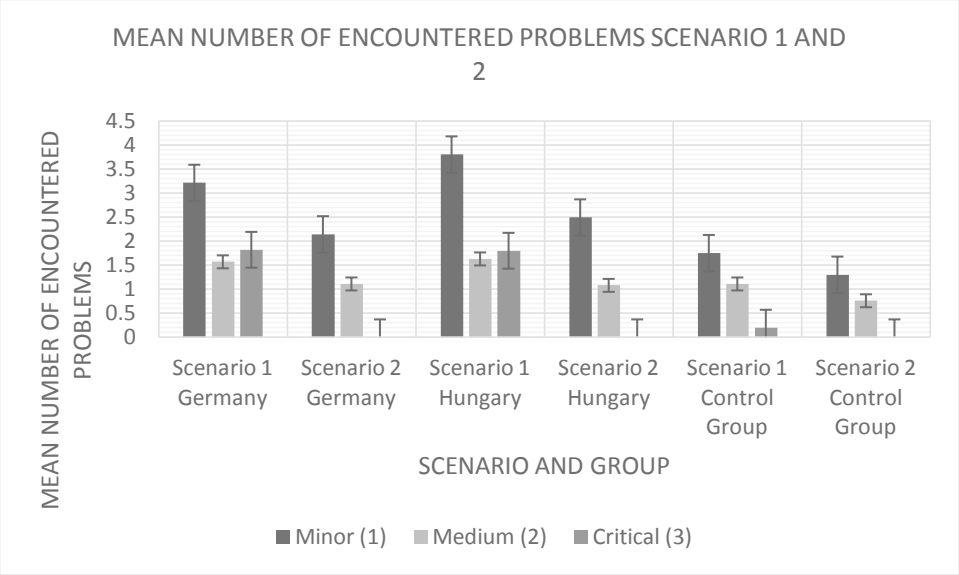

Figure 3: Mean number of problems encountered by the users – Both scenarios

The high number of minor problems can also be considered unsatisfactory when testing an interface. Some help from the test leader was even required in the second scenario, which followed the first and should have eliminated most problems for the users through a learning effect. This was also demanding for the elderly, with 1.98 minor and 0.98 medium problems encountered on average. Critical usability failures could not be observed in this second scenario. This can be substantiated by the effect of the learning curve (Wright, 1936), (Yeh, et al., 2009). It can be assumed that this learning effect would eventually lead to acceptable results after three to four tests with the AusweisApp. This is however not the solution for an interface which has to be usable the first time by users without previous experience with similar systems. A change in the process would nullify the learning effect immediately. Tests after this would produce similar results as seen above.

We can therefore state that the tested interface is not usable by elderly users without repetition or that it requires at least a deep understanding and experience with interactive e-services. Further tests based on the RSME and the ASQ also strengthened this indication. The mental effort needed for the interface was measured during testing with the standardised RSME (Rating Scale Mental Effort) created by Zijstra (Zijstra, 1993). This enabled the measurement of the subjective mental workload by comparing the user-experience to everyday tasks from easy to extremely frustrating. The results are expected. The user experience of the AusweisApp was considered by the user to require definite mental workload, scoring in the rage of 55-60 for individuals (M_{75}=58.45) on the scale of 0 to 150. This means that rather much mental effort is needed to complete the scenario. The learning effect described earlier caused the second scenario to score lower, in the region of 35-40 (M_{75}=39.72). Experience gathered through the first test lowered the mental effort needed for this scenario.

The definite method of analysing the scenario was the After-Scenario-Questionnaire (ASQ). This allowed us to compare the user experience directly through perceived attributes by the users. The three questions enabled the users to assess the scenarios and their user-experience on a scale of five scale (5 best, 1 worst)[1]. The results from the ASQ of the first scenario can be seen in table 1.

[1] This rating was used as a compromise between the German and Hungarian rating systems, and corresponds with the ratings used in the research of e-commerce websites.

The data gathered from these tests in Germany and Hungary enabled to build new interface prototypes, which served as showcases for a generalisation of usability rules and practices. This enabled us to formulate a general approach for a usability improvement process for e-government systems.

6. The IGUAN guideline

The main consideration for the new guideline is twofold. It should not only help to develop or redesign applications in accordance with the requirements of the target group, but also provides elderly users with an easy access. Multiple studies (Hipp, 2009), (Robinet, et al., 2008), (Bruder, 2008) show that elderly can benefit from certain improvements of the user interface. Acceptance can be highly increased through optimisation of the interface, thereby giving elderly a better user experience and offering systems which are not only accepted, but are preferred to current uncomfortable and time consuming offline services. In addition, it should offer aid and a visual process for developers, which leads to UI (User Interface) optimised systems. The best-practices incorporated in the guideline therefore do not have to only include the requirements for optimal usability, but also a development cycle and the general criteria, which are considered essential for system acceptability. Our user tests of the AusweisApp were used as a basis for the framework. This draft process was channelled into a more formal and standardised form to formulate a complete set of guidelines, which result in the planned improvements. This, followed by the contextual design process enabled us to implement the findings into the final application. The generalisation of the research process was possible, as it was considered from the beginning on as the first step towards a standardisation effort.

Reproducibility was also a high priority for the validity of our research, enabling an easy generalisation of the process. The framework was created with the focus on e-government and particularly electronic identification, but the guidelines can be used for any interactive Internet service which has an elderly target group. The guideline is constructed along the following three main aspects shown in figure 1. These aspects are built upon the general usability improvement methods of Richter and Flückinger (Richter & Flückinger, 2010). The guideline describes how the acceptance of an application can be optimised, and how the separate aspects are interlinked with the acceptance of the Internet service. For controlling the usability improvement, IGUAN provides the three aspects, each forming a dimension of the usability aspects. The structure of the guideline enables to incorporate the internal and external aspects of the usability improvement process by integrating the core requirements of the application design with the requests of the users. This is broken down into functions which can be easily executed for an increased acceptance.

The first aspect of the guideline is the contextual inquiry (Richter & Flückinger, 2010), which provides the fundamental requirements of the target group by categorisation of the needs in three definite groups: functional requirements, design requirements and application requirements.

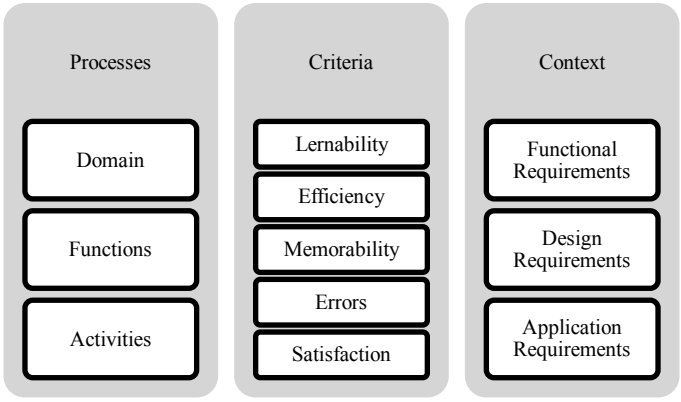

Figure 5: Structure of the IGUAN framework

The functional requirements include general guidance aspects and general configuration requirements. These are set by the objective of the application. These requirements cannot be modified, as they describe the internal functions and processes of the e-government service. The design requirements include generalised design issues. These are derived from the TAM (Davis, 1989) and include as focus the perceptions and attitudes towards the actual system. These have to be declared in relation to the targeted user group. The application requirements include needs which are characteristic for the connection of the target group and the

system. An aspect of e-government systems is trustworthiness, representing the citizens' perception of the credibility of the application. In addition these requirements implement factors which are characteristic for the elderly users, such as an increased font size. The second aspect describes the criteria, which control the usability of an application. These have been selected in accordance with the experience from comparable studies in general software usability assessment (Nielsen & Loranger, 2006), (Park & Lim, 1999), (Nokelainen, 2004), and represent a link to the ISO 9126 (ISO, 2001). These criteria are the basic attribute of the interaction between the system and the user. Fisk et al. (Fisk, et al., 2009) define five core factors, which determine the acceptability of a system. These criteria were also used in the early phases of our research into the requirements of the users. The interviews, which enabled an overview about the user requirements, were constructed along them.

The process aspect represents the main aspect of the usability improvement of the application and provides the actual best-practices for the IGUAN. These can split up into the domains, functions and activities, which directly influence the usability.

Domains – The domains describe the improvement process by describing the redesign cycle with four domains. These domains are aligned with the contextual design and the usability improvement sequence cited earlier for the better understanding of system requirements of the elderly. The hybrid flow-model based on the ISO 9241-110 and shown earlier was refined to create the domain model of the IGUAN. See figure 16 for more details.

Functions - The functions are the activities which result in usability improvements by specifying what is to be done to archive a better acceptance for the application. The steps, which guide the process towards the improvement, are modelled by the 23 activities.

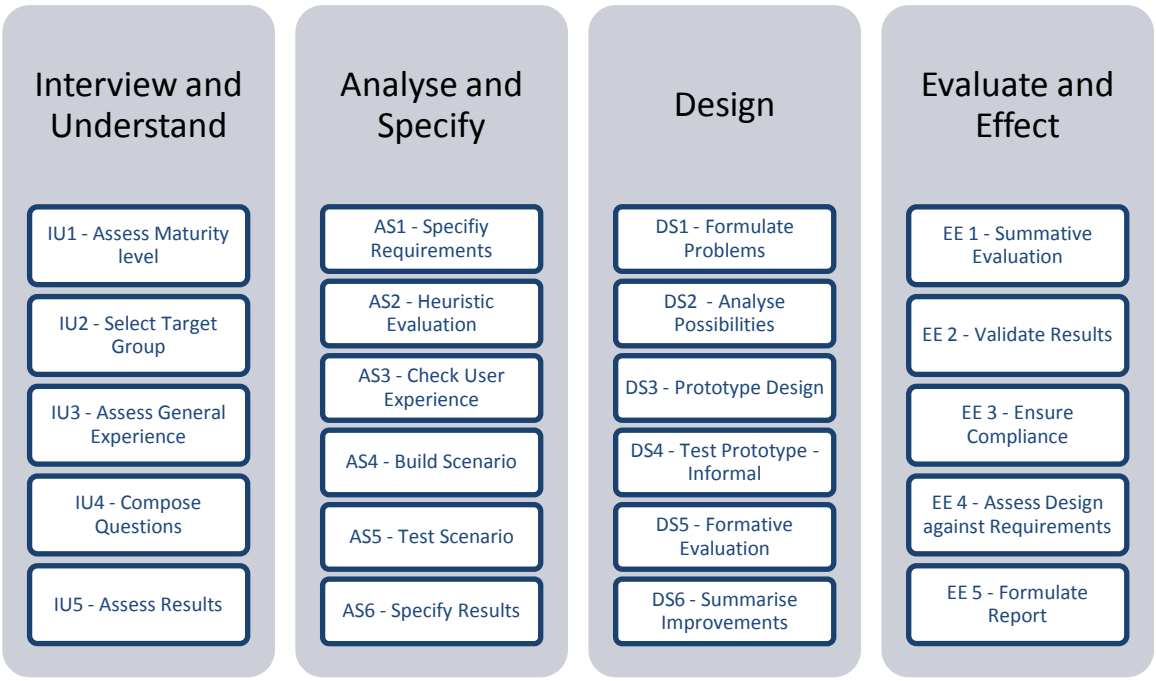

Figure 6: Function model of the IGUAN

Activities - The activities are the direct actions which are required to archive a measurable usability improvement. These can be seen as the execution of the more general functions and allow for a wide customisation of the guidelines for the particular application. The activities also contain the actual methodology of the functions, thereby enabling to use the sophisticated toolset, which the actual usability improvement requires. The functions are grouped by the domains, each domain representing a key component in the usability improvement process.

7. Proof of Concept

The IGUAN framework was verified by the final phase of our research. An iterative development cycle along the recommendation formulated in the guideline was used as a proof of concept. This enabled to create prototypes according to the actual needs and concerns of the target group. This concept was based on the success of this method in other projects. (Bailey, 2005) (Tan, et al., 2001) (Righi, et al., 2011) The proof of concept of the data acquired by the third step was used to build a new and improved prototype through validation. Each modification of the new GUI was validated through expert analysis and comparison to standards. These gave the foundation for the next prototype, which was developed in the application development step of the next iteration.

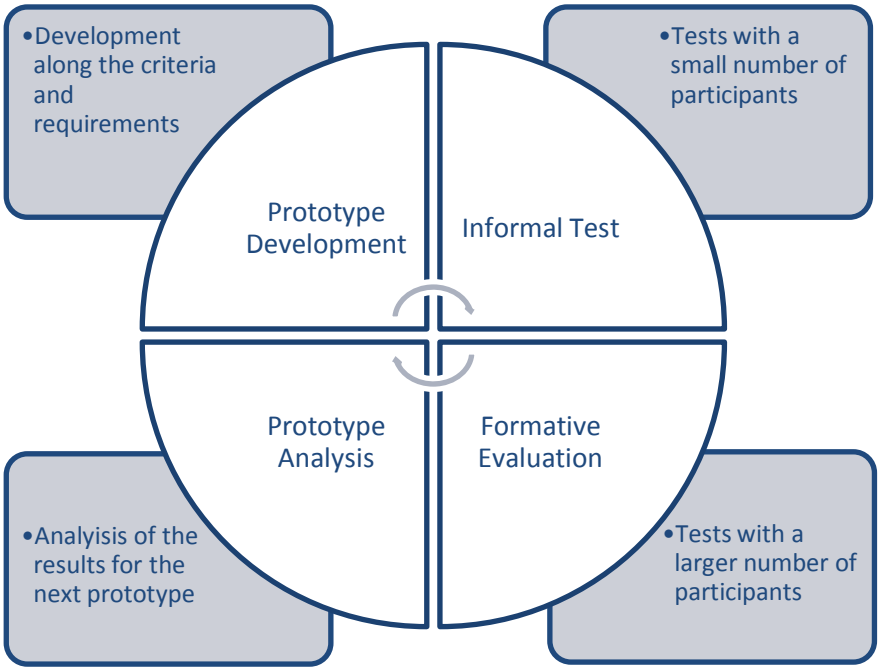

Figure 7: Iterative prototyping and testing (Source: based on (Boehm, 1986))

We based our method on a spiral software development (Boehm, 1986), which combines both design and prototyping phases, thereby bonding top-down and bottom-up methods. A further refinement of this cycle with a usability centred design can be created when using this method along common usability models, thereby improving not only the functional aspects of the software, but also the usability for the target audience. The iterative improvements incorporated into the prototypes were based on the results from the previous phases. The incorporation of small-scale component based usability testing further enhanced this improvement effect. This enabled a deeper understanding of the needs of the target group thereby allowing further usability tailoring of the middle-ware to the actual and measured usability requirements. The formative evaluation of each prototype enabled to visualize usability problems at an early stage by testing with a reduced but still significant number of participants. This allowed for a seamless incorporation of improvements into the final prototype.

This development stage was followed by a summative evaluation of the final prototype in comparison to the results gathered earlier in phase 2. These final tests were conducted in accordance to the previously used analysis and evaluation methods, thereby delivering not only verifiable data, but also enabling a direct comparison with the original middle-ware. This comparison also permitted the isolation of key weaknesses in the original application, and supported thereby a general usability framework. The results from this comparison can be seen in the table 2.

Table 2: Average number of problems encountered by the users – Scenario 1

N = 75		Minor (1)	Medium (2)	Critical (3)
Germany N_G=40	AusweisApp	3.21	1.57	1.82
	Prototype 7	1.42	0.5	0
Hungary N_H=30	AusweisApp	3.8	1.63	1.8
	Prototype 7	1.35	0.7	0
Mean	Prototype 7	1.39	0.6	0

We used an identical methodology for the measurement of the usability as in the phase 2. This enabled a direct comparison of the results. The conclusion from this multi-level analysis is that the improved interface does increase the ASQ scores significantly. This also indicates that the independent variable (the interface) has significant direct influence on the acceptance of e-government systems and that it is possible to enhance systems so that elderly perceive them as ease to use.

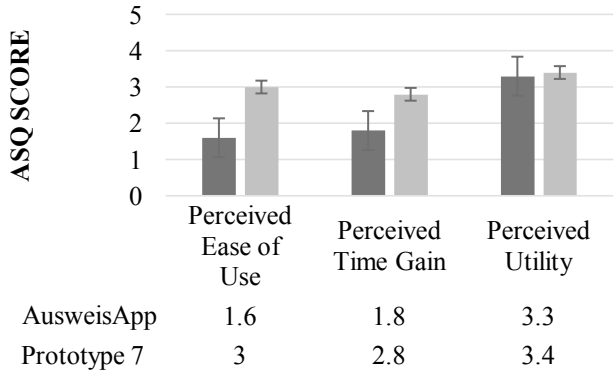

Figure 4: Comparison of ASQ Scores **N_a = 75, N_p=75**

The improvement of the GUI and the higher acceptance of the system were illustrated by the higher respective ASQ scores and the lower RSME rating in comparison to the original AusweisApp. The RSME rating was N_{75}=41.98 for the online banking and N_{75}=31.10 for the film rental application. This not only shows that the system is generally better accepted, but also that less mental workload was needed for the improved application, which not only enables a faster use, but also reduces the frustration with the interface.

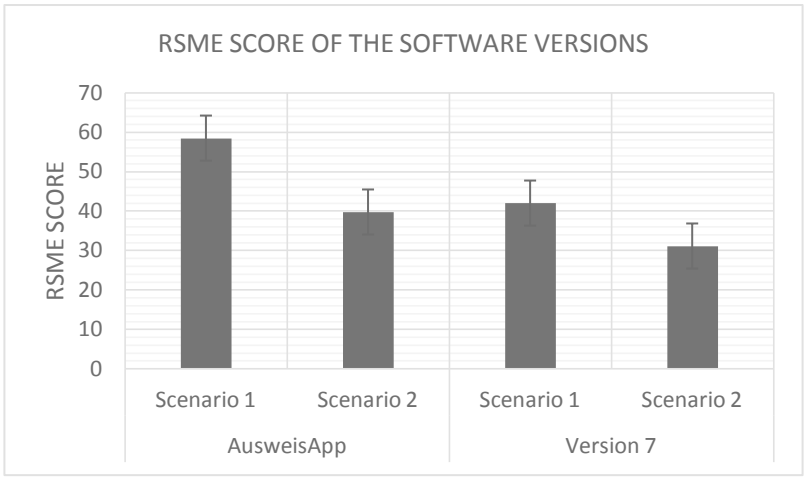

Figure 8: Results from RSME analysis of the AusweisApp and the Prototype 7 for both scenarios. Source: (Zijstra, 1993)

The lower mental effort needed to use the application contributes to a higher willingness to use the e-government system instead of offline services. The mean number of encountered problems could be reduced significantly, with no critical problems observed. This enabled every participant to complete the process

without the likelihood of abort and supports the hypothesis that better interfaces contribute to a higher number of successes and to a better user experience.

8. Conclusion

The results from the proof of concept have shown that usability engineering along a scenario based guideline such as IGUAN results in improved acceptance of e-government systems for elderly users. This also implicates that the IGUAN is applicable as a structured approach to the usability improvement process. The proof-of-concept shown in this chapter makes a reproduction of the procedure possible independently from the application and enables a better understanding of the usability improvement process.

The visible performance of a user centred approach such as the IGUAN illustrates the possibilities of e-government, which have not been utilised until now. Other research groups throughout Europe (van Velsen, et al., 2009), (Schedler & Summermatter, 2007) have also come to this conclusion. The general statement that e-government can present major benefits to elderly, particularly reducing or eliminating difficulties related to the natural ageing process has also been declared by other studies. Compared to Lines et al. (Lines, et al., 2007) our research made a further step from evaluation of this statement into development of a possible solution and it offers a tool to translate the evaluated requirements into system design.

The solution shown in our research by introducing the IGUAN guideline is a first step into this direction. The proof-of-concept phase has shown however, that more research in this field is necessary if we want to utilise the full possibilities of e-government for elderly. Our research also built upon the results by Czaja and Lee (Czaja & Lee, 2007) and followed their recommendation to develop guidelines and examples to aid the design process of applications for elderly. They note however that this cohort is not homogeneous and such guidelines might not be enough. The involvement of the elderly into the design process, which was incorporated in the first phase of our research, might be the solution to this problem according to Czaja and Lee.

The connection of these inputs resulted the IGUAN guideline, which connects the recommendations of Czaja and Lee with the conclusions of other research groups about the behaviour of elderly users with e-services. As we have shown earlier in our research the interface of elderly users and e-government is not fully understood, but we hope that guidelines like the IGUAN can help service providers to offer systems which are accepted by this demographic group.

9. Outlook and further Research

Our vision is that e-government is not only seen by providers as a possibility to reduce costs, but also as a prospect to offer higher quality services for all citizens. The access to these applications should not be reduced through usability and acceptance barriers; any member of the society should be able to use these systems without regard of age or previous experience. Our research accomplished in Germany and Hungary describes a guideline for the successful implementation of such systems. This guideline is however only a tool, which has to be used by providers in order to achieve a higher acceptance of e-government which truly adds additional value for both the government and the citizens.

It will be challenging but not impossible to offer systems which are perceived by the *"late majority*" and "*laggards*" (Rogers, 1962) as a superior way of communication with the government. The vision for such systems should include an effort for a European Union wide standardisation, which would enable a barrier free access of applications, independent from language, experience or complexity. Upcoming challenges include the utilisation of new technologies for an improvement of services quality. Strategies for optimal usability will need to be adjusted faster and faster as new technology offers not only new ways of interaction, but also paradigm shifts in GUI and human-computer interaction. Touch screens on tablet computers need new ideas of usability compared to "normal" computers with keyboard and mouse input. In the three years of this research, the pace and impact of this paradigm shift could already be observed. Early 2010, when our research was initiated, tablet computers were uncommon and expensive. By 2012, tablets have become a mainstream medium as the technology barrier has been overcome and the systems are becoming more and more sophisticated and affordable. Implementation of e-government systems with touch screen input will require more in depth research. This input concept might bring improvements for elderly users. Schneider and Vetter (Schneider & Vetter, 2008) has shown that elderly users clearly prefer this input method over mouse and

keyboard. We therefore expect that the implementation of e-government systems with touchscreen input will increase the acceptability of these services by elderly users. The special issues of this will however need further research, as it is not fully understood how core requirements of e-government systems can be implemented on such devices.

An additional problem, which will be visible in the future of e-government, will be the connection of trust and acceptance. It is a critical commodity, especially for elderly users, when forming communities and implementing new ways of government (Nordfors, et al., 2009). Questions about the encouragement of trust and acceptance will have to be answered in the future if e-government shall be successful in maintaining the promise of efficiency.

In the near future, wide acceptance will be needed to reach goals of supranational and multilateral programs like the Europe 2020, and to enhance the e-government penetration in each member state of the European Union to levels seen in Sweden or other Nordic countries. As shown in our research, these systems become increasingly complex and expensive, therefore it is increasingly vital to assess and incorporate user feedback. The assessment of the demand will therefore become one of the most important requirements for governments. Standards or guidelines like the IGUAN developed in our research will be invaluable for this task and will lead to better and more efficient systems built in accordance with the demands of the citizens. Systems with enhanced will transform the G2C communication in the next decade giving citizens a higher service quality and better user experience.

References

Abramson, M. & Morin, T., 2003. *IBM Endowment for The Business of Government: E-Government 2003.* Lanham: Rowman & Littlefield Publishers, Inc..

Atkins, W., 2004. *The Smart Card Report.* Elsevier Advanced Technologies: Oxford.

Bailey, B., 2005. *www.usability.gov.* [Online]
Available at: http://www.usability.gov/articles/newsletter/pubs/082005news.html
[Accessed 12 Dezember 2011].

Boehm, B., 1986. A spiral model of software development and enchancement. *ACM SIGSOFT Software Engineering Notes,* pp. 14-24.

Bruder, C., 2008. *Gestaltungsprinzipien für das Training älterer Benutzer elektronischer Geräte.* Berlin: Technische Universität Berlin.

Czaja, S. J. & Lee, C. C., 2007. The impact of aging on access of the technology. *Univ Access Inf Soc*, Volume 5, pp. 341-349.

Davis, F. D., 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly,* 13(3), pp. 319-339.

de Jong, M. & Lentz, L., 2006. Scenario evaluation of municipal Web sites: Development and use of an expert-focused evaluation tool. *Government Information Quarterly,* pp. 191-206.

De Jong, M. & Van der Geest, T., 2000. Characterizing Web heruistics. *Technical Communication,* pp. 311-326.

Eurostat, 2011. *Eurostat.* [Online]
Available at:
http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tsdgo330

Fisk, A. D. et al., 2009. *Designing for Older Adults.* Boca Raton, FL: CRC Press.

Hipp, C., 2009. *Elderly Friendly HMI: Graphical User Interface forAmbient Assisted Living,* Stuttgart: Fraunhofer IAO.

Inforum, 2008. *e-Befogadás Magyarországon,* s.l.: Inforum.

International Organization for Standardization, 2010. *ISO 9241-210:2010.* Geneva: International Organization for Standardization.

ISO, 2001. *ISO/IEC 9126-1:2001 Software engineering - Product quality - Part 1: Quality model.* s.l.:ISO.

Kantner, L. & Rosenbaum, S., 1997. *Usability studies of WWW sites: Heurisitic evaluation vs. laboratory testing.* s.l., Snowbird, Utah, pp. 153-160.

Lewis, J. R., 1991. Psychometric evaluation of an after-scenario questionnaire for computer usability studies: the ASQ. *SIGCHI Bulletin*, January, Volume 1, pp. 78-81.

Lines, L., Ikechi, O. & Hone, K. S., 2007. *Accessing e-Government Services: Design Requirements for the Older User.* Berlin, Springer, pp. 932-940.

Maeda, J., 2007. *Simplicity - Die zehn Gesetze der Einfachheit.* München: Spektrum.

Mehra, B., 2004. *Virtual Communities on the Internet: Social Interactions Across the Digital Divide.* Univerisity of Kansas: Univerisity of Kansas.

Nielsen & Loranger, 2006. *Prioritizing Web usability*. the University of Michigan: New Riders.

Nokelainen, P., 2004. *www.uta.fi.* [Online]
Available at: http://www.uta.fi/laitokset/aktk/papers/tech_ped_usability/edmedia2004_pn.pdf
[Accessed 5 December 2011].

Nordfors, L., Ericson, B., Lindell, H. & Lapidus, J., 2009. *eGovernment of Tomorrow Future Scenarios for 2020,* s.l.: Swedish Governmental Agency for Innovation System.

Park, K. S. & Lim, C. H., 1999. A structured methodology for comparative evaluation of user interface designs using usability criteria and measures. *International Journal of Industrial Ergonomics*, Volume 23, pp. 379-389.

Richter, M. & Flückinger, M., 2010. Die 7±2 wichtigsten Usability-Methoden. In: *Usability Engineering kompakt.* Heidelberg: Spektrum Verlag, pp. 21-76.

Righi, V., Sayago, S. & Blat, J., 2011. Towards understanding e-Government with older people and designing an inclusive platform with them. *International Journal of Public Information Systems*, Volume 3, pp. 131-142.

Robinet, A., Picking, R. & Grout, V., 2008. *A Framework for Improving User Experience in Ambient Assisted Living,* Plymouth: University of Plymouth.

Rogers, E., 1962. *Diffusion of innovations.* Glencoe: Free Press of Glencoe.

Schedler, K. & Summermatter, L., 2007. Customer orientation in electronic government: Motives and effects. *Government Information Quarterly*, April, 24(2), pp. 291-311.

Scherer, M., 2008. *Senioren im Internet Beispiele für die Überwindung des altersspezifischen Digital Divide,* Zürich: Universität Zürich.

Schneider, N. & Vetter, S., 2008. Altersdifferenzierte Adaption der Mensch-Rechner Schnittstelle. *IAW SPECTRUM,* Volume 3, pp. 1-3.

Sengpiel, M. & Dittberner, D., 2008. The computer literacy scale (CLS) for older adults - development and validation. *Mensch & Computer*, pp. 7-16.

Snellen, I. & van de Donk, W. (., 1998. *Public Administration in an Information Age.* Amsterdam: IOS Press.

Tan, W. et al., 2001. Design improvements through user testing. *Proceedings of the Human Factors and Ergonomics Society,* pp. 1181-1185.

van Velsen, L., van der Geest, T., ter Hedde, M. & Derks, W., 2009. Requirements engineering for e-Government services: A citizen-centric approach and case study. *Government Information Quarterly*, July, 26(3), pp. 477-489.

Wandke, H., & Jörn, H. (1999). Zum Navigationsverhalten von Anfängern im World Wide Web. *Zeitschrift für Arbeits- und Organisationspsychologie, 43*(1), S. 46-54.

Wright, T. P., 1936. Factors affecting the cost of airplanes. *Journal of Aeronautical Sciences*, Volume 3, pp. 122-128.

Yeh, S., Rubin, E. S., Hounshell, D. A. & Taylor, M. R., 2009. *Uncertainties in Technology Experience Curves for Integrated Assessment Models.* [Online]
Available at: http://gspp.berkeley.edu/academics/faculty/docs/mtaylor/Yeh,%20Rubin-Uncertainties%20in%20Tech%20ExpCurves%20for%20IA%20Models%20-%20IJETP%20accepted%2005.pdf
[Accessed 22 06 2012].

Zijstra, F. R. H., 1993. *Efficency in work behaviour. A design approach for modern tools.* Delft: Delft University of Technology.