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Seppo Pahnila

ASSESSING THE USAGE OF PERSONALIZED WEB INFORMATION SYSTEMS

FACULTY OF SCIENCE,
DEPARTMENT OF INFORMATION PROCESSING SCIENCE,
UNIVERSITY OF OULU

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Academic Dissertation to be presented with the assent of the Faculty of Science, University of Oulu, for public discussion in Auditorium IT115, Linnanmaa, on June 1st, 2006, at 12 noon

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Abstract

The focus of this thesis is to assess factors which have an influence on the acceptance of personalized Web information systems (WIS). This study is primarily based on the widely used and accepted Technology Acceptance Model (TAM).

The qualitative part of the study presents an approach for developing dynamic Web information systems. The development process was based on the work done in the OWLA (Open Web/Wireless Adaptive Hypermedia Applications) research project in 2000–2002.

The quantitative part of the study, which includes the main objective of the study, is related to assessment of user acceptance of the given system. The researcher performed a field study in 2003 in which data was collected using a web questionnaire. The field study resulted in a sample size of 209 responses. Moreover we carried out a comparison with the 2002/2003 field study aiming to study possible differences in respondents' attitude toward personalization. The previous field study was carried out during the OWLA research project. The responses were analyzed using SPSS and AMOS.

Results of the quantitative part of the study show that the respondents accept personalization but they like to and want to adapt and personalize the content themselves. This was one of the most important findings of the study. Respondents do not want the system to provide content automatically; they want to control the content themselves. The results of the 2003 field study indicate that respondents do not consider layout adaptation, whether automatic or manual, to be important or desirable.

The formulated model reveals that perceived relevance is one of the most important aspects that have an effect on attitude toward using and intention to use the given IS. Perceived expectancy and intention to use the given WIS are significant antecedents of actual use. Perceived behavioral control and normative beliefs also have a significant effect on intention to use portal. Enjoyment has a significant effect on attitude.

Overall, we have identified in this study some significant factors which will provide useful information to IS practitioners studying the voluntary adoption of specific personalized systems. The results will also provide useful information for systems designers and will contribute towards assessing possible individual barriers to the use of personalized information systems. The study includes several proposals for future research including developing deeper understanding activities related to presented development approach, creating a more detailed view of factors which have an influence on the user's decision to use or not to use personalized information system, studying several systems.

Keywords: adaptive hypermedia, personalization, user modeling, web information systems

Preface

Someone once said “It's what you learn after you know it all that counts.” I hope and I believe that I have learned how to do research.

There are many people who have supported and helped me in my aim to graduate as a doctor. My warmest thank to my supervisor Professor Harri Oinas-Kukkonen who has motivated and shepherded me from my Master of Science degree to this point. His supportive comments and guidance have helped me a lot. Prof. Oinas-Kukkonen offered me the opportunity to work with the OWLA research project and learn how to do research. Actually, through involvement in the OWLA research project my research interest toward personalization evolved. I would like to acknowledge the OWLA research team – especially Toni Alatalo. Several discussions and brainstorms with him have left their marks on this thesis.

I would also like to thank Professor Helen Ashman and Professor Hock-Hai Teo, reviewers of my thesis for their insightful and constructive comments. Their feedback highlighted the shortcomings and helped me to work on the focus of the study.

I am deeply indebted to Professor Juhani Warsta for his help. He has ensured that I made progress with my thesis. Juhani has pushed me forward by offering persistent support, valuable comments and practical views as to how to go on. I am also grateful to Professor Veikko Seppänen. He has always had time to give valuable advice and guidance with respect to the guidelines of the research. I would like also to thank Vesa Puhakka for his statistical advice.

I appreciate the invaluable aid of the staff at Coronaria, especially Ilari Kerola, Teppo Linden, Markus Junttila and Marika Kylli. Without Coronaria’s support this research would not have been possible.

I want to express warm thanks to the Department of Information Processing Science for the financial and other support which has contributed to my research. So many peoplein my department have contributed their time in promoting the accomplishment of my research.

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Finally, I am very grateful to those close to me: Aila, Tuija and Otto. Their patience and encouragement has strengthened my motivation and given me energy to keep on working with my thesis over the years.

Oulu, April 2006 Seppo Pahnila

Abbreviations

AHS	Adaptive Hypermedia Systems
AIC	Akaike Information Criterion
ANOVA	Analysis of Variance
CAI	Computer Assisted Instructional systems
CFI	Comparative Fit Index
CR	Critical Ratio
FIMNET	Finnish Medical Network
HCI	Human Computer Interaction
HTML	Hypertext Markup Language
IT	Information Technology
ITS	Intelligent Tutoring System
MBA	Master of Business Administration
OECD	Organization for Economic Cooperation and Development
OOHDM	Object-Oriented Hypermedia Design Method
OWLA	Open Web/Wireless Adaptive Hypermedia Applications
RMM	Relationship Management Methodology
SEM	Structural Equation Modeling
TAM	Technology Acceptance Model
TLI	Tucker-Lewis Index
TPB	Theory of Planned Behavior
TRA	Theory of Reasoned Action
T-test	Student's t-test
URL	Uniform Resource Locator
VIF	Variance Inflation Factor
WIS	Web Information Systems
WWW	World Wide Web
XML	Extensible Markup Language

Contents

1 Introduction

The rapid development of information and communication technology enables a multitude of people to have access to global information resources. The more often the world opens to users the more often users expect specialized information services. Users of these services do not want to spend a lot of time solving their problems; instead they want to get reliable solutions to the problems as soon as possible. Often this means that people need to know exactly what they are looking for, where to look, and how to find the solutions. Recently, information systems have been developed that aim at learning usage behavior, and adapting the system according to the user in order to help them perform their daily work (Brusilovsky & Maybury 2002).

Individual users are also quite different. They differ in background, preferences, and knowledge. Traditional "static" hypermedia systems are user-neutral, providing the same view to every user, thus a user meets irrelevant information while navigating in the hypermedia information space (Brusilovsky 2001). To avoid uselessly overloading the user's memory, systems may adapt content, navigation support and presentation to the needs of the user (Thüring *et al*. 1995, Brusilovsky & Maybury 2002). Adaptive hypermedia tries to overcome the negative consequences of hypermedia: cognitive overload and disorientation (Conklin 1987, Thüring *et al*. 1995). Brusilovsky defines (1996b) adaptive hypermedia systems as "hypertext and hypermedia systems, which reflect some features of the user in the user model and apply this model to adapt various aspects of the system to the user."

Web information systems are inherently hypermedia systems. However, Web information systems are not fully compliant with hypermedia systems; they are lacking many features of hypermedia systems (Vitali & Bieber 1999). Web information systems do not support rich structuring, navigation and annotation features (Bieber & Vitali 1997b, Vitali & Bieber 1999, Oinas-Kukkonen *et al*. 2000a). Isakowitz *et al*. (1998) stress that Web information systems are different from Web pages. They suggest that Web information systems are systems which are based on web technology, they are often integrated to other non-Web information systems for example organizations' databases and they support knowledge work. Personalized Web information systems are hypermedia systems which are based on Web techniques providing information considering the user information recorded in the user model (Brusilovsky 1996b, Kobsa *et al*. 2001b).

Although the science behind personalization has undergone tremendous changes in recent years, the basic goal of personalization remains the same: to provide users with what they want or need, and to provide tailored products, services and information relating to products, without requiring users to ask for it explicitly (Mulvenna *et al*. 2000).

The aim for personalizing Web information systems is:

1. to provide users with services of better quality and impressive experiences, getting them to return, to make visitors loyal users and to get new users (Riecken 2000, Kuo & Chen 2001, Kobsa *et al*. 2001b)
2. to allow the users to make individual navigational choices and let them tailor the user interface and operations of the provided service (Kuo & Chen 2001, Kobsa *et al*. 2001b).
3. to collect more detailed information about the users with the purpose of providing the users with products, services and content in the right place at the right time in a convenient manner (Mulvenna *et al*. 2000)

Personalized solutions have been implemented on the Web by allowing the user to modify personalized pages or by allowing the system to make the adaptation automatically (Wells & Wolfers 2000). Both of these solutions have some negative effects. If the user modification is based on a series of alternatives to check on or off, the result may be an annoying experience for the user, which may cause the user to abandon the site, never to return. The alternative is that the system collects data about the user's behavior and applies a series of rules to the site, and as a result of this changes the content of the site when the user revisits. As a result, the user may be become confused because the content of the site changes constantly. Instead of drawing the customer back to the site, a negative experience may drive the user away (Wells & Wolfers 2000). Nielsen (1998) questions the automatic adaptation, and puts an emphasis on the adaptation executed by the users themselves. He suggests that the user is the one who knows exactly what information (s)he needs, and the user is the one who can tailor it best. This is partly true, but when navigating on the Web users often have a lack of time, a lack of expertise in navigating the Web, or they do not recognize the accessible information already available on the Web.

Due to the rapidly growing importance of Web-based applications, new Web oriented approaches for designing and developing these hypermedia-based systems are needed (Lowe & Webby 1999b, Deshpande *et al*. 2002). On the other hand, the complexity and diversity of Web-based information systems has grown from information distribution to complex enterprise applications. The Web has become much more than just an information medium. For this reason, system developers should pay more attention to the Web development processes than to visual design and user interface design (Murugesan *et al*. 2001). Businesses have realized the potential of the Web: its distributed nature, easy access to information, and the potential for interaction between the user and the service producer. When developing Web applications, system developers should understand the turbulent nature of modern business environments and should try to develop new approaches that are capable of reacting quickly to users' transient needs in this challenging environment (Truex *et al*. 1999, Oinas-Kukkonen *et al*. 2000a).

Information systems can only improve organizational performance if these systems are actually used. All technical advances and improvements are negligible and valueless if users will not use them. Therefore it is important for system developers to understand how people decide to use or decide not to use any given system (Mathieson 1991). On the other hand, organizations are very interested in individual decision-making processes concerning the use of certain Internet-based services: why do they use these services, why do they return to the services or why they do not want to revisit certain services (Lederer *et al*. 1998, Heijden 2003).

Research has been conducted to develop models that incorporate attitudinal, social, and control factors to explain information technology usage. One sub-goal for such research is to develop better measures for predicting and explaining information systems usage. This shows the importance of information system usage as a research topic. This is also important for both vendors and system designers. Practitioners generally emphasize the ability not only to predict acceptance, but also to analyze the reasons for which individuals accept or reject information systems.

1.1 Background

Firstly this research focuses on the development of a personalized Web information system. Secondly this research focuses on acceptance factors for the personalized WIS, incorporating the field study. Thus the specific objective of this research is to study the factors affecting the attitude and intention to use the personalized Web information system at hand. By applying the Technology Acceptance Model (TAM) (Davis, Bagozzi *et al*. 1989b), theory of planned behavior (TPB) (Ajzen 1991), innovation diffusion theory (Rogers 1995) and self-efficacy theory (Bandura 1977), this research will take a look at the factors that explain user acceptance of personalized WIS.

Although TAM is a widely used model for explaining the acceptance of information systems, it has some limitations, which have shown up in the context of prior studies:

- TAM does not explain, for example, what motivates individuals to use information systems. Moreover, in most cases TAM is confined to the US (Igbaria *et al*. 1995a).
- TAM has not been applied widely in WWW context (Lederer *et al*. 1998, Heijden 2003).
- user data is collected mainly from students in a university environment, not in a “real environment” (Heijden 2003).
- TAM does not include variables related to human and social change processes and adoption of the innovation model (Legris *et al*. 2002).
- although TAM is a predictive model, it does not provide sufficient understanding related to user acceptance for designers who are creating new systems (Venkatesh 2000d).
- TAM does not consider the importance of social factors (Mathieson 1991).
- TAM assumes that using IS is volitional (Mathieson *et al*. 2001)

This research aims to identify specific behavioral patterns in a specific personalized WIS (medical portal) within a specific context (a real environment). This research will provide a significant contribution for both practitioners and researchers working with the development of personalized WIS.

Rapid development in the area of information technologies has led to the massive growth of the Internet. Companies have seen potential in Internet-based business and have invested huge sums of money in it when competing for potential customers. By using personalized services, companies may serve each user individually at the same time, even all around the world. Therefore more research is needed to increase our understanding related to personalization processes, user behavior on the Web, and the techniques that make Web services attractive to users (Mobasher *et al*. 2000, Mulvenna *et al.* 2000, Straub & Watson 2001).

1.2 The research question

From the theoretical perspective, this study aims to provide new information as to how users adopt personalized services. This study emphasizes a user-centered view, trying to explain and predict users' acceptance of personalized Web information systems. A deeper understanding of users' psychological and behavioral incentives, as well as of their behavior, attitude and intention, will help systems designers and managers to provide better systems and services. This study is primarily based on widely used and accepted theories – in particular the Technology Acceptance Model (Davis *et al*. 1989b), the theory of planned behavior (Ajzen 1991), and the theory of diffusion of innovation (Rogers 1995). When users accept and use personalized systems they also accept and use technologies and innovations. The above-mentioned theories focus on this view.

This research started through surveys in the OWLA project between 2000 and 2002 (2002). Among other issues, the OWLA project studied the features of personalized Web information systems. The idea behind this was to enhance the accessibility of the information system with the developed features. The development of the above-mentioned system was based on user experiences and prior research. According to the preliminary surveys, the potential users were interested in personalized services but they were not willing to implement the personalization themselves, for various reasons. Basically, the motivation and topic of this research arose from the findings of the OWLA project.

The focus of this research is to design and evaluate a personalized Web information system. The research is limited to studying personalization from the point of view of adaptive hypermedia. Assessing the individual acceptance and use of WIS can be done in many ways. In this research, assessment is based on the Technology Acceptance Model, which is widely adopted and accepted in IS research. Experimental results confirm that even a minimal use of adaptive hypermedia can improve the subjective measure of user satisfaction at low cost (Strachan *et al*. 1997, Billsus *et al*. 2002). This research emphasizes a user-centered view of personalization, focusing on the identification of factors that affect a user's intention to use and adopt personalized Web information systems and on the development process. The main research question is to study:

How to design and evaluate personalized Web information systems?

In order to answer this research question, we must also consider an additional subquestion as follows:

How and to what extent does the technology acceptance affect users' attitude toward the use, the intention to use and the actual use of personalized Web information systems?

1.3 Research method

The research approach of this study is multimethodical, combining quantitative and qualitative research comprising nomothetic, theory-testing (Järvinen 2001) and action research (Baskerville & Wood-Harper 1996). According to Järvinen (2000), in the theory-testing approach, theory, a model or framework is used, built or refined based on the literature and prior studies.

With respect to the first research question, an action research approach was adopted. Action research is an iterative process, which combines action and research, practitioners and theory in a single practice (Avison *et al.* 1999). One of the best known definitions of action research is by Rapaport (1970) "Action research aims to contribute both to the practical concerns of people in an immediate problematic situation and to the goals of social science by joint collaboration within a mutually acceptable ethical framework". Rapaport's definition emphasizes the goals of the research. According to Susman (1978), action research is based on an iterative, rigorous cyclic process with five phases: diagnosing, action planning, action taking, evaluating and specifying. The activities of the phases conducted in this research are described in Figure 1.

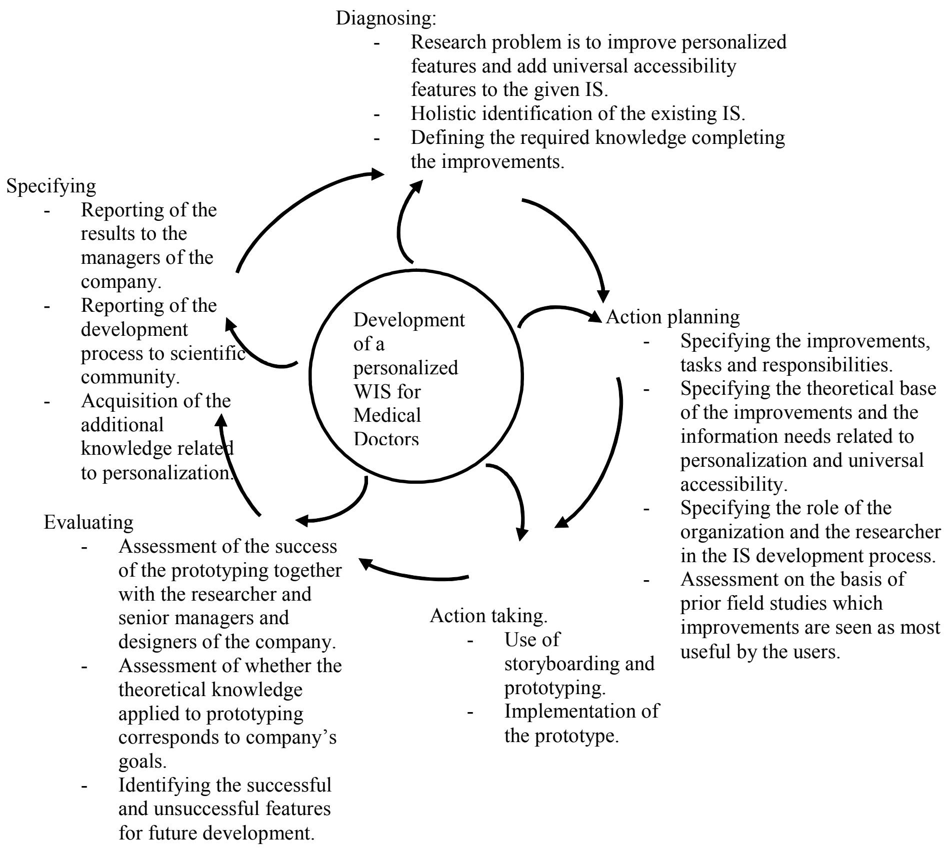

Fig. 1. Action research process model cycles in the development of WIS.

Susman's view emphasizes the process and a clear definition of the research environment, taking into consideration the variety of research projects. Therefore, the number of phases may vary. Although the exact number of phases may differ, the main focus is that a researcher works closely with practitioners in all of the phases (Susman & Evered 1978, Baskerville & Wood-Harper 1996). The duration of the action research process may vary widely. It may last for weeks, months or even years (Mumford 2001).

The research focus set out to improve the personalized features and universal accessibility of the existing system. The research focus was based on the studies that the company had conducted earlier. This action research turned out to be facilitative (Baskerville & Wood-Harper 1998), as the researcher was an expert representing theoretical knowledge. In facilitative involvement, the work is cooperative but the tasks of the researcher and the company are quite clear (Baskerville & Wood-Harper 1998). Thus, in this research the task of the researcher was also to provide theoretical and independent viewpoints and the task of the company was to take care of technical viewpoints. The intention was to carry out the actual development by using a flexible development process model with defined phases during the project. The idea was that by using a process model, the development process would be guided and made easier.

As Figure 1 shows, in the diagnosing cycle the research problem of the existing information system was determined and the essential development features were identified and defined with the senior managers of the target organization. These plans were then refined during the project. In addition, prior surveys executed by the company, technology reviews and discussions with the representatives of the company were exploited when determining this study's objectives. In the action planning phase the researcher and practitioners developed principles and actions towards solving the problem. In the action-taking phase the consequences of the choices were realized by using prototyping and storyboarding[1]. The modifications planned are implemented in the prototype. In the evaluating phase, the researcher and the representatives of the company together evaluated the prototype and the consequences of the chosen modifications. Particular emphasis is placed on examining the extent to which the implemented features promoted or did not promote the organization's goals. Thus, the evaluation cycle also assessed to what extent the theoretical knowledge was realized in the development process. The specifying phase laid the ground for the next steps. We agreed that the prototype offers a good foundation to implement universal accessibility features into the system.

One field study was conducted during the project, and another field study was conducted a year after the project had ended. The results of the latest field study partly indicate how well the development has succeeded. The results of the field study are presented later. According to Mumford (2001), these follow-up studies are essential in an action research project.

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1. Storyboarding is an interactive technique which can be used as an additional aid in redesigning in order to increase the designer's understanding of the system that is being developed (Beyer & Holtzblatt 1998). *Contextual Design. Defining Customer-Centered Systems*. San Francisco, California, Morgan Kaufmann Publishers, Inc. It may consist of a series of pictures with annotations showing how a specific task, for example user interface or some other implementation, will be realized (Beyer & Holtzblatt 1998). *Contextual Design. Defining Customer-Centered Systems*. San Francisco, California, Morgan Kaufmann Publishers, Inc.

The iterative action cycle process may continue regardless of the positive or negative consequences of the selected action. This research process continued for one cycle. Baskerville and Wood-Harper (1998) suggest that action research process may continue for only one cycle if the outcomes of the first cycle are satisfactory. The prototype showed that the project was succeeded. The functionality of the prototype matched up with the goals of the company. The suggested solution could be implemented in to the company's IS and the solution was adaptable into different environments. According to Baskerville and Wood-Harper (1996), disciplinary prototyping "shares all of the distinguishing characteristics of action research and is a frequent cohabitant of IS action research".

In brief, the researcher tests their own assumptions and theories in a real environment, in cooperation with a practitioner, by using feedback to modify the theory and go through these cycles. As stated earlier, the motivation for this research is based on the development completed in the OWLA research project. In that project, in cooperation with the senior managers of the target company, new features for the existing portal were developed, aiming to increase accessibility. User involvement was based on feedback, which was mainly collected by carrying out a survey (field study 2002) during the development work. Moreover, the researcher had an opportunity to exploit prior studies related to the system. The field study was carried out on the Web using an electronic questionnaire. The aim of the field study was firstly to identify user expectations in terms of the existing portal, and secondly to assess the development work executed. Another field study was conducted about one and a half years after the first one. From a business point of view, the primary motive was to make the portal more effective by adding features to the existing system which would enable physically impaired users to use the portal freely. From a research point of view, the aim was to carry out this development rigorously, exploiting our scientific and research expertise. During the project we had regular meetings with the senior managers of the target company. As Mumford (2001) emphasizes, regular meetings throughout the project are important in order to discuss the project's progress and future development. Our meetings followed normal project procedures writing down the plans, requirements, decisions and actions. In every meeting, the actions that had been executed and the impacts of the actions in relation to the development of the given IS were dealt with. Secondly, we planned future actions to be executed before the following meeting, and each time we divided responsibilities for the future work. All the decisions were recorded in the minutes of the meeting. We also communicated through electronic mail and phone calls. As Mumford (2001) emphasizes, the project member or facilitator has an important role as a communicator during the project.

This research is also nomothetic. Burrel and Morgan (1979) describe nomothetic research as follows: "It is epitomized in the approach and methods employed in the natural sciences, which focus upon the process of testing hypotheses in accordance with the canons of scientific rigor. It is preoccupied with the construction of scientific tests and the use of quantitative techniques for the analysis of data. Surveys, questionnaires, personality tests and standardized research instruments of all kinds are prominent among the tools which comprise nomothetic methodology." Nomothetic research is based on empirical data, which is used either to confirm the hypothesis, or in questioning the hypothesis (Salmi & Järvenpää 2000). Nomothetic research aims to discover regularities between phenomena, cause and effect relations, by using statistical analysis and trying to explain the phenomenon under study. It is based on positivism, emphasizing empirical and perceivable relationships and regularities between phenomena (Neilimo & Näsi 1980, Lukka 1991). According to Neilimo and Näsi (1980), typical features of the nomothetic approach are:

– It is explanatory by nature, answering the question "why". These questions characterize relationships and regularities among the variables, which explain the phenomena.
– It consists of a conceptual phase, especially in terms of hypothetic-deductive cases. In inductive cases, a model is built, which is then refined over time.
– It includes an empirical phase. Data gathered in the empirical phase is essential for the research.
– In the confirmation phase, the conceptual and empirical findings are examined.
– The researcher tries to act in a neutral role in relation to the object.
– The researcher tries mostly to examine the object's extrinsic behavior. The researcher is not particularly interested in examining norms and values.

Nomothetic research involves deductive or inductive methods. In practice, deductive research and inductive research are not mutually exclusive; they can be used in the same research. As presented above, the nomothetic approach is based upon a theory, which is used in order to create hypotheses and to build a research model. The hypotheses are then tested on the basis of the empirical data gathered. Usually, a nomothetic approach follows the formula presented in Figure 2 (Lukka 1991).

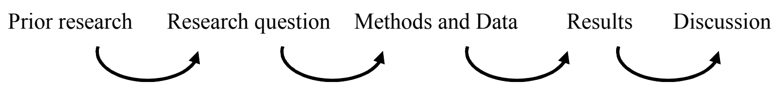


Fig. 2. Linear nomothetic research approach.

This research follows a causal chain based on the widely used and accepted Technology Acceptance Model, which deals with the relationships between attitude, intention and actual use of personalized Web information systems. Usually, causal research is prescriptive by nature, but it may also involve a descriptive approach, especially in the case of longitudinal research or when the phenomenon under study is new in the research field (Alkula *et al.* 1994). Personalization research can be regarded as comparatively new in the field of IS research (Brusilovsky & Maybury 2002).

One goal of nomothetic research is to aim at generalization. Nomothetic research tries to find out, based on the empirical, common features, structures and regularities among the variables (Niiniluoto 1982, Lukka 1991). Generalization is appreciated in natural sciences. It is a critical question with respect to many research areas (Lee 1989, Benbasat & Zmud 1999, Lee & Baskerville 2003).

The above description is consistent with this research process. The research model was formulated on the basis of literature review, and of development work completed in the OWLA research project. Furthermore, during the actual project, many discussions with senior managers in the target company guided the research. Finally, the model formulated was confirmed by the data gathered using Web questionnaires, the data gathered was analyzed and the results were discussed.

1.4 Rigor and relevance of the research

As mentioned earlier with respect to action research, research within the business field is particularly open to debate concerning the rigor of the research, and its relevance in practice. Robey and Marcus (1998) argue that, even if research relates to consumable environments it can be useful for practitioners, and it can be rigorous at the same time. Robey and Marcus (1998) make the following suggestions for rigorous academic research and consumable IS research:

- Pursue practitioner sponsorship: practitioners will fund the research if they will profit from the cooperation. The OWLA project was funded partly by the target company involved in this project. The aim of the study was to enhance the existing system in such a way that it would help the business and the business goals of the companies involved in the project.
- Exploit new research models: the researcher should try to solve practical problems relevant to practitioners using rigorously developed and validated theories. This research applies theories to solve existing problems relating to personalization. These theories are naturally based on prior research.
- Research reports should be of use for both academic and practical purposes. When writing reports, academics should take into consideration a wider audience, and use expressions and concepts which can be understood by practitioners. During this study, summaries related to personalization research and project reports were written using normal project practices. Reports were reviewed by the experts in the target company. The goal was both to create a deeper understanding of the development of personalized WIS, with scientific rigor in a research setting, and to serve practitioners in their work.
- Use both traditional and non-traditional publication outlets. Robey and Marcus emphasize that there are several ways to present research findings, in addition to respected academic journals. Moreover, they emphasize the importance of taking into consideration the practical implications of the findings in the outlets. A state of art of the research was introduced (Pahnila 2003) and preliminary working methods of the study (Pahnila 2004).

Benbasat (1999) requests more such discussion forums which would benefit practitioners. He agrees with Robey and Marcus that the IS field should communicate more effectively with the business community in order to make IS research more familiar to practitioners. Benbasat identifies five reasons which cause lack of relevance to practice in empirical research in the IS field: a) rigor is commonly emphasized, over practical relevance, among IS academics; b) in IS research there is a lack of a cumulative research tradition, which has affected the relevance of IS; c) the dynamic nature of information technology has attracted too many IS researchers, leading to results which are not necessarily relevant for practitioners when they are published; d) for various reasons (for example, lack of resources), IS researchers have limited connections with relevant contexts; and e) finally, institutional and political factors have emphasized and promoted rigorous research rather than practice-oriented research.

IS researchers should take the practitioners' view into consideration, rather than basing research primarily on academic literature. Researchers should also deal with practitioners more, and try to identify issues which will be of interest to or important for practitioners in the near future, rather than those which are of interest at the moment. Benbasat (1999) emphasizes the relevance of IS research outputs: they should enhance practitioners' objectives. When carrying out theory-based research and developing complicated models for explaining phenomena, the researcher should note that the practitioner expects solutions for the problems at hand. We have tried to consider the above-mentioned aspects in this research. This research is based on needs defined by the target company. The results should enhance the company's objectives. On the other hand, this research is based on the literature, incorporating the aspect of rigor.

1.5 Structure of the study

This study consists of seven chapters. The first chapter is an introduction to the study. The second chapter describes principles for hypermedia systems development. The third chapter depicts approaches for Web information systems development based on conventional software engineering approaches. The third chapter also describes the OWLA approach for developing Web information systems. The fourth chapter consists of the literature review related to information system acceptance research considering research related to an information system's success and technology acceptance. In the fifth chapter is described the field study and the statistical analysis of the field study. In the sixth chapter are discussed the results of the study. In the seventh chapter is introduced the conclusions of this study. The structure of study is presented in Figure 3.

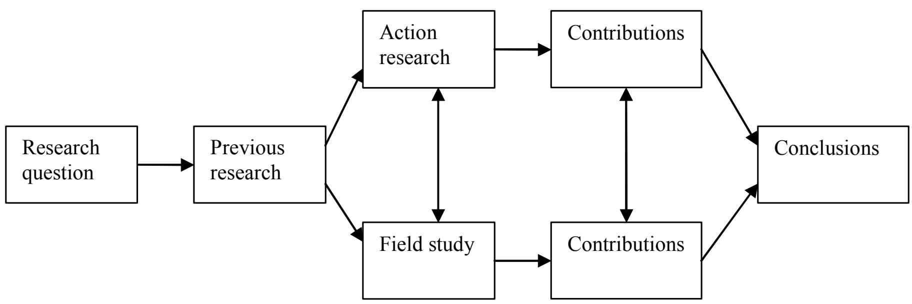


Fig. 3. The structure of the study.

Figure 4 presents the timeline of the activities of the study. The first IS application that included personalized features was launched in 2001. The OWLA (Open Web/Wireless Adaptive Hypermedia Applications) approach was involved in the development of the system. In 2003, the field study was conducted. The aim of the field study was to examine user acceptance of the system. The results of the field study are also relevant in terms of the OWLA approach.

First version of the personalized medical system launched.	OWLA approach to enhance the personalized features of the IS	Field study Sept. 2003
	1. Action research	2. Theory testing
2001	2002	2003

Fig. 4. Timeline description of this study.

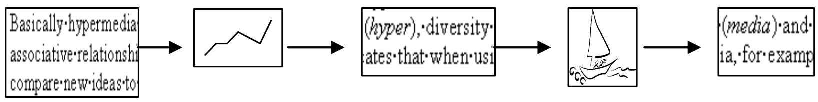
2 Hypermedia system development

This section analyzes the hypermedia development process, and attempts to describe typical features of the hypermedia application which must be taken into consideration when developing it from concepts, requirements and design to finished application. This development process involves different phases, activities and deliverables, which can be modeled in different ways. There are numerous different process models for development work, but the purpose of this section is to describe perhaps the most commonly used models of Web information system development.

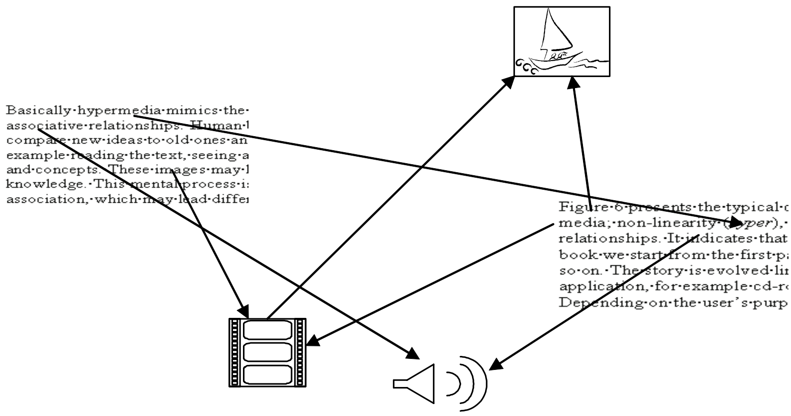
2.1 Hypermedia systems

Hypermedia essentially mimics the human memory, linking information by using associative relationships. Human beings remember information via associations; they compare new ideas to old ones, and this is how they create new concepts. For example, reading a text, seeing an image or hearing a sound may bring to mind new images and concepts. These images may lead to new ideas complementing the existing human knowledge. This mental process is context-dependent: certain situations may arouse associations, which may lead to different situations. (Lowe & Hall 1999).

Figure 5 presents the typical characteristics of hypermedia compared to traditional media; non-linearity (*hyper*), diversity of different media (*media*) and associative relationships. It indicates that when using traditional media, for example reading a book, we start at the first page of the first chapter, then read the next chapter, and so on. The story evolves in a linear way until the book finishes. When using a hypermedia application, for example a CD-ROM encyclopedia, there are different paths to choose. Depending on their needs, users have to make a decision about the appropriate path to take when moving from one page to another.



Linear “linking” of traditional media



Nonlinear “linking” of hypermedia

Fig. 5. Traditional media vs. hypermedia (Lowe & Hall 1999).

Kobsa (2001b) defines a hypermedia system “as an interactive system that allows users to navigate a network of linked *hypermedia objects*. In the case of the WWW, these hypermedia objects are Web pages.” Hypermedia objects consist of information chunks, which can be different media types such as text, images, audio clips, video clips, etc (Kobsa *et al*. 2001b). Chunks are linked to elements or to other chunks making up an associative information structure. As discussed above, the links can be between chunks within the same Web page, between the pages of the same website, between the pages of the local website or between the pages of global websites (Kobsa *et al*. 2001b).

The main focus of hypermedia is that it combines different media elements composed of an associative network of nodes supporting the interaction between user and system. Lowe and Hall (1999) summarize the goals of hypermedia as follows:

– Hypermedia should facilitate the actions which will lead to identification of the appropriate information. ‘Appropriate’ means the relevant information in a given context.
– Hypermedia should facilitate the effective use of information

– Hypermedia should facilitate the actions which will lead to control of the appropriate information, which means that we can use information effectively, and analyze and manipulate it in appropriate way.

Lowe and Hall (1999) define hypermedia as “an application which uses associative relationships among information contained within multiple media data for the purposes of facilitating access to, and manipulation of, the information encapsulated by the data”. Lowe and Hall emphasize that the definition of hypermedia includes two important aspects: firstly access to and manipulation of the information, and secondly associative relationships amongst the information (Lowe & Hall 1999). Associative relationships differentiate hypermedia systems from other information systems. These relationships act as links when navigating from one site to another. The problem is that we cannot know for certain which path we should take, and, furthermore, we do not know beforehand how relevant this path’s destination will be. The relevance of the information is dependent on an individual’s background, motivation, preferences, given task etc. This sets high requirements for the developers and managers when developing hypermedia systems. How could the developer of the system know the individual’s different purposes, goals, preferences etc, and link the nodes in appropriate way? Basically there are two ways. Either the system developer has to try to foresee the correct linking structure, taking into consideration the requirements of diverse users, or the system has to collect individual information about the user, combining this information with the content and recommending appropriate choices to the user.

Hypermedia engineering is based on the same systematic and disciplined approach as software engineering. According to Lowe and Hall (1999), hypermedia engineering can be defined as “the employment of a systematic, disciplined, quantifiable approach to the development, operation and maintenance of hypermedia applications.” Although there are certain similarities between hypermedia engineering and software engineering related to the processes of system development, Lowe and Hall (1999) see clear differences between the tools and methodologies used in the processes. Therefore they emphasize that hypermedia engineering is necessary: the conventional software engineering approach cannot satisfy the requirements and the ambiguous nature of hypermedia systems. When debating and comparing the differences between hypermedia engineering and software engineering, Lowe and Hall cite Nanard and Nanard (1995): “Fundamental differences, however, make a pure transposition of techniques both difficult and inadequate. An important part of hypertext design concerns aesthetic and cognitive aspects that software engineering environments do not support.”

2.2 Adaptive hypermedia systems

The history of adaptive systems (and user modeling) can be traced back to the Artificial Intelligence field of the late 1950s and early 1960s. At that time many researchers had the dream of making computers ‘think’ as humans do. In July 1945, Vannevar Bush published the article “As We May Think”, in which he envisaged a future in which computers assist humans in many activities, by trying to simulate a human being’s mental model. Bush’s visions, which are concerned with relationships between pieces of information, include similarities with the concept of hypermedia. He was dissatisfied with the linear and hierarchical indexing system mechanism used when searching for information in libraries at the time. According to Bush,

> "The human mind does not work that way (using indexing, researcher's remark), it operates by association. With one item in its grasp, it snaps instantly to the next that is suggested by the association of thoughts, in accordance with some intricate web of trails carried by the cells of the brain. It has other characteristics, of course; trails that are not frequently followed are prone to fade, items are not fully permanent, memory is transitory. Yet the speed of action, the intricacy of trails, the detail of mental pictures, is awe-inspiring beyond all else in nature."
>
> "Man cannot hope fully to duplicate this mental process artificially, but he certainly ought to be able to learn from it. In minor ways he may even improve, for his records have relative permanency. The first idea, however, to be drawn from the analogy concerns selection. Selection by association, rather than indexing, may yet be mechanized. One cannot hope thus to equal the speed and flexibility with which the mind follows an associative trail, but it should be possible to beat the mind decisively in regard to the permanence and clarity of the items resurrected from storage." (Bush 1945)

In 1950, Turing (1950) introduced the idea of a logical machine and the question whether machines can think. The research work relating to Artificial Intelligence was mostly carried out in the area of tutoring systems. Computer Assisted Instructional (CAI) systems were the main achievement of the research work. In the 1970s, considerable improvements occurred and the CAI systems gained the ability to anticipate the student's answers with the help of a student model. Later, in the1980s the term Intelligent Tutoring System (ITS) was coined. ITSs were systems which took care of the monitoring, coaching and instruction of the students. The main limitation was that those models did not perceive information about the student's knowledge of the information domain. Later, in the 1990s, as a consequence of the World Wide Web becoming a primary information delivery medium, both the user modeling and the adaptive interface communities combined their ideas and laid the foundations for adaptive systems (Bailey 2001). Over the last ten years, researchers in adaptive hypermedia and Web systems have developed many adaptation methods. The common goal of this work has been to move towards systems with an ability to tailor interaction to different users in the same context, instead of providing the same adaptation effect to all users, that is, the "one-size-fits-all" approach (Brusilovsky & Maybury 2002).

Adaptive hypermedia systems can be defined as "*all hypertext and hypermedia systems which reflect some features of the user in the user model and apply this model to adapt various aspects of the system to the user"* (Brusilovsky 1996b). According to Brusilovsky, an adaptive hypermedia system should encompass three criteria:

1. it should be a hypertext or hypermedia system
2. it should have a user model
3. it should be able to adapt the hypermedia using this model

(ibid.)

An adaptive hypermedia system tries to anticipate the actions of individual users based on their prior Internet behavior, and will help them to navigate in many ways by hiding links, limiting the hyperspace or by showing appropriate link annotations. Essentially, the idea of adaptive hypermedia is based on monitoring what the user is doing and, when necessary, asking questions. In other words, the system tries to learn how the user will behave.

The goal of adaptive hypermedia is to increase the functionality of hypermedia by making it personalized (Brusilovsky 1996b). This requires the system firstly to collect comprehensive information about the user, secondly to adapt the content, information structure and/or presentation according to this user information, and thirdly to provide the user with the results of this adaptation. Systems that perform these steps automatically are called adaptive.

2.2.1 The importance of adaptive hypermedia

As the information space is growing all the time, it has become too complex for the user to manage; hence new methods and techniques are needed. Thus, managing the continually growing hypermedia space has become more difficult for authors, and for users. Several researchers have indicated that hypermedia has some inherent disadvantages, such as coherence, cognitive overhead, comprehension and disorientation which affect user navigation (De Bra & Calvi 1998). Adaptive hypermedia tries to overcome the negative aspects of hypermedia. Adaptive hypermedia systems can be useful especially when the users have different backgrounds, different preferences, different knowledge of the domain and different expertise relating to familiarity with the structure of the hyperspace. Users may, for example, use different link paths depending on their varying expertise or goals, when navigating in hyperspace (Brusilovsky 1996b).

In a non-linear hyperdocument there may be many different alternative paths to follow. This could be very confusing for the user, thus it is impossible to ensure that the user has reached all the pages that any given page depends on. Therefore it is important that the user has an understanding or view of the structure of the hyperdocument (De Bra & Calvi 1998). The feeling is quite similar to one you might get when visiting a big city and trying to find the best clothing store. You have many stores to choose from but you are uncertain about which is the right one, so you have to visit several stores to assure yourself that you have made the right decision.

Thuring, Hanneman and Haake (1995) differentiate two kinds of applications designed for users. One encourages wandering in information space gathering interesting information, while the other assists in problem-solving and in learning. According to Thuring *et al*. (1995), in cognitive science, comprehension is characterized as the construction of a mental model. The readability of a hyperdocument can be improved by assisting readers in the construction of their mental models in a way that corresponds to facts and relations in the real world. Moreover, improving coherence and reducing cognitive overhead have positive effects on readability (Thüring 1995). Conklin describes cognitive overhead as “the additional effort and concentration necessary to maintain several tasks or trails at one time” (Conklin 1987). Cognitive overhead refers to the mental state or situation which arises when the user has been presented with several links to follow. It is very difficult for the user to know or to decide which links are the most relevant; basically the problem is of making the right decision.

Disorientation, also known as the “lost in hyperspace problem”, occurs when users move about in hyperspace, and suddenly find that they do not know where they are, how they got there or where they should go next (Thüring 1995). Users have lost the sense of location and direction in a hyperdocument (Conklin 1987). Disorientation also implies that there could be broken links, the information structure could be too complex, or navigational clues could be missing.

2.2.2 Hypermedia adaptation and adaptability

In hypertext and hypermedia systems, a user can navigate freely in information space. The motivation for navigation is based on the user’s skills, knowledge and preferences. The user can manage her/his personal view e.g., using bookmarks. It is difficult for the system to predict a user’s behavior if the user does not give the system information about her/his preferences, intentions, goals, and so on (Brusilovsky 1996b). This interaction process is often called *adaptability.* Adaptive hypermedia systems can provide relevant and interesting information automatically, based on a user’s preferences. *Adaptation* can be seen as an end product, while adaptability and adaptivity are two different methods of implementation (Scharl 2000).

One of the major problems in developing user-friendly computer systems is the question of the system’s understanding of its users, their goals, knowledge and preferences. In order to build such a model it is necessary for the system to collect some specific pieces of information about the user and to take into account specific characteristics of the individuals (Rich 1979), (Rich 1999). If we want to treat users as individuals rather than as if they were all alike, there are two ways to build a user model, depending on the amount of user control over adaptation; one is to allow the user to modify the system to suit themselves. This is also called an *adaptable* or configurable user model. This kind of personalization is convenient for users who are casual visitors, where the system in question does not have enough information about the user (Rich 1979). Adaptable systems allow the user to control different settings of the user model, and the role of the system is to provide help or guidance and behave according to the user’s adjustments. The user can make changes to her/his settings, for example at the beginning of a session or by answering questions or selecting options (De Koch 2000).

Another, more advanced way is to allow the system to obtain information about the user in order to allow the system itself to take care of personalization without human intervention. This kind of automatic personalization carried out by the system is called adaptive user modeling. Adaptive user modeling is especially effective when the system gradually gains more information about the users, and learns more about the user’s interests, behavior and preferences. For example, Amazon.com tries to discover what kind of books the user likes based on the behavior of other users, so it can recommend appropriate books. Most people, especially nowadays, are unwilling to stop and answer a large number of questions; instead they want to continue working with the computer. In cases like this it is better to allow the system to build its own user model based on the known characteristics of the system’s overall community (Rich 1979).

Figure 6 shows a conceptual model of an adaptive hypermedia system with an embedded user modeling component. Adaptive hypermedia systems and hypermedia systems can be seen as two mutually-exclusive approaches. Basically, hypertext systems are user-neutral: they offer the tools necessary for navigating and searching. Moreover, users can manage their personalized views by making note of – bookmarking – pleasing pages, or by defining different settings. Truly adaptive systems are primarily managed by the system. They provide automatically personalized information navigation on the basis of the user model information (Scharl 2000).

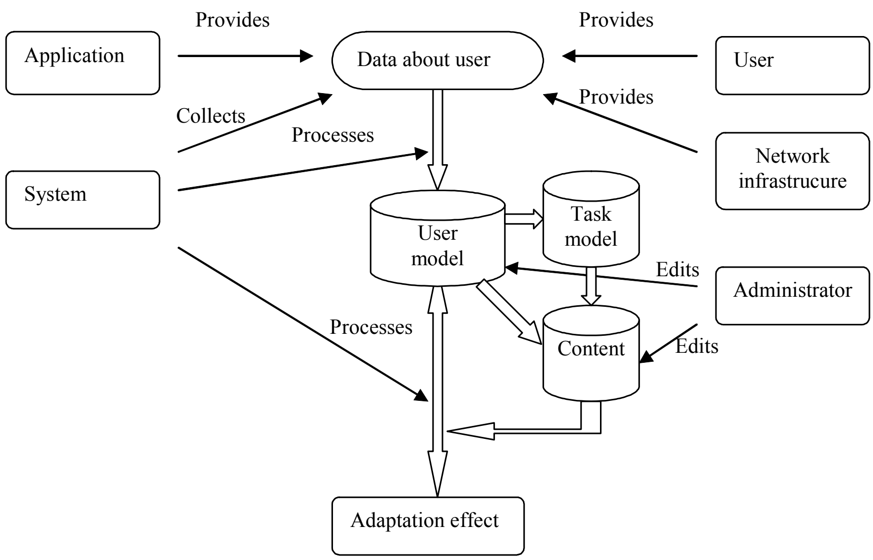


Fig. 6. User modeling adaptation based on Brusilovsky (1996b).

Different functions can be highlighted in the adaptation process:

- Collecting data about the user. The application may provide some user information for example via cookies, a session or registration. The user may also provide some explicit information, for example related to hobbies, work or leisure, when answering inquiries or filling in a form. The system may collect data using session information.
- The system processes data to build or to update the user model. The administrator (or in some cases the user) may edit user model information.
- The system uses the user model information, combining it with content to provide the adaptation effect. The task model determines the tasks at hand.

Data about the user can be supplied by the application (e.g., using cookies), by the system (e.g., through sessions), by questionnaires or by registration. The adaptation can be carried out using intelligent adaptation technologies, e.g., using adaptive content selection, adaptive navigation and adaptive presentation (Brusilovsky & Maybury 2002).

In fully automated systems, the adaptation process is executed by the system. However, to some extent adaptation usually includes both manual and automated operations. Some researchers have criticized fully automated systems. Nielsen questions the need for artificial intelligence (adaptive hypermedia systems, which are based on user models) and emphasizes the importance of natural intelligence (user intelligence) or user adaptation. He suggests that the user is the one who knows exactly what she/he needs, and the user is the one who should tailor the information (Nielsen 1998). On the other hand, in most cases users do not have enough expertise to perform the adaptation themselves: they do not know what they want or they do not want to waste their time on adaptation.

Individual users differ greatly. They differ in terms of background, preferences, and knowledge. Standard hypermedia systems are user-neutral, providing the same view to every user, thus the user meets irrelevant information while navigating in hypermedia space. To avoid overloading her/his memory unnecessarily, the system adapts information and links to the needs of the current user (Brusilovsky 1996a).

2.2.3 Adaptation methods and techniques

The most important question in developing hypermedia systems which are based on user preferences is what can be adapted. Since hypermedia consists of nodes (or, as they are referred to here, pages) connected by links, the most common ways of creating the adaptation effect are centered on the content of the page and the links. Adaptation can be divided into two categories (see Figure 7): adaptive presentation, which is linked with content-level adaptation, and adaptive navigation support – that is, link-level adaptation. Adaptive presentation techniques consist of the selection of different media relating to the user's current knowledge, goals, preferences, or to other characteristics of the user. Adaptive navigation support consists of different techniques e.g., direct guidance, sorting and hiding links, which help users to navigate in the hypermedia space (Brusilovsky 1996b). This kind of link-level adaptation can be useful: it provides navigation support for novice users, it prevents users from encountering irrelevant pages and it accounts for users with different preferences by offering new, tailored paths to navigate. On the other, hand some of these techniques – for example hiding links – also shrink the information space, reducing the user's cognitive load.

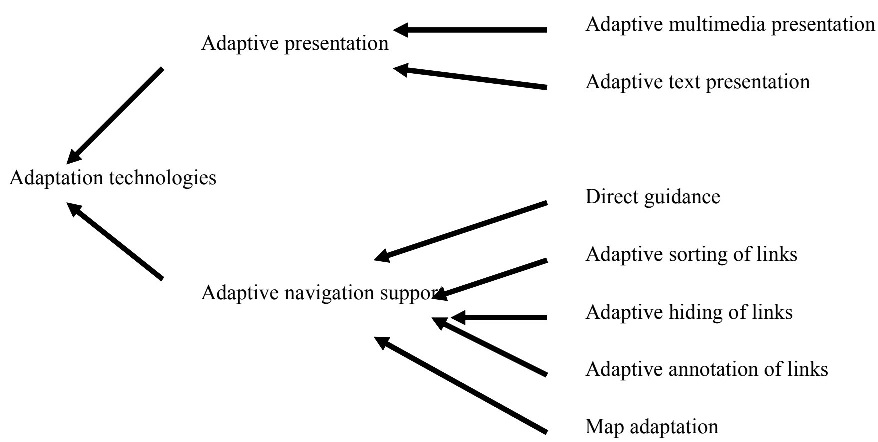


Fig. 7. Adaptation technologies in adaptive hypermedia (Brusilovsky 1996b).

As mentioned above, the history of adaptive hypermedia can be traced to the field of intelligent tutoring systems. Hence the most popular application area for adaptive hypermedia is education applications. Other popular application areas are (Brusilovsky 1996b):

- on-line information systems and on-line help systems
- information retrieval systems
- institutional information systems
- systems for managing personalized views in information spaces
- personalized sites like my.yahoo.com or Amazon.com

2.2.3.1 Adaptive presentation

Adaptive presentation techniques will adapt the content of the page to the needs of the identified user. The adaptation is based on recorded information about the user. The content of the page or information provided can be text or multimedia. Brusilovsky distinguishes between adaptive text presentation and adaptive multimedia presentation because some existing hypermedia systems do not contain non-textual items and some adaptive hypermedia systems can only provide adaptive text presentation. Generally speaking, there are many different techniques for providing adaptive text presentation, but the goal is the same (Brusilovsky 1996b). De Bra (2002), among others, uses the notions of fragments, pages and concepts to describe the domain model. Pages are XML files which include fragments of HTML text or embedded images. Pages are connected to each other with hypertext links. A concept is a fragment of a page or a chunk of information that describes an item of knowledge. Concepts can be connected with information topics the user knows about, the user's concerns, preferences, goals, questions, etc.

2.2.3.2 Adaptive navigation support

Adaptive presentation aims to generate appropriate content in the document. Adaptive navigational support tries to help users find the relevant relationships between the documents. One goal of adaptive navigation support is to make it easier to find the relevant information more quickly, saving the user's time and workload. There are a number of different techniques for navigational support: direct guidance, link sorting, link hiding, link annotation, using maps, etc. The main purpose of these techniques is to reduce the disadvantages of navigation by trying to support and improve guidance, orientation and the management of the interface (Brusilovsky 1996b).

2.3 User modeling

One of the first to use the notion of the user model was Elaine Rich. She suggested that one "major problem to be confronted in the quest for a sympathetic computer system, besides that of man-machine communication, is the question of the system's understanding of its users, their goals, knowledge, preferences, etc. In order to deal effectively with its users a system must have a model of them" (Rich 1979). Building such a model requires that the system collect some specific pieces of information about the user. Rich proposed that if we want to treat users as individuals and not all alike, there are two ways to make systems different for different users. One is to allow the users to modify the systems appropriately for their own needs, and the other is automatic personalization. This demands that systems have to gather enough information about the users to provide personalized information to the users (Rich 1979).

There are many definitions of the user model, dating from the early days of natural language systems up to the present day. According to Rich, the term 'user model' refers to a wide variety of knowledge about people (Rich 1999). Kobsa has used the notion of adaptivity in his definition of user models: "User models are collections of information and assumptions about individual users (as well as user groups) which are needed in the adaptation process" (Kobsa 1995). This implies that the system should be able to monitor user interaction continuously and use this monitoring data to make assumptions which are valid for the user. Kobsa's definition includes the manual adaptation of the interface by the system developer according to the requirements of the users (Kobsa 1995).

The main purposes of user modeling are (De Koch 2000):

- to help the user find information
- to help the user in navigation
- to provide information to the user based on her/his knowledge and preferences
- to help the user to manage information
- to support collaborative work
- to empower the user to interact with the system
- to adapt the interface to the user

The success and advantages of adaptive hypermedia depend on user data; hence it is important to supply sufficient, relevant and up-to-date data about the user. The essential question is, therefore, how to find out the user's real needs and collect adequate information. The problem is that the users' needs may vary depending on time, location, cultural background, expertise, knowledge, cognitive skills and other reasons for searching for information. This is why the system should always know the user's varying preferences. The main information which systems usually record is related to the user's navigation path, the user's Internet protocol (IP) address, how long the user spent on a certain page, which pages the user has visited, how much information the user has downloaded from certain pages, the operating system used, and the user's connection speed. It is quite difficult to predict from this recorded information how the user will behave or when he will revisit. A wide variety of user models have been developed to support specific applications. Figure 8 shows an archetypal employing a user model component.

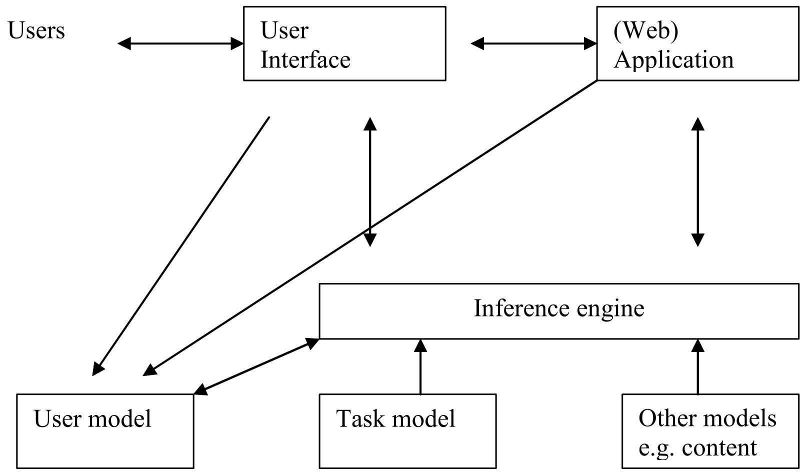


Fig. 8. Archetypal system employing a user model component.

As mentioned earlier, adaptive hypermedia systems are always based on a user model. On the basis of the user model, the adaptive hypermedia system tailors its content, structure and interface representation to the needs of the user(s). Typically, this user information is stored in a database (Scharl 2000). The system builds a model of each individual user, taking into account the user's goals, preferences and background, and applying that model in order to adapt to the user (Brusilovsky 1996b). In order to build as accurate a user model as possible, the system must have access to a wide variety of information about the user. In practice, the system's knowledge about the user and ability to build an accurate user model increases the more the user interacts with the system.

The purpose of the user model is to collect together the essential information from a vast amount of information, and make assumptions about the users or groups of users in order to provide relevant content. User models also try to protect users from the harmful consequences of the Web: information overload and the "lost in hyperspace" problem (Lowe & Hall 1999). The content, the structure of the user model and the user interface may all be tailored either by the Web information system or by the administrator. Therefore, the design of the user model should be an important part of the designing process, and it influences substantially the functionality of the Web information system. According to experimental results, even a small-scale user modeling component can improve user satisfaction and has an influence on the functionality of the Web information system (Strachan *et al.* 1997, Billsus *et al.* 2002). Information about the user and their interaction history is a prerequisite for relationship marketing. One major obstacle in relationship marketing on the Internet is the lack of user data. User needs, preferences, tasks and actual behavior are vague variables, which are very difficult or even impossible to measure (Scharl 2000).

Typical user information recorded and maintained in the user model is (Brusilovsky 1996a):

– User preferences and interests (e.g., related to information, products, services)

– Attitudes and goals (e.g., find a certain product or topic of information)
– Proficiencies (e.g., domain knowledge, expertise, skills, capabilities)
– Interaction history (e.g., interface features used, tasks performed/in progress, goals attempted/achieved, number of requests for help)
– User classification (stereotype)

Values for the attributes are collected by questionnaires, by monitoring user behavior and actions, or by analyzing recorded data.

Inputs to the user model:

– Explicit preferences from questionnaires
– Explicit demographic data (e.g., name, address, age, gender, occupation, city)
– Specific actions (e.g., using help and guidance)
– Self-assessment

There are some risks of using user models in adaptive hypermedia systems. Brusilovsky emphasizes, for example, that the user model is not reliable because the user modeling is based on a deduction of how the user will behave. It is difficult to carry out adaptation based on, for example, the preferences and background of the user (Brusilovsky 1996b). Even if the user model is not accurate, it can be useful because it may help the user to manage the continually growing information space. Moreover, by using techniques which are able to limit browsing space, navigation can be made easier, and the user can save time and effort. Users appreciate having quick access to information they need. Wahlster and Kobsa (1989) emphasize the user's need for control over the user model. They suggest that if the user is aware that the system collects information in a comprehensive way, users may become anxious about the system and they may try to hide their beliefs, goals or preferences.

To improve user interaction and to provide more accurate adaptation, the system can request user feedback directly, and can allow users to make the required adaptation themselves. By monitoring users' Internet behavior the system can instantly update the information received from its users. Requesting feedback can be intrusive too, because it demands user activity, such as mouse-clicks. If the user is to be allowed more control over the system, this can be provided in many flexible ways. One should still remember the possible negative consequences and not provide too many options and choices in setting up the application (Scharl 2000). On the other hand, the user should be aware of all the information that is gathered. For example, in the countries where the European Union directives are applied users should be informed how the collected information is going to be processed (informed consent).

One harmful feature of a sophisticated agent-based user model system is that agents can make wrong guesses, and make hidden changes that users do not like. It could be impossible for the users to turn off these agents, which can lead to undesirable consequences because the user feels that she/he has lost control (Fischer 2001). Secondly, user models collect and record a wide diversity of information, for example addresses, age, occupation, and Internet behavior. One cannot be sure that one's information will not be misused, and users do not have control over the private information recorded in user models (Fischer 2001).

Without a user model, the system will act the same way towards all users using a "one-size-fits-all" principle. The user model enables the system to adapt its performance taking into consideration differences between users as well as changes in user skills, background, preferences and interests. As mentioned before, one goal of hypermedia systems is to limit hypermedia-browsing space. This can reduce the "lost in hyperspace" effect, and, furthermore, adaptive hypermedia can reduce "cognitive overhead" and coherence effects (Thüring 1995).

There are many research fields which have focused on human behavior in trying to understand it and the interactions between humans and computers. The automatic adaptation of software systems to the current needs of users is recognized in many areas. The history of user modeling can be traced to the field of natural-language dialogue systems and man-machine communication. The research work done in user modeling has spread into many other research fields, for example Intelligent Interfaces, Adaptive Interfaces, Hypertext Systems and Human-Computer Interaction (Kobsa 1993).

The main focus in Human-Computer Interaction (HCI) studies has been on the interactions and the relationships between humans and computers. However HCI is more than user-interface interaction: it is a multidisciplinary and wide field of research which seeks to improve the way people use computers. At the beginning of HCI history, the studies focused on interfaces, with the aim of attempting to understand how to increase the usability of technology and create more usable systems. At present, HCI studies focus on collaborative work, dealing with the issues of how to create more useful systems, for example by examining how people work, communicate or in general interact with computers. Similarly, user modeling research focuses on issues relating to information access and providing information that satisfies user needs (Fischer 2001). However, the focus of HCI is on increasing usability, not necessarily acceptance.

Information about the users is an absolutely essential condition for an adaptive hypermedia system. User data can be supplied in many ways. The easiest way is to ask the users for the necessary information directly. It is also proper and according to regulations to ask the user whether this information can be recorded and used for future communication. The other way to gather and exploit user information is by doing it behind the scenes.

The more user information the system has access to, the better the model the system can build about this user. Sometimes people might be willing to give out information, but sometimes it can be an obstacle and turn the visitor away from the site. Information can be supplied by the user or by the system both explicitly and implicitly. Usually, when the user logs onto the system for the first time, the system may ask him or her to fill out a registration form, for example. In this case, user information is collected implicitly by using cookies and explicitly by filling out a form.

The system may track the user's browsing behavior, attempting to determine and learn about the user's actions. Some of these implicit and explicit ways of gathering data may employ information of a private nature. Recently there have been discussions about privacy related to the Internet and the World Wide Web in particular (Bauer & Scharl 1999). Those who gather user information should take into consideration privacy laws and regulations, which vary from country to country, and respect these laws. (Bauer & Scharl 1999, Kobsa 2001a).

Questionnaires are commonly-used, explicit methods for information acquisition. However they do have some disadvantages. Using questionnaires may arouse negative feelings in the user, which can cause problems as such questionnaires are usually based on the willingness of the users; questionnaires require user activity; and they are based on the subjective views of the user, which may question the relevance of feedback. Users are not very objective, even when they are trying to be (Scharl 2000). One simple way to gather user information is by using registration. When the user visits a site and is willing to log in to the site, the system will ask them questions relating to their work, hobbies, preferences etc. After the form has been filled out, these answers are stored in a database. By using a unique user ID or password, the registration information can be connected to the user profile. The system asks for this user ID or password when the user revisits the site and logs in.

Gathering data implicitly is based on unobtrusive observations of online behavior. By analyzing a user's online behavior, for example by analyzing HTTP cookies and session file information, it is possible to get to know the user's preferences and navigation behavior better, even though analyzing HTTP cookies and trying to interpret IP addresses can be an arduous process. Implicit acquisition methods also create less of a burden for the user, and are based on users' real interaction with the IS.

Cookies are small computer files for identifying Web users, making it easy to track their movements around a site. Site administrators aggregate and analyze cookie information, which can be useful in evaluating the site's effectiveness as well as in identifying visitors. Web server cookie information contains useful pieces of information, for example for Internet shopping site administrators. When a browser requests a page from the Web site, the Web server creates a cookie with an ID-number, if you are visiting for the first time. The server records this cookie in its database and sends a copy of that cookie to the browser. Cookies are enduring. When the user leaves the Web site, the recorded cookie information is kept, ready for the next connection. In other words, when the client connects to the server again, the server identifies the user based on the cookie information. This cookie information is transmitted between the server and the client only if the file on the requested URL is identical to the information (domain and file) recorded in the cookie when it was created. The server acts this way whenever the user requests a new page, and hence can monitor the user's access to different pages. Cookies can be useful: for example, if the site requires registration, this registration information will be recorded in a cookie file ready for future access. Cookies are also secure because the information is transmitted only between the server which created the cookie, and the client to which the cookie was sent. If confidential information is transmitted, for example when using online-banking systems, security can be ensured by using an encrypted transmission protocol.

Implicit information acquisition models do not offer any causal explanations for the observed activities, and when trying to analyze document viewing time, it always remains unclear what the user was actually doing during this time. Was he watching TV while occasionally surfing the Net, or was he perhaps on the phone (Scharl 2000)? This is why cookie information is unreliable in measuring the 'stickiness' of Web sites. As mentioned before, the main purpose of the user model is to interconnect all the domain information available, with the users' knowledge and preferences.

Doing business via the Internet (having a 'virtual presence') introduces new challenges in the interaction with the customer, compared to a traditional business (a 'physical presence'). The key question is how to predict user preferences, needs and behavior. It might be impossible to predict user behavior, for example, as it can change for various reasons. Users tend to change their behavior unexpectedly, over time (Scharl 2000). Collecting, analyzing and managing the user data gathered offers a competitive advantage in e-business and could be a key to success. Compared to traditional mass media – TV, radio, etc. – the Internet and its techniques make it easy to get to know users' preferences. Different information acquisition sources and their attributes are presented in Table 1.

Table 1. Online user information sources based on Bauer (1999).

Source		Acquisition method	Information
Client/ Network	Network information	Environment variables, http log files	Remote host name, browser and platform etc.
Implicit	Browser support Passive acquisition	Cookies, Java-applets, hidden CGI data, agents	Pages visited, clickstream analysis, mouse movements
User	(Inter)active acquisition	Online forms, registration information, controlled questions, exercises, etc.	Questionnaires, responses, solutions, etc.
Explicit	Records	Customer database	All of the above
Third Party (Explicit)	Active/passive	Network infrastructure	Verified network information, location information

Active acquisition methods refer to user information acquisition where the information is gathered by asking the user (Kobsa *et al*. 2001b). This method is based on the interaction between the user and the system. Passive acquisition methods gather user information in the background without disturbing the user (Kobsa, Koenemann *et al*. 2001b).

2.4 Personalization

Personalization can be linked to direct mailing and telemarketing, which were mostly based on mass marketing or segmentation. Later, especially when marketing began to focus on individuals and their preferences, personalization and customization became an essential element in the business environment. At the same time, the massive growth of available information on the Internet has forced system owners to pay more attention to content personalization. The science behind personalization has also undergone tremendous changes in recent years, but the basic goal of personalization remains the same: to provide users with what they want or need, and to provide tailored products, services and information relating to products, without requiring users to ask for it explicitly. The usefulness of a Web site depends on the relevance of the content provided, the layout of individual pages, and the structure of the Web site. The appropriateness of these three features has an affect on user satisfaction. On the other hand there is a principled disharmony between the assumed needs of the user, the true needs of the user and the Web site designer's view on what is relevant (Mulvenna *et al*. 2000). Therefore, a feeling of closeness is an important issue in both the real world and the virtual world. People like to deal with people. Personalization tries to promote this sense of individuality; personalization of the user's Web experience adds value to the site and may lead to better customer retention and loyalty (Zemke & Connellan 2001). Essentially, personalized systems can record users' movements on the Internet, remember facts related to users, and learn about and predict their behavior.

Brusilovsky (1996b) defines personalized systems as adaptive hypermedia systems that increase the functionality of adaptive hypermedia by making them personalized. As previously mentioned, Brusilovsky demands that a personalized (adaptive hypermedia) system should fulfill three criteria:

– it should be a hypertext or hypermedia system
– it should have a user model
– it should be able to adapt the hypermedia using this model.

This requires the system to collect information about the user in a comprehensive way, to adapt the content, information structure and/or presentation according to user information, and to serve this adaptation effect to the user (Kobsa *et al*. 2001b). Both in everyday life and in the literature, 'customization' and 'personalization' are sometimes used as synonyms, sometimes confused for each other, and sometimes used with different meanings. There is no clear definition of personalization or customization. The distinction can be made on the grounds of user control. Customization occurs when the user can to some extent manipulate the interface, user profile or content manually (Figure 9). It is quite similar to the situation when you are buying a car: you can customize the color of the car, the material and color of the seat covers or the size of the tires, but you cannot customize the sizes and positions of meters and pedals, the positioning of lights or the sizes of the windows. In personalization, the user has less control; essentially the system takes care of content selection and presentation in a fully automatic way, based on information from the user model. Similarly, Nielsen (1998) separates customization and personalization based on user involvement, although he is doubtful of the system's ability to produce accurate guesses in terms of the user's needs. Normally, in order to improve the reliability of the system and increase interaction between the user and the system, users are given control over certain aspects of the system. Hence in some cases it might be difficult to see the difference between customization and personalization.

Eirinaki *et al*. (2003) clearly consider personalization as a automated process. They define personalization "as the process of customizing the content and structure of a website to the specific and individual needs of each user, taking advantage of the user's navigational behavior." Pahnila (2004), in his definition, emphasizes the importance of interaction between users and service providers, and of a user-friendly Web experience.

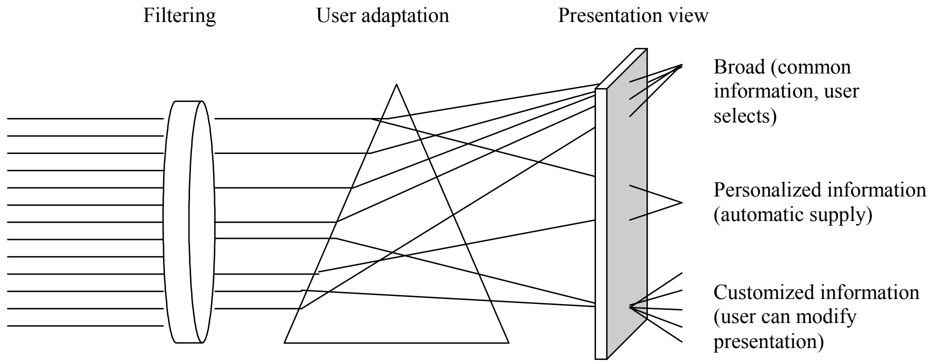


Fig. 9. Personalization and customization based on Watson (1988).

Comparing personalized hypermedia to "traditional" adaptive hypermedia applications, the main difference is that personalized Web applications may involve more business logic – that is, functionality. A common area for these applications is e-commerce. If the user is seeking a certain product, the e-commerce application may recommend certain links which relate to that product best. This kind of implementation, link personalization, is based on the ratings of other users. In content personalization, the actual content information is personalized, thus nodes (pages) present different information to different users (Rossi *et al*. 2001). This kind of customer service may have positive effects for both business and customers: service providers have to develop their services and take their customers' needs into consideration constantly, and customers get to receive the correct information.

Another definition states that: "Web personalization can be defined as any action that tailors the Web experience to a particular user, or set of users." Here, 'experience' refers to occasional Web browsing, for example trading stocks, or purchasing a car (Mobasher *et al*. 2000). Mittal and Lassard emphasize the social side of personalization, defining personalization as "the social content of interaction between service employees and their customers." This definition of personalization includes the quality of interaction or closeness between the service employees and customers. The interaction can range from cold and impersonal to very warm and personal (Mittal & Lassar 1996). These are the same factors that are important in everyday business life.

The aims of personalization can be stated as follows:

1. to provide users with a better quality service, and to give them good experiences, aiming to get them to return to the site, to make visitors loyal users and to gain new users
2. to collect more detailed information about users, in order to provide these users with products and services in the right place at the right time, and to provide them with relevant content

3. to allow the users to navigate individually and let them tailor the interface and operations of the service provided.

As stated above, from a business point of view, personalization tries to create the opportunity to provide the customer with high-quality products or services. The personalization of Web pages may result in increased corporate branding and customer loyalty (Riecken 2000). Secondly, personalization also demands some degree of user control. In general, personalization tries to provide a successful Internet experience and hence tries to improve user satisfaction.

Personalization has been implemented on the Internet largely in two ways: by allowing the user to modify personalized pages, or by allowing the system to make the modifications. Both of these solutions may have some negative effects. If the user's modification is based on a series of alternatives to check, it may create an unpleasant feeling and may cause the user to abandon the site never to return. If the system collects data about the user's behavior and applies a series of rules to the site, radically changing the content of the site when the user revisits, the user may be confused. "Did I ask for this new information?" he will ask. Instead of attracting the customer back to the site, a negative experience drives the user away (Wells & Wolfers 2000).

As mentioned earlier, users are concerned about the right to control information about them. Therefore they are careful about what kind of information they will give in return for personalized content. Most people are willing to give personal information (e.g., information relating to gender, age, education or hobbies), but they are unwilling to give sensitive information (e.g., information relating to income or credit card number). So, businesses must realize that in order to get customers they must provide personalization and ensure the personal information the customer supply will stay confidential (Volokh 2000).

Every method is based on some form of user profile or user model that connects information about the user or task to expectations about the user's behavior (Hirsh *et al*. 2000). The success of personalization depends on user data; therefore it demands sufficient data about the user, which must be updated constantly with new data.

There are different ways to provide personalized services to users; the stereotype approach, rule-based systems, content-based systems and collaborative filtering. All these methods are faced with some problems. Each method for predicting a user's preferences is constructed by somebody other than the user. It is possible that the Web page designer's view differs from the user's experience.

2.5 Personalization techniques

Web page personalization can be carried out in many ways. Basically, the question is how much automation can be used. Most personalization methods have been limited to checkbox personalization, where the user can build a personal site by selecting relevant links. This restricts opportunities to take full advantage of the service provided, because this approach is based on the user's knowing beforehand which content is of interest. Personalization technology can offer more sophisticated, usable and tailored methods, saving the user from irrelevant noise. One of the first user modeling methods is the so called "stereotype approach" originally proposed by Elaine Rich (1979). Most Web-based personalization systems apply collaborative filtering and a content-based approach. According to Mulvenna (2000) collaborative filtering, which is originally based on artificial intelligence, is the first promising attempt at providing personalized services to users in an intelligent way.

In everyday life, we often use recommendations, such as word of mouth suggestions or reviews of books, TV programs or films. On the Internet, recommender (personalization) techniques mimic, assist and augment this well-known social process. Recommendations act as the inputs of the system, which are then combined, and provided to the appropriate user (Resnick & Varian 1997). Recommendations or filtering techniques in general may act as tools of conformity. As other people's recommendations can affect a person's decisions, so recommendations provided by computers, rated "high" or "low", may have an influence on users' behavior. People seem to apply the same social rules to computers and they rely on computers' recommendations as on the recommendations of human beings. This behavior is not based on emotions; people are polite to computers and regard computers as peers in a social interaction (Nass & Moon 2000, Cosley *et al*. 2003).

Stereotypes capture typical information or characteristics about users or groups in the application domain of the system. When building stereotype user models, individuals are classified in several groups of users on the basis of their characteristics. In her user model, Rich used people's descriptions of themselves to recommend books that they would probably like. Stereotypes contain a so-called concept of 'activation', which means that if an individual fulfills the activation conditions (s)he is accepted as a member of the group (Kobsa 1995). The stereotype approach is very popular in many user-modeling systems. It provides quick but not necessarily satisfactory information about the user's background knowledge. Stereotypes are typically constructed so that only the classification of users can be automated. According to Kobsa, the stereotype developer has to take into consideration three tasks (Kobsa 1993):

– User subgroup identification
– Identification of key characteristics
– Representation in (hierarchically-ordered) stereotypes

In manual-decision rule-based systems, the Web site designer can formulate rules based on user registration information, session history or questionnaires. Through these rules, the content is provided to a user (Mobasher *et al*. 2000). This is probably the easiest way to implement personalization. This technique has limited uses because it depends on the user's knowing what content interests them beforehand (Mulvenna *et al*. 2000). Thus, the designer has to foresee how the user will behave, based on prior behavior. For example, if the user decides to buy a skateboard, next the system will suggest appropriate trucks and wheels for the skateboard. This kind of personalization is static and needs constant updating according to the needs of the users.

Content-based methods build a model based on the similarity of the Web document's content to the preferences of the user (Hirsh *et al*. 2000, Mobasher *et al*. 2000). In practice, content-based filtering is based on content analysis of the object using keywords. It is used in cases where behavior is likely to be easily predictable from past behavior, assuming that the user behaves the same way in certain situations. This method works fine and can be automated if the object is text-based, because it is quite simple to formulate and seek appropriate keywords and provide content appropriate to user responses.

However, this method is limited. When the object is an image or video clip, the analyzing process is more difficult.

Collaborative filtering systems build a model which is based on the preferences or ratings of other users. It resembles a virtual implementation of word of mouth marketing. A correlation engine uses these user ratings to compute pairwise correlation coefficients among the users, and provides the user with links to information which closely matches their user ratings or preferences. Thus the system makes predictions and recommendations based on the correlation coefficients (Hirsh *et al*. 2000, Mobasher *et al*. 2000). This technique was the first attempt at using artificial intelligence to carry out personalization in a more intelligent manner (Mulvenna *et al*. 2000). Collaborative filtering is a widely used personalization method. It is quite a familiar method: for example when you order a book from an Internet shop and the system tells you "People who bought this book also bought…" Because the principle of collaborative filtering is based on information from previous users, its effectiveness becomes gradually better as the system is supplied with more information about the users' actions.

As mentioned earlier, the technique of collaborative filtering works better when it is applied to homogenous product types, for example books, CDs or computer games. If the product is complex, consisting of many items – for example, a computer configuration usually consists of a hard drive, floppy disk drive, screen, memory modules, etc. – a collaborative filtering system's recommendations may be unsatisfactory because there are a wide variety of different combinations and not many similarities (Yu 1999).

2.6 Personalization and privacy

When researching personalization it is important to pay attention to privacy issues. Personalization and privacy are very much linked together. In personalization research, privacy issues are not yet widely studied: most studies are related to studies done concerning the Internet in general. Furthermore, privacy issues are very complicated to examine, partly because the terms and concepts are not explicit for the Web users, or because cultural issues and laws are quite different in different countries (Davison *et al*. 2003, Malhotra *et al*. 2004). The fact is that people are greatly concerned about online privacy issues (Graphics 1998, Westin & Maurici 1998, Cranor *et al*. 1999).

Traditional Web sites constantly collect different information about users, and personalized systems especially so, because comprehensive knowledge of users' needs and preferences is dependent on the amount of user data collected. According to eTrust Internet Privacy Study (Group 1997), gathering and recording data about users without their awareness causes them concern:

- 86% expressed a desire to control the use of demographic data
- 70% of consumers cite privacy concerns as the primary reason for not registering demographic information
- 34% of consumers give inaccurate registration information
- 76% expressed concern about sites monitoring their Internet browsing
- (70% concerned about purchases)

- 71% are more concerned about information transmitted over the Internet than by telephone
- 42% of consumers refuse to give registration information because of privacy concerns
- 27% sometimes falsify information because of privacy concerns

Considering the research above, many users may leave Web sites that require registration, some may give false registration information, and some may abandon online shopping because of worries about their privacy. The results, in terms of privacy, the tracking of Internet activities and the sharing of personal financial information on the Internet, are concordant with the results of DePallo (2000). Overcoming the privacy issues would have positive impact on Internet usage leading to an increase in online business with time (Kobsa 2001a). Therefore, public trust is the key factor in the success of new businesses; it is a significant factor behind user loyalty (Hoffman *et al*. 1999b). User trust can be gained by ensuring that the organization has committed to a strict privacy policy, and tells the users explicitly that gathering user data should lead to improved services (Schonberg *et al*. 2000). Hoffman *et al*. (1999b) suggest that companies should approve users' rights to their data and companies should tell the users how they are going to use personal information. This is the most effective way to achieve users' trust and loyalty.

Users want to control what kind of data is collected, for what purposes, how long the data is kept, and how and with what purposes their data may be processed (Malhotra, Kim *et al*. 2004). Those who collect and store data in a user model server must also respect the laws of their own country, and if they serve clients abroad they have to take into consideration the laws of that country (Kobsa 2001a, Kobsa 2002). One solution to the user's locus of control dilemma is to develop new kinds of flexible architectures which could dynamically take into account the preferences of each individual user, the relevant privacy laws, and the locations of the system and the user. Moving from server-side personalization to client-side personalization would give users better control over all their personal data, and over the processes that operate on these data. If clients are located abroad, respecting the privacy laws of different countries sets practical challenges for the service provider. In cases like this it may be better to follow a single privacy agreement, such as the OECD privacy policy guidelines (OECD 1980, Kobsa 2002). As discussed above, personalization, control issues and privacy are closely linked (Hoffman *et al*. 1999b, Malhotra *et al*. 2004), so it is important to study the significance of these issues on the acceptance of personalized WISs.

Many researchers (Watson 1988, Wahlster & Kobsa 1989, Kobsa 1993) also emphasize that one should be aware of ethical and social risks when exploiting a user modeling component. When collecting, combining and utilizing individual information in order to provide users with easy access to relevant information, there is always a possibility of misuse and abuse. In order to minimize these risks, Kobsa (1993) suggests the following guidelines:

- Users should be aware of the fact that the computer system contains a user modeling component. It is the user's decision whether or not s/he consents to being modeled by the system.

- Users should be aware that computer systems are not flawless. User modeling components rely on assumptions about the user. Therefore there is always the risk of misunderstandings. Users should be able to inspect the user model in case of possible misunderstandings, as they are used to doing in normal communication with other people.
- Users should be aware that computer systems might pursue interests other than those of the user. Computer systems based on user models may not only support the user's goals, but may also take into consideration the interests of some company, for example, when providing services to the user.
- Users should have the option to inspect and edit their user models. In practice this is difficult because user models quite often include enormous numbers of assumptions.
- If technically possible, users should be able to "switch off" the user modeling component if the user does not want to allow the system to collect information about her/him.
- Long-term user characteristics should be modeled with caution since their misuse is probably more serious than the misuse of short-term user characteristics. Furthermore, long-term user characteristics are normally more intimate or personal than short-term user characteristics.

These guidelines emphasize the interactive nature of user modeling, and show that users should consider user models with caution, as they are based more or less on guesses, they may act in an imperfect way. On the other hand, in order to promote users' confidence in the user model, they should be given the ability to control the user modeling component. To sum up, control issues are important with respect to personalized WISs. Therefore, the need for control is included in this research, in order to shed more light on its possible impact on the acceptance of personalized WISs.

3 Web information systems development

In this section we describe the differences between traditional IS and WIS development. Moreover, we present the OWLA approach to develop WISs. Table 2 summarizes the principles of the process models and OWLA approach discussed in this section. The differences noted here form the basis of a need for the development of a new approach to the construction of WISs. In the next sections, we describe two traditional and maybe most widely-used IS development process models, which are used and modified for WIS development. We also highlight some weaknesses of these models in terms of WIS development. The last part of this chapter introduces the OWLA approach for developing WISs. Because research related to Web Information Systems is young, we believe that this kind of constructive research is needed in the WIS field.

Web Information Systems are based on hypermedia systems using Web technology e.g., hypertext mark-up languages. The phrase 'Web Information Systems' is too often used as a synonym for 'Web page' but the difference is obvious. According to Isakowitz *et al*. (1998), Web Information Systems are interactive systems, for example e-commerce solutions, which support different facets of work (Isakowitz *et al*. 1998). In addition, WISs are closely integrated with other non-Web information systems such as databases and transaction processing systems. They are developed to support work focusing on the interaction between the user and the system. As Dennis (1998) states "Web Information Systems are systems, not pages. WISs are information systems first, and Web systems second. Unlike Web pages that are designed to be browsed like magazines, WISs enable users to perform work – work that is inherently more complex than the rest of the Web." Isakowitz *et al*. (1998) describe how these characteristics set new managerial and technical challenges for the design and development of Web Information Systems, therefore this demands new ways of thinking compared to the development of traditional systems. Although the Web is related to hypermedia, it does not fully support many of hypermedia's features and only exploits hypermedia's capabilities in a very limited fashion (Vitali & Bieber 1999, Oinas-Kukkonen *et al*. 2000a). In short, Web Information Systems are based on Web technology, they are driven by a browser, they are focused on performing work and they stress the importance of continuous consideration of user interaction with the system.

The development of adaptive hypermedia systems can be separated into two complementary components: the product and the process. The objective in terms of the development product is to develop a high quality hypermedia product – a hypermedia application which fulfills the desired characteristics related to e.g., navigability, search mechanisms, presentation, maintainability and security. The desired characteristics and functions of the product will determine the process which will be used. Thus, the choices of methods, techniques and different mechanisms used in hypermedia development have a significant role when selecting the process. The objective in terms of the hypermedia development process is to carry out the development in an effective and efficient way. This implies that we may have a process which will result in a perfect application, but which is not acceptable because of its high costs. One of the most important tasks of the hypermedia development process is striking a balance between the desired characteristics (a high quality product) and a cost-effective process. (Lowe & Hall 1999)

Therefore before and during the development process it could be possible that one has to decide to make sacrifice either in terms of certain requirements and of certain costs. Careful planning and analysis helps to avoid these kinds of situations.

When choosing an appropriate process one should remember that the most important element is the outcome (product) not the action (process) (Lowe & Hall 1999). As discussed earlier, processes are action-dependent, therefore because different actions entail different processes we can modify the process models to fit different types of development. In addition to the desired characteristics, the size of the application, the availability of capable human resources, the time span of the development process, and the focus of the application may all have different effects on the selection of an appropriate process (Lowe & Hall 1999). Despite the fast-growing popularity and complexity of Web-based applications, there is still a lack of disciplined and sophisticated development approaches. "The world has glimpsed a subset of hypermedia functionality and its potential for structuring and accessing information through the recent surge in World-Wide Web (WWW) activity. Yet we lack guidelines and tools to design and develop hypermedia applications. This is especially true for commercial-scale systems, which involve frequently-changing information" (Bieber & Isakowitz 1995).

Every now and then there is some debate among researchers, concerning the differences in principle between WIS development and conventional software systems development. It has been suggested that Web engineering, the systematic and disciplined development of Web Information Systems, is a direct clone of software engineering. This kind of debate about the need for new methodologies arises every time new innovations (e.g., the Web) emerge. Although Web engineering uses similar concepts, methods and activities to software engineering and has adopted some of the principles of software engineering, there are differences in how these methods and activities are conducted (Pressman 2000). Considering the fact that Web development is time-sensitive – projects have short lifetimes – this development requires unique tools, in order to enable systems to provide constantly updated information. Traditional methods do not necessarily offer solutions to these requirements. Therefore, faster, new solutions are needed for Web development (Pressman 1998). There are some major differences between Web-based systems development and software development. Murugesan *et al*. point out the following factors, among others, that differentiate Web engineering from software engineering and make the use of conventional software engineering processes inconvenient (Murugesan *et al*. 2001).

- Most Web-based systems are content-driven. In developing content one has to take into consideration the characteristics of different media, including text, audio, video and graphics.
- Web-based systems focus on presentation; in other words, visual creativity, aesthetic nature and look-and-feel have important roles when presenting content to the end-user.
- The Web is a diverse delivery medium. Applications may operate on the Internet, or on an Extranet or Intranet. Conventional software usually operates in a well-defined environment.
- Most Web-based systems are evolutionary by nature. They are evolving all the time and need to be developed within a short time.
- When developing Web applications, one has to take into consideration individual users with diverse skills, and their different characteristics and preferences. This means that one has to pay attention to user interface design, and the personalization of information.

Table 2. Summaries of the three traditional process models and OWLA approach.

Model	Waterfall model	Spiral model	WebE model	OWLA approach
Phases/cycles:	Project planning, analysis & specification, design & implementation and evaluation are usual phases.	Objectives, alternatives and constraints. Evaluation of alternatives and risk analysis. Product development. Planning and management.	Formulation, planning, analysis, engineering, page generation and customer evaluation.	Starting phase may follow traditional waterfall process. Interaction (usage), analysis, design and implementation.
Process	Linear, sequential model. Web development projects are rarely sequential.	Evolutionary, iterative approach, which is focused on risk management.	Consistent with the spiral model. In the engineering cycle, content and architecture are developed in parallel.	Evolutionary
User involvement	Extensive specification of user requirements is important. Web projects involve uncertainty related to requirements and goals, especially at the beginning of the project.	Development process requires skilled people, time and money. Development process requires active user involvement.	As in spiral model.	Focus on dynamic interaction
Modification	Difficult to handle unexpected situations e.g., changes in environment.	Incremental process. Changes that users request for the system can be integrated during the next cyclic process. Does not offer flexible support for maintenance. No clearly-defined starting-point for maintenance	Incremental, iterative process.	During usage users' transactions are monitored and analyzed, and corrective actions are exploited.
Application	Working application is completed late in the process.	Demanding for small projects. Appropriate for high-risk projects.	Demanding for small projects. Focus on tasks which are related to content design and production.	Continuous updating of the adaptable application.

In order to achieve user satisfaction, reducing maintenance costs, the WIS development process requires disciplined execution. From the early days of the Web up to the present day, WIS development has moved in a more disciplined direction. Earlier, when the Web was young, everyone who knew the principles of hypertext markup language was a designer and content producer. From the point of view of Web engineering, the situation was chaotic (Murugesan *et al*. 2001). Hence Web development has been criticized as immature, time-consuming and lacking appropriate tools and techniques (Pressman 1998). Nowadays, as commerce has adopted the Web, the demands of a systematic, disciplined, efficient and quantifiable approach have become key factors.

3.1 Waterfall model

A process model is a general outline for the software's development throughout its lifecycle, consisting of different phases or stages that describe how the software is developed from the initial idea to finished product. The process model determines the mutual relations between the phases. The primary goal of the software process model is to determine the order of the phases and the criteria for when to move from one phase to the next. (Boehm 1988). The process model helps in fulfilling the requirements of each phase and minimizing the possible risks and economical losses of the developing phase. The process model is general by nature and it does not include specific rules governing how to act. This is natural because domains, environments and technical issues may vary a great deal. The process model may contain the different subprojects, resources, artifacts, activities and actors involved in the project. (Lowe & Hall 1999). Because each phase can include different subprojects and activities, one has to determine certain acceptance criteria for finishing the phase, and entrance criteria for when to move to the next phase (Boehm 1988). These acceptance criteria for each phase aim to minimize and prevent in advance the potential risks of the development process, and also to maximize the efficient management of development work. When the acceptance criterion of the phase is achieved, the output of that phase acts as the input to the next phase. The primary reasons for the grouping of different activities into phases or subprocesses are the management of cognitive issues of the project and the effective management of the development process (Lowe & Hall 1999). The number of phases varies depending on the process model chosen. The choice of an appropriate process model is based on the nature of the project and application, the tools and methods that will be used and the level of developer expertise (Lowe & Hall 1999).

The waterfall model is a linear, sequential and also cumulative model. The documents generated by the previous phase formulate the basis of the following phase. This is also the primary limitation of the waterfall model (Boehm 1988). In many situations it is impossible to include correct and complete requirements in any given phase. It is typical, for example, that the requirements, techniques and environment will change during the development process. This will create new requirements, and a need for changes.

The waterfall model is widely used in software engineering. The typical phases or steps used in software engineering are analysis and specification, design, implication, testing and maintenance. The refinement of each phase of the waterfall model is carried out by feedback loops (Boehm 1988). Each phase usually includes different milestones or evaluation points. Typically, the milestone acts as the transition point to the next phase. The waterfall process model, adapted for hypermedia development, is presented in Figure 10.

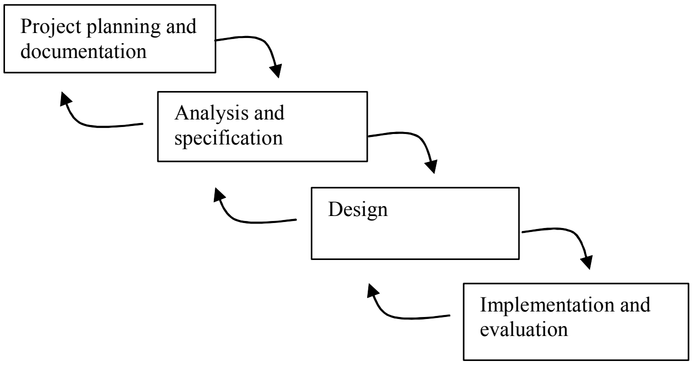


Fig. 10. Waterfall process model adapted for hypermedia development (Lowe & Hall 1999).

When using the waterfall process model for hypermedia development, the process begins with an attempt to discover the user's problem. This phase is based on the interaction between the user and the system developer, and aims to develop a mutual understanding about the issue which is being developed. This is a very important phase because it forms the groundwork of the future phases and the whole development process. This phase typically includes an application description, in terms of technical and cost issues. The goal of the analysis and specification phase is to record this mutual understanding in a clear form, as the application specification. It should include a detailed application analysis and specification, and forms the basis for the application design phase. One typical problem of the analysis and specification phase is that the users are not aware of the possibilities of hypermedia technology, and so the requirements are typically based on the existing environment. When the new application is introduced it may create new requirements, which will in turn cause other new requirements (Lowe & Hall 1999).

The application design phase exploits the results of the previous phase. In the design phase, the technical architecture, main components, information structure, application user interface, etc. of the developed application are designed. The results of this phase usually include different reports, diagrams and figures. In the implementation and evaluation phase, the results of the design phase are made into a real, functional product. The goal of the evaluation phase is to make sure that the development process has been carried out in an appropriate way (Lowe & Hall 1999).

Exploiting the waterfall model successfully requires that documents are clear and complete. This is difficult to ensure, especially if the application under development is interactive (Boehm 1988). It may often be the case, especially when developing interactive hypermedia systems, that during the later phases, for example, you will gain a better understanding of how the requirements should be accomplished, or perhaps you will notice later that you have misunderstood the requirements. There are always uncertain situations due to a lack of particular expertise or appropriate tools, or due to the rapidly changing environment and technology, or uncertain goals. The waterfall model does not offer an adaptable way to handle unusual or unexpected situations like this. This means that you have to return to an earlier phase and complete that phase once again (Lowe & Hall 1999). Secondly, when using a waterfall process model, the usable application is completed very late in the process. This reduces the effectiveness of the development work because most hypermedia projects are poorly defined, and incompletely understood. In practice, the linearity and the inflexibility of the waterfall model demands that developers have to use different feedback paths (Lowe & Hall 1999).

In stable systems, rigorously specified and designed systems may operate in a satisfactory manner and with reasonable maintenance costs, for a long time. In the past when developing information systems, the focus was on thorough analysis and design activities in order to reduce maintenance activities and costs. In dynamic environments, for example in commercial environments, emergence seems the dominant state (Truex *et al*. 1999). According to Truex *et al*., today's organizations are not stable; they are changing all the time and they constantly have to adapt their functions to the changing environment. Truex *et al*. define modern organizations as emergent organizations, which are "in a state of constantly seeking stability, while never achieving it". This requires continuous redevelopment, rather than thinking of information system development as a process with a clear beginning and end (Truex *et al*. 1999). Therefore there is an obvious need to rethink Web Information Systems development, and to take into consideration the unstable environment when analyzing, designing and making changes to the system (Scharl 2000).

3.2 Spiral model

The spiral model, presented in Figure 11 and originally proposed by Barry Boehm (1988), is based on the experiences of the waterfall model. The waterfall model is a linear model, whereas the spiral model is an incremental and evolutionary model. The development process of the spiral model proceeds in a similar way to the waterfall model, but instead of following a straight path forward, it proceeds incrementally; that is, plans and requirements are refined based on the feedback from preceding increments. In an evolutionary approach the system is developed by gradually completing it with new information until the required objectives have been achieved. A lack of risk management – the inability of the activities to handle risks – is one of the main problems of the waterfall model. Hence risk analysis is an essential element of the spiral model. The evolution of the software development proceeds in cycles. Thus the complete product is the output of a series of phase products. There are four different cycles: concept of operation, requirements validation, design validation and implementation. Each cycle involves the same activities: determination of objectives, alternatives and constraints; evaluation of the alternatives, identifying and resolving risks; development and verification of next level product, and planning for the next round (Boehm 1988). In every round, the same four cycles are repeated and every round the risks are evaluated. The various rounds resemble series of the waterfall model being carried out. Early iterations of the spiral model can be paper-based models or prototypes. Later iterations are more sophisticated versions of the system under development (Pressman 2000). In practice, the number of activities may vary depending on the scale of the application under development. In small projects the number of activities may be low, whereas in large projects containing more work tasks, the number will probably be higher. In addition, the content of the activities is dependent on the characteristics of the project (Pressman 2000). One significant feature of the spiral model is that every cycle is ended with a review involving all the concerned parties. When they have mutually accepted the outputs of the cycle, the development work can move on to the next phase (Boehm 1988).

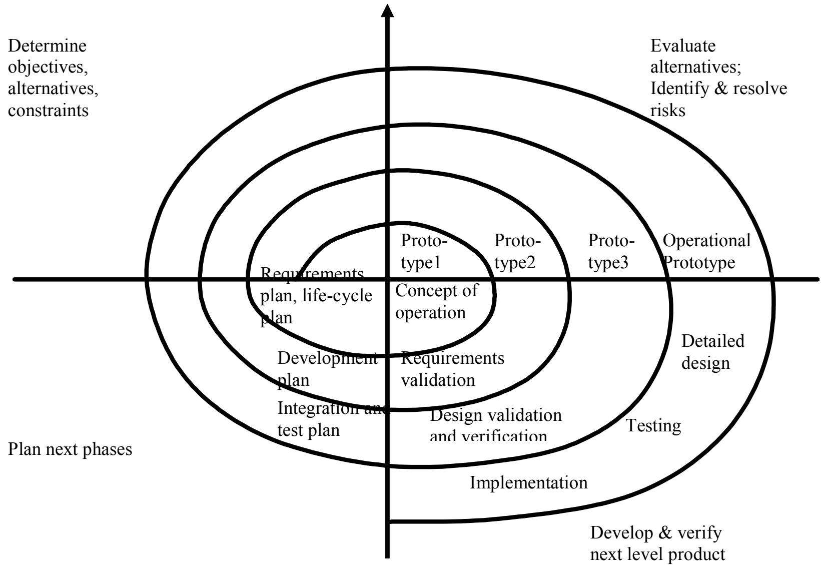


Fig. 11. The spiral process model (Boehm 1988).

In the first quadrant of each cycle, the project's objectives are identified and determined, different alternative solutions are elaborated and evaluated, analyzing the different constraints or risks – for example costs or scheduling issues – which relate to these alternatives. In the second quadrant, the existing alternatives are re-evaluated, taking into consideration the objectives and constraints of the system. The essential goal of this quadrant is to identify and solve possible risks using techniques such as prototyping, simulations or benchmarking. In the third quadrant, the specifications are again refined, in relation to the objectives, alternatives and constraints. Moreover, the importance of the possible remaining risks is evaluated. The last quadrant may involve planning a more sophisticated prototype for the next cycle or, in the final cycle – implementation – the detailed design, implementation and validation are completed.

The main problems of the spiral model relate to the commitment of the client, and risk analysis. In the case of small hypermedia projects, if the spiral model is chosen it may take a long time to complete all the phases and activities. It could be difficult to motivate and commit the client for extended development work. The rapidly changing environment and the client's lack of knowledge of the capabilities of hypermedia may mean that new risks come up constantly (Lowe & Hall 1999). The spiral model requires good risk-assessment capabilities. If the main risks are not perceived, there will probably be problems ahead (Pressman 2000). The iterative nature of prototyping and risk analysis causes delays in the progress of the development work. Furthermore, maintenance issues are not handled well in the spiral model. As the size of hypermedia applications is expanding continuously, there will be an increasing need to take ease of maintenance into consideration. Constant adaptation of environmental changes into the system is important for the sake of applicability and relevance (Lowe & Hall 1999).

3.3 WebE model

Continuous evolution, fast-changing technology and information, clients' uncertainty about their requirements and about the available technology, current laws and other demands force us to rethink conventional development process models. The ability to implement changes flexibly, quickly and efficiently in the Web development process will play a significant role when developing information systems. Many Web applications are time critical, for example stock markets, banking business or medical applications, which demand that updates to the system are performed quickly.

The Web Engineering (WebE) process model has been developed for Web-based processes (Figure 12). It tends to take into consideration the special characteristics of Web development, which are not included in conventional process models: the nature of the content, the aesthetic nature of the application, continuous evolution, the requirements of diverse users, and security. Moreover, WebE involves parallel development activities relating to the content design and the architectural design of Web applications (Pressman 2000).

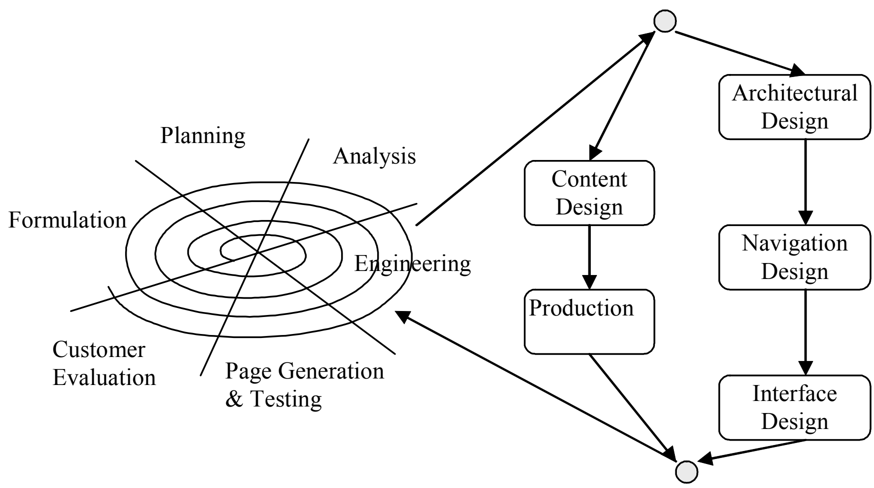


Fig. 12. The WebE process model (Pressman 2000).

The main activities of the WebE model in part resemble the activities which make up the spiral model:

- The formulation of the problem incorporates identification of the goals and objectives of the Web application. The main goal of this activity is to build mutual understanding between the developer and the client about the issues mentioned above.
- The planning activity incorporates the overall project costs, risks and scheduling of the development process.
- The analysis activity incorporates technical requirements for the system, identifying content items and graphic design.
- The engineering activity incorporates two parallel threads: content design, which is non-technical by nature, and architectural design, which is technical. The content design thread focuses on the creation and presentation of content using different media elements: text, video, graphics and audio. Architectural design focuses on the hypermedia structure of the application. The basic idea of the parallel development is to solve obvious problems immediately.
- The page generation activity merges the two parallel threads in order to produce executable Web pages. The testing activity aims to uncover any errors in applets, scripts or forms and tries to ensure the interoperability of the application.
- The customer evaluation activity focuses on the review of each increment produced, and any changes required by the client are incorporated in the next increment (ibid).

Basically, the WebE model includes the same problems as the spiral model. These problems are related, as mentioned earlier, to maintenance, the commitment of the client and the need for risk analysis expertise.

3.4 Web information systems development: case medical portal

In this section is we describe in chronological order the development of the target IS (Table 3). As the field study was carried out on version 3.0 of the medical portal, this section emphasizes version 3.0. Therefore, the description of the version 3.0 acts as the background for the field study with respect to personalization.

In version 1.0, identification of the medical IS's users was based on the Fimnet identification system. In this version user categorizing was introduced. Information was offered based on different user groups. Special field information (ten special fields) and special field news were offered to users based on categorizing. Therefore the system included some limited static personalization features. When the system has identified the user, it sends special field information, and this requires a lot of manual actions by the system administrator. The system did not include the utilization of data bases. Quite soon, high growth of the users put pressure on the systems developers to broaden the categorization. There was a need to reduce manual work and make the system more effective.

From version 2.0 on, there was a principled change in implementation. Individual user were not regarded only as a member of a group, the individual was regarded as an individual. This was realized in the calendar, which included some personal features, for example, SMS reminders. Categorizing was extended to new special fields. One important advance was the introduction of data bases which increased the efficiency of the IS. System's appearance was also improved. Future developing was focused on dynamics.

Version 3.0 is important with the respect of this research. Therefore we will take a closer look at personalizing the target IS. As discussed above the identification of the medical IS's users is primarily based on the Finnish medical network (Fimnet) identification system. Fimnet registration requires potential users to answer around 20 questions, including demographic and occupational information. After the portal has identified the users, it can provide personalized services. Personalization takes place according to special field (there are 19 different fields) including special field news, special field links, special field journals, different training and portal services, and advertisements, among others. The user can also create a personalized list of links. The system creates a profile for its users, recording explicit and implicit user data and updating this data store with new user information. Registration is not necessary because of the medical IS itself; it is necessary because the system includes medical advertisements. Finnish legislation concerning drug advertisement prohibits the advertisement of prescription drugs to consumers. At the same time, the registration information provides a convenient way to consider individual users or user groups and offer personalized services.

We categorized personalization into three levels: no personalization, segmented personalization and one-to-one personalization. A system with no personalization is an information repository with a standard Web browser. Users have only limited access to information, and the accessibility of information is based on the user's own selections. In this case, the same information is provided to all users according to a "one-size-fits-all" principle. With segmented personalization we mean personalization, which is based on demographic data to group or segment users into smaller, identifiable groups. The user can configure options using checkboxes, for example in the case of Calendar and Search services. When using Search services, the user has the option to select between different databases. In segmented personalization, demographic data is collected mostly in the organization's data store. By one-to-one personalization we mean personalization which is based on individual data taking into account the properties of each user and assisting individual users in the most effective way when they are interacting with the system. Thus, one-to-one personalization is based on individual profiling and real-time solutions which utilize user's behavioral data; for example, by monitoring users' Internet behavior the system can instantly update the information received from its users. The personalized services offered in the target system were segmented on the basis of the data already collected (during the field study in 2003), including, among others, the following menu headings:

- Specialized field news – segmented personalization based on the specialization or work duties. For example, anesthesiologists are offered information related to anesthesia.
- Calendar – segmented personalization also including functions with one-to-one personalization.
- Congresses – segmented personalization based on the specialization or work duties.
- Specialized field links – segmented personalization based on the specialization or work duties.
- Specialized field journals – segmented personalization based on the specialization or work duties.

– Pharmaceuticals – segmented personalization based on the specialization or work duties.
– Specialized – segmented personalization for Bachelors of Medicine and for doctors who are specializing.
– Forms – forms which are partly automatically filled out. Segmented personalization based on the specialization or work duties.
– Drugs – segmented personalization based on the specialization or work duties
– Leisure time services – no personalization. Leisure time services are based on static sites including sub links such as Timetables, Banks and post offices, Shops, Culture, TV and radio, Insurance companies.

The portal's user interface is split into three frames (see Appendix B). On the left are the menus, including the ones above. In the middle is the content information and on the right there are advertisements, which are personalized according to the user's field of specialization. One should take into consideration that all these menu headings may include several sub links. For example, 'Specialized field journals' consists of domestic journals, foreign journals and other journals.

Table 3. Steps in the development of the medical portal.

Evolution of the portal	Information acquisition		Developers', administrators' role. Issues related to involvement/maintenance
	Portal inputs and outputs	End users	
Version 1.0 (spring 2001) No personalization	On-line questionnaires. Cookie data. Login through Fimnet. Medical special field information was categorized.	Surveys were conducted in order to define user requirements. Field study relating to doctors and Internet use, in terms of users' attitude towards personalization (discussed in chapter 5.1).	Design criteria existed, but personalization was not employed. Based on HTML technology
Version 2.0 (autumn 2001) Static personalization	Online questionnaires; cookie, session and usage data. User information acquisition mainly based on own stores. Segmented personalization: based on categorizing the users. Considering dynamics and privacy issues are critical.	Surveys were conducted. Field study during the OWLA research project (January 2002) focusing on personalization and universal accessibility (discussed in chapters 3.5–3.7).	Efficient use of cookie data. System was based on HTML and PHP technologies. Question manager query program was introduced for effective handling of online feedback. OWLA research project: development of universal accessibility and OWLA approach.
Version 3.0 (autumn 2002) Static-dynamical personalization	Online questionnaires; flow of cookie, session, and usage data. Effective use of database. Different user information acquisition techniques were used. Sophisticated personalization techniques were developed. Dynamic updating managing data flow is critical.	Surveys were conducted. Field study in September 2003 related to thesis. Focus on examining user acceptance of personalized WISs (discussed in chapter 5).	New personalization features. Focus on technical implementation of universal accessibility. More effective analysis of online questionnaires and usage, cookie and session data. Amount of recorded data quite massive – need for one-to-one personalization. Focus on increasing automatic personalization. Dynamic question manager query program for handling user feedback.
Version 4.0 (2004) Sophisticated, one-to-one personalization	Different user data acquisition techniques. Data flow and mobility are critical.	Field study is planned to be executed by the researcher in 2006.	Use of sophisticated automatic analysis and personalization techniques.

Version 4.0 of the portal includes effective use of data bases, sophisticated one-to-one personalization and extensive user control. In the future development, the ability of each user to build the service personally will be the key issue. Researcher's intention is to carry out field study in 2006 and examine users' behavior toward the system.

3.5 The main objectives of the development of the medical portal in OWLA research project

This development process is based on work done during the OWLA research project (2002). Our focus was twofold. First we researched how to incorporate features related to universal accessibility into the portal, and secondly we were developing a practical approach for producing personalized services. At a higher level, the OWLA research project originally consisted of seven different tasks. Research work was done mainly in collaboration with the participating companies. The main goals of the OWLA research project were to develop design methods, techniques, tools and principles for the design of Web-based and wireless information systems. Moreover, these systems should recognize the special requirements which different platforms require. These information systems should then adapt systems functionality based on e.g., user, task or domain information. In order to design such systems, the project aimed to develop methodology fragments that the companies involved in the project could use seamlessly as parts of their processes. Thus, integratability and scalability to systems and work practices in organizations were important focuses in the method engineering work carried out (OWLA 2002).

As mentioned above, one of the key tasks of the research project was to examine how to enhance the existing portal with new features. We approached this topic by analyzing existing methods and developing an appropriate methodology for adapting the system to users' needs. From the point of view organization which was involved in the OWLA research project, the starting point was to create an effective, portable business concept which would enhance and support the organization's existing personalized information system. In fact we developed the existing information system, which was based on Web technology, with the aim of extending its personalization features. Thus, project members' role was to put to use their knowledge in order to develop the existing system by adding features which support universal accessibility. Table 3 presents the development stages of the portal, information acquisition methods and different changes in terms of development and/or administration.

The development process of the IS can be divided into three evolution phases, according to the technical progress made. In the first evolution phase, the IS was a "conventional" Internet portal, an information distribution channel, offering up-to-date information to a wide variety of users in the medical field. The same information was provided to all users according to a "one-size-fits-all" principle. In general, at that time the Internet was a new innovation just starting to arrive more generally in organizations.

In the second evolution phase, the level of personalization was increased on the basis of prior experiences, and based on user feedback. Moreover, systems for gathering and using the user information were developed. As a consequence of positive user feedback, the role of personalization became more significant and some personalization processes were automated. Personalization mainly took the form of segmented personalization, based on user categorization. Categorization was performed on the basis of occupation; no sophisticated personalization techniques were used. Personalization was performed mainly manually, thus the role of the administrator was significant. At the same time, users' behavior towards the system was followed by regularly gathering user feedback. Feedback during this phase was gathered using questionnaires.

In the third evolution phase, prior experiences were again exploited. The development process was focused on technical improvements e.g., the use of more effective databases. The analysis and usage of user data was also developed. Data analysis is quite an easy and economical means of getting useful information when developing a more accurate adaptation effect.

Modern information technology has brought globalization to our workplaces, schools and homes. The internet enables easy access to information sources 24 hours a day. The problem is that the amount of available information is nearly impossible to manage. Therefore, search engines were developed, to provide easy and quick access to information. Unfortunately, search engines can only search for information on the basis of single words; they do not include sophisticated information analysis tools. Personalization tries to take into consideration the user and her/his individual characteristics and needs. In a way, personalization acts as an information marketing tool; it takes a user and her/his information needs into account when providing services. Through the Internet, doctors can get specialized, real-time scientific information within a few seconds, from all over the world, and in the case of personalization they can get it automatically. This information may be vitally important, especially if it is related for example to drugs or medical treatment.

In the current research, the portal – a personalized medical portal – is a free information channel for doctors and medical personnel. The main objectives of the portal can be summarized as follows:

- To provide easy access to a specific field of information.
- To facilitate the flow of information. Personalization in a medical portal is designed for certain particular groups with differing duties and preferences. For example, the portal offers up-to-date information (scientific, medical and research-based) related to users' work, and information related to different social activities.
- To provide up-to-date information to the users, with immediate availability.
- Ease-of-use and the quality of the information content are priority features because of the potential users' responsibilities.

According to the preliminary surveys, the potential users were interested in personalized services but they were not interested in implementing the personalization themselves, for various reasons.

3.6 The OWLA approach developing personalized Web information systems

The theoretical background of the presented approach is based on a combination of the dynamic Web Information Systems development model (Scharl 2000) and the collaborative user model of adaptive hypermedia (Brusilovsky 1996b). The popularity of Web-based applications is growing rapidly; therefore a practical approach for developing hypermedia-based systems is needed. Schonberg (2000) suggest that in the case of personalized WISs, the process must take into consideration the highly dynamic nature of the content. Similarly, experience of how to apply a process model in a real development environment is needed. Business has realized the potential of the Web: its distributed nature, its growing user acceptance, the ease of access to information, its importance as an information channel, and its potential for real interaction between the user and the service producer. When developing Web applications, we should understand the turbulent nature of the modern business environment and try to develop approaches which are able to react to the user's changing expectations.

The efficiency of personalized systems is based on the user information recorded in their databases. The more extensive user information there is in the system, the more accurate a model can be built about the user's behavior. User information can be gathered in many ways, both explicitly and implicitly. The gathered information can be analyzed effectively using today's tools, especially when it comes to explicit information such as log files and cookies. When developing interactive Web Information Systems, one has to take into consideration on the one hand the rapidly-changing environment and tight, fixed deadlines, and the other hand user feedback and how these issues can be incorporated in the system in a flexible way. Web Information Systems are evolutionary by nature; they tend to evolve over time. Therefore one has to employ a development approach that itself evolves over time too. The evolutionary software development process models used in "conventional" software engineering, such as the spiral model, are iterative and require longer development cycles. At the beginning of the project we decided to apply some form of development approach in order to structure our work in certain phases. Moreover, we aimed to apply an approach that included the concept of guiding our future activities throughout all of the development work. We could easily identify the state of the development process: where we are, what we should do next and where we should go next.

As stated earlier, evolutionary development is based on an existing implementation which is refined with numerous cycles until a satisfactory system has been developed (Sommerville 1996). Traditional development approaches are very much focused on different specifications. In our case, where the number of developers was small, a solution which could lighten documentation was desirable. On the other hand, our approach was based on constant feedback (Figure 13). The main motivations for using an evolutionary approach were:

- appropriate for relatively small system
- unpredictable nature of the personalized systems
- fast changes in environment and users' behavior
- light documentation, system evolves on the basis of user feedback

After analyzing the appropriate process models which could satisfy both our goals and the goals of our target organization, we decided to adopt an evolutionary approach. From the researcher's point of view, the evolutionary approach was flexible, easy enough to utilize among the portal developers, and easy to use for illustration purposes when analyzing the current state of the development process. Moreover, it can be used in situations which incorporate the dynamic nature of the Web, where the application requires continuous redevelopment in a changing environment. Our goal was to support the development process by applying an approach which emphasizes continuous interaction between the user and the system by reacting to user feedback as quickly as possible. Moreover, our goal was to carry out our project using a practical development approach.

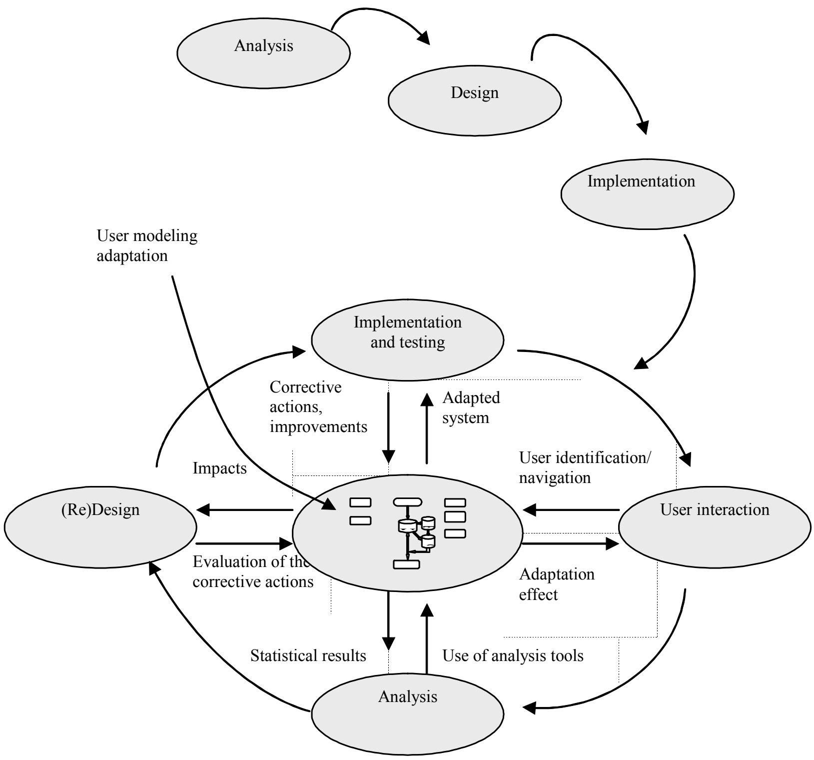


Fig. 13. Process model for developing dynamic Web IS (based on Scharl 2000).

The core element, labelled "User modelling adaptation", refers to 6, which was presented earlier. In our case, user information was gathered both explicitly – e.g., using FIMNET registration information – and implicitly – e.g., using cookie or session information. Using a database enables quick and dynamic updating, and the adaptive presentation of personalized information. The starting phases of the development process (analysis, design and implementation) may follow the traditional waterfall process. Thus, our approach can be considered as partly constructed around the waterfall process. The proposed approach follows an evolutionary cycle consisting of four phases: user interaction (usage), analysis, design, and implementation and testing (Figure 13). The preceding phases were based on the company's routines for system development. The evolutionary development consists of four cycles:

- User interaction cycle: Use of the system. During this cycle users' transactions are monitored. Explicit and implicit input data, including logging information, request information and user navigation behavior, is recorded in the server's log file and database. The system identifies the user on the basis of their login information, and uses this data in order to provide tailored services.
- Analysis cycle. During this cycle a large amount of recorded data (explicit and implicit) is analyzed using, for example, web session and cookie analysis tools, clickstream analysis tools, or sophisticated data-mining tools, in order to produce useful information. This cycle also includes observation of the system's actions, faults, bugs and functionality. The use of specific analysis tools helps the administrator to develop the system effectively. User interest can be assessed by, for example, examining which pages a user has visited, or how long the visit took. The aim of this cycle is to ensure quality, the validity of the content and data, and awareness of input data.
- (Re)Design cycle. Here, possible modifications are assessed in order to improve the efficiency of the WIS. This cycle may also include bug corrections, and improvements in the design, layout and functionality of the system. Various techniques may be used, for example Relationship Management Methodology (RMM), the Object-Oriented Hypermedia Design Method (OOHDM) or rapid prototyping. The results of the initial design cycle are also reused if this is feasible. The arrows shown in Figure 13 are valid e.g., if prototyping is used.
- Implementation cycle. During this cycle, corrective actions and the updating of content, structure and presentation are continuously executed. Testing is also included in this cycle. This phase includes release management when significant reported faults are fixed, or new features are added to the system.

The 'user interaction' and 'analysis' phases are intensive and continuous processes. For example, if functionality problems are detected during the analysis phase, the system has to react to this as soon as possible and take corrective actions. Both of these phases are running parallel, as are '(Re)Design' and 'Implementation and testing'. In our case, most of the development work was carried out manually, partly because of certain technical limitations or a lack of appropriate tools. The ideal goal of evolutionary development should be a fully automated system; however, the development of a WIS always includes some manual interventions.

3.7 Summary

The objective of the presented conceptual model is to react interactively to user behavior and to identify weaknesses in the system. The ability to react immediately to user or system feedback is lacking in traditional development approaches. In the sophisticated systems presented, the personalization process can be automated including only a minimum of human intervention. Our intention was to increase the degree of automation in future cycles. The automation of the adaptation process was highly dependent on technical issues. The key question is the efficiency of the system. The sooner the cyclic process is executed, the better the system can fulfill users' diverse demands. As discussed earlier, the depicted development approach is more parallel than cyclic, as it is based on intensive and continuous analysis which feeds (re)design and implementation. Thus, the word 'activity' may describe this ongoing parallel development better than 'cycle'. Truex *et al.* (1999) suggest that ongoing information systems are under constant (re)development, adjustment and adaptation. They need constant analysis.

During development, medical portal usage data was processed and used in order to identify users' needs. The recording of explicit and implicit information enables individualized communication and information provision. Usage data analysis was executed both manually and by using special analysis tools. In the design cycle, different realization alternatives were analyzed. For example, storyboarding (Appendix C) and prototyping were both used. However, universal accessibility features were not added to the existing portal version during the OWLA research project, so our experience of the success of our approach was partly limited to the results of one evolution. Thus, we cannot explicitly demonstrate that certain features we developed during the OWLA research project were implemented into the IS which was examined in the field study. However, we were satisfied that our experiences of the project proved that the presented development approach could be exploited when developing a WIS. Our experience told us that successful adoption of the approach demands commitment, comprehension and collaboration among the developers.

4 Information system success and technology acceptance research

The goal of this chapter is to introduce research related to the factors which have an effect on information system usage. At the beginning of this chapter, research on evaluating the success of an IS is described. This is followed by research describing human behavior concerning information system usage. Many studies have been carried out aimed at discovering the main features in an information system's success. Organizations have also been interested in learning about these success elements, in order to make the right decisions or to provide better services. IS success factors are difficult to define, as well as difficult to measure. Every scientific field makes certain simplifying assumptions about the complex reality it studies. We can say that there is not one simple 'success' factor to measure; success consists of many factors.

4.1 Information system success

A system that fulfills user expectations may reinforce satisfaction with the system. Thus, it is easy to believe that system usage can be an indicator of success in some cases. Whether the system is good or bad depends on how the user feels about the system. Users' feelings towards the system could be negative, particularly if the users do not trust the system and its information. Thus, success is not necessarily dependent on the technical quality of the system; it may depend on individual matters (Ives *et al*. 1983).

DeLone and MacLean (1992) concluded in their comprehensive study that there is not one single success factor measure. They distinguished six dimensions, or categories, for information success (Figure 14):

- System Quality
- Information Quality
- Use
- User Satisfaction
- Individual Impact
- Organizational Impact

They surveyed articles from seven publications, organized the articles in appropriate categories, and tabulated a description of each study and assessed them. In measuring user satisfaction, the key issue is that of whose satisfaction should be measured. DeLone and MacLean (1992) suggest that in measuring user satisfaction one should also measure users' attitude towards computers, because users' attitude toward computers may have a biasing effect on their attitude towards success. The main finding of the study was that user satisfaction is linked with the user's attitudes toward computer use, that is, the user's attitude towards computers has an impact on user satisfaction. Moreover, DeLone and MacLean's study shows that user satisfaction, or user information satisfaction, is a very widely used measure of IS success.

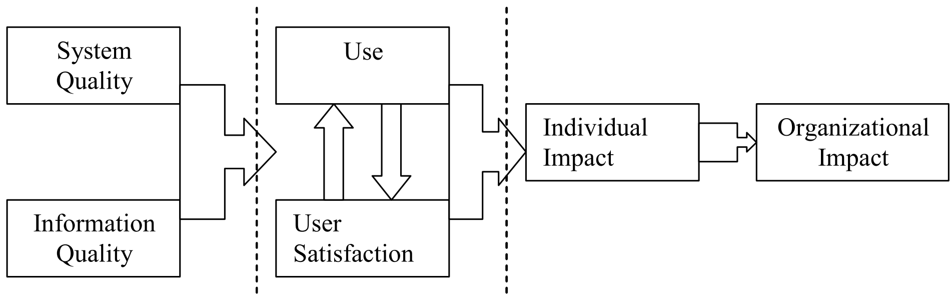


Fig. 14. Model of Information Systems Success (DeLone & MacLean 1992).

As mentioned above, user satisfaction is an abstract concept. It is hard to claim that a system is a success if the user is not satisfied with it. Yet, there is no consensus on the correct measure of information systems success (DeLone & MacLean 1992). Measuring individual impact will meet the same difficulties as measuring satisfaction. How can we objectively measure individual impact, since the positive impact of the IS is closely related to better performance? Impact may have an effect on decision-making, productivity or user activity. The variability of satisfaction measures may be caused by the differing quality of the systems themselves: users are unhappy if they feel the systems are unsatisfactory even though they have had an effect on the systems' development. Other possible ways of measuring the impact of the IS include estimating the value of the information system on a given scale, or estimating the financial benefits of the output (DeLone & MacLean 1992). Later, DeLone and MacLean (2002) refined the model shown above, by replacing 'use' with 'intention to use'. This reduced some causal problems related to use and user satisfaction. However, there is a major principle: use is a behavior and intention to use is an attitude (DeLone & MacLean 2002). Iivari (2005) tested the DeLone-McLean model for IS success in a mandatory IS use setting. He found that perceived information quality has a significant influence on user satisfaction, but the influence of perceived information quality on actual use was not significant.

As mentioned earlier, 'success' is dependent on the feelings of the user. For example, if the user feels that the quality of information offered by the Web Information System is not useful, or if the user does not trust the offered information, her/his attitude towards the system may become negative. Empirical evidence has demonstrated that output quality will have a positive effect on perceived usefulness and enjoyment. The better the output quality, the better one's job performance (Davis *et al*. 1992). In personalized Web Information Systems, information is provided by the system based on the user information recorded in the user model. Therefore, it is important to find out if the provided information really reflects the needs of the user. If the users are satisfied with the quality of information, there should be a positive impact on the acceptance of the WIS.

The concept of user information satisfaction is based on the work of Cyert and March (1963). They presumed that an information system which suits the needs of its user will lead to increased satisfaction with that system, and maybe to repeat use of the system (Cyert & March 1963, Ives *et al*. 1983). The use of the system is connected with the effectiveness of the system. Useless systems cannot be effective. Therefore it is important to discover the reasons people decide to use or not to use an IS. This knowledge will help both systems designers and developers in their work (Mathieson 1991). During the last thirty years, IS research has attempted to identify the conditions and factors affecting computer usage. Identifying these factors is seen as important for organizations because computer-use satisfaction is believed to improve the productivity of information systems. Therefore measuring satisfaction is dependent on many factors whose influence on satisfaction is difficult to measure. According to research, user satisfaction can be defined as the sum of one's feelings or attitudes toward a variety of factors affecting the situation (Bailey & Pearson 1983). It can be defined as the sum of a user's weighted reactions to a set of factors:

$$\mathrm{Si} = \sum_{j=1}^{n} RijWij$$

where Rij is the reaction to factor *j* by individual *i* and Wij is the importance of factor *j* to individual *i*. The main requirements of using this formula for identifying user satisfaction are that the set of factors relating to the domain of satisfaction must be identified, and that an appropriate way of scaling an individual's reaction to those factors can be found. In their study, Bailey and Pearson identified 38 factors which could affect IS satisfaction, but some of them did not play a significant role in certain users' satisfaction measurements, and the importance of certain factors varies from user to user (Bailey & Pearson 1983).

4.1.1 Self-efficacy theory

Large amounts of resources have been invested in systems which are not accepted by users. Refusing to use the system has been seen as a result of users' negative beliefs towards and prior experiences of the system. One important reason could be that some users do not believe they have the capabilities to handle the task ahead. They do not have a positive belief in their self-efficacy. Users believing in themselves could lead to increased acceptance. Reinforcing the self-efficacy of users could save time, effort and money. It could have a positive impact on acceptance because the users would feel more comfortable with computers and the use of computers (Venkatesh & Davis 1996). Self-efficacy can be a strong and significant predictor of use over a lengthy time period, even when users have gained more experience (Compeau *et al.* 1999). However, some researchers for example Igbria and Iivari (1995b), have not found a significant direct effect on usage, although they did find a significant indirect relation between self-efficacy and computer usage.

Bandura (1986) defines perceived self-efficacy "as people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances." This definition involves two aspects: people's belief in their skills, whether they are low or high; and people's belief that they have the skills to cope with the task ahead. According to Bandura (1982), perceived self-efficacy relates to judgments about how well one can execute the courses of actions required to deal with certain situations. The self-efficacy theory suggests that if organizations can increase employees' self-efficacy and judgments about their abilities to cope successfully with the tasks ahead, this can improve their efficiency. Essentially, self-efficacy concerns both an individual's beliefs about her or his ability to use the computer, and her or his behavior (Bandura 1977, Bandura 1982, Compeau *et al.* 1999).

In this analysis of self-efficacy theory, Bandura differentiates between two expectations: efficacy expectations and outcome expectations (Figure 15). 'Efficacy expectations' relate to one's ability successfully to carry out the behavior required to produce the outcome. 'Outcome expectations' are related to a person's judgment that a given behavior (e.g., computer skills), will lead to a given outcome, (e.g., sending e-mail or navigating on the medical information portal).

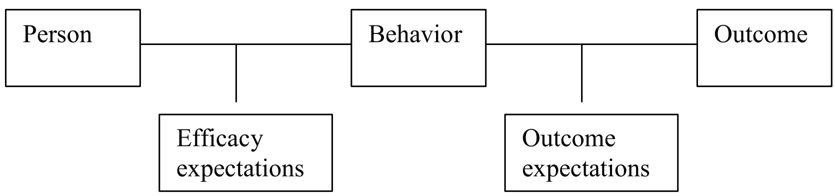


Fig. 15. Differentiation of efficacy expectations and outcome expectations (Bandura 1977).

Self-efficacy theory is a central component of more general social cognitive theory (Bandura 1986). From the point of view of social learning, expectations of self-efficacy are based on four principal sources of information (Bandura 1982). The first source of information, 'performance attainments', refers to an individual's genuine accomplishments; success increases mastery expectations, repeated failures lower them. Occasional failure cannot reduce strong efficacy expectations, which are based on repeated success (Bandura 1977). The second, 'vicarious experience', refers to observations of others' performance. By watching others perform successfully, the observer can improve her/his own performance and increase self-efficacy (Bandura 1977, Bandura 1982). The third, 'verbal persuasion', aims to influence human behavior. People are led, through suggestion, into believing that they can cope successfully with certain tasks (Bandura 1977).

The final source of information, ‘physiological state’, refers to the effects of people’s physiological and emotional state on self-efficacy, in judging their abilities to cope with the task ahead. Stressful and demanding situations generally elicit emotional arousal that might have effects on personal competency (Bandura 1977, Bandura 1982). Thus, considering the prior research and the findings of research related to doctors and Internet use (Isotalus & Mäki 2001), it can be predicted that computer self-efficacy will be a significant antecedent of the use of personalized WIS.

4.1.2 Theory of Reasoned Action

Concepts such as attitude, attraction, attribution of dispositions, liking, and behavioral intention are widely used to account for a variety of interpersonal behaviors. Research in social psychology has shown that an individual’s attitude towards the behavior is the best predictor of behavior (e.g., using an IS). It is even more important than the attitude towards the system (Fishbein & Ajzen 1975). Behavior is a function of one’s intention and attitude (Fishbein & Ajzen 1975). The Theory of Reasoned Action (TRA) has proven successful in predicting and explaining behavior across a wide variety of domains (Davis *et al.* 1989b). TRA explains that individuals will use computers if they have a feeling that there could be positive benefits (outcomes) associated with using them (Compeau & Higgins 1995).

According to TRA a person’s performance of a given behavior can be defined as a formula

$$BI = A + SN$$

where BI is the person’s behavioral intention to perform a given behavior, which is jointly determined by the person’s attitude (A) and subjective norm (SN). Behavioral intention means the person’s subjective probability that he will perform some behavior (Fishbein & Ajzen 1975).

Attitude (A) is defined as a person’s positive or negative feelings toward some stimulus object. The central equation of TRA depicts the person’s attitude (A_o) toward the object (o) as a function of their beliefs (b_i) about the object multiplied by their evaluation (e_i) of attribute (i) associated with the given beliefs; n indicates number of beliefs:

$$A_o = \sum_{i=1}^{n} b_i e_i$$

Intention is a motivational factor that influences a behavior by indicating how hard people are willing to try and how much of an effort they are planning to exert in order to perform the behavior. The stronger the intention to engage in the behavior, the more likely it is to be performed (Ajzen 1991). The determinants of TRA are shown in Figure 16.

The normative component SN defines the influence of the social environment on behavior, where SN is determined by the person’s normative beliefs (b_i) – i.e. perceived expectations that a reference group or individual i thinks that the person should or should not perform behavior B – multiplied by the person's motivation to comply, m_i (Fishbein & Ajzen 1975):

$$SN = \sum_{i=1}^{n} b_i m_i$$

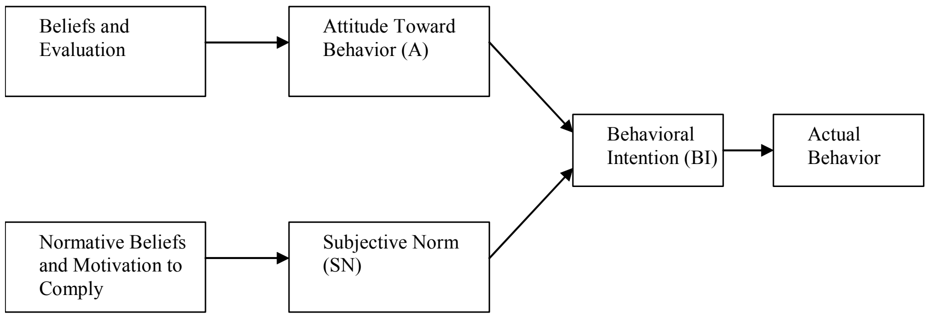


Fig. 16. Theory of Reasoned Action (Fishbein & Ajzen 1975).

From the IS perspective one relevant element of TRA is its assertion that any other external factors that influence behavior – for example characteristics related to system design, users, tasks, political influences and organizational structures – do so only indirectly, by influencing attitude toward behavior, subjective norm, or their relative weights (Davis, Bagozzi *et al*. 1989b).

4.1.3 Theory of Planned Behavior

The Theory of Planned Behavior (TPB) is an extension of the Theory of Reasoned Action, except that TPB focuses on predicting intention and action when explaining human behavior (control beliefs) (Ajzen 1991). According to TPB, human behavior is guided by three sets of beliefs: behavioral beliefs, normative beliefs and control beliefs. Intention to perform a given behavior is the central determinant of TPB (Figure 17). According to Ajzen (1991) "Intentions are assumed to capture the motivational factors that influence a behavior; they are indications of how hard people are willing to try, of how much of an effort they are planning to exert, in order to perform the behavior." Intensity of intention is directly proportional to performance; the stronger the influence of the intention on a behavior the more likely it is that the behavior will be performed (Ajzen 1991). TPB differs from TRA in that TRA does not include TPB's determinant perceived behavioral control. TRA predicts behavior based solely on attitude and subjective norm, and is predictive in situations where there are no significant barriers to behavioral performance (Fishbein & Ajzen 1975).

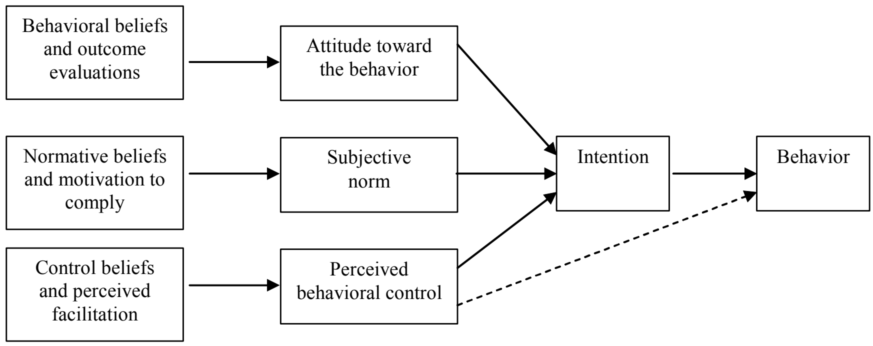


Fig. 17. Theory of Planned Behavior (Ajzen 1991).

Perceived behavioral control is compatible with Bandura's (1977, 1982) concept of perceived self-efficacy. Perceived behavioral control reflects perceptions of internal and external constraints on behavior, for example in terms of skills, self-respect, time, opportunities, the cooperation of others, and the resources needed to use a system. The concept can be used with that of behavioral intention, to predict behavioral performance. The more resources and opportunities individuals believe they possess, and the fewer obstacles they are expecting, the stronger their perceived control over behavior.

Briefly, it is likely that an individual with high behavioral control should also have a stronger intention to perform (Ajzen 1991). The internal factors of perceived behavioral control are related to the individual's beliefs, as well as to having enough resources such as time and money. The external factors are related to self-efficacy, the individual's self-confidence in his or her ability to perform a behavior. Furthermore, past experiences, both positive and negative, have an effect on perceived behavioral control (Bandura 1977, Bandura 1982, Ajzen 1991). Taylor and Todd discovered that the importance of intention depends on prior experience. For inexperienced users, perceived behavioral control has less impact on intention but has a significant influence on behavior (Taylor & Todd 1995b). Perceived behavioral control is more important for users with prior experience. Taylor and Todd's study indicated that perceived behavioral control was a significant determinant of both behavioral intention to use IS, and actual IS use.

Subjective norms are related to perceived social pressure: peers or groups whose beliefs may be important in the individual's decision to perform or not to perform a behavior. A behavioral belief refers to the subjective view of the probability that the behavior will lead to a particular outcome. 'Attitude toward the behavior' reflects the individual's positive or negative judgment or evaluation towards performing a behavior (Ajzen 1991).

An example might be: "using e-mail instead of using the current information delivery systems will save costs". Here, the behavioral belief is the extent to which the user believes that using e-mail could save costs. The outcome of the evaluation would be the importance of improving information delivery systems. When using TPB in predicting IS usage intention, one should remember that TPB uses beliefs that are specific to a given context. They can vary across behaviors and situations; beliefs that are valid in one context may not be valid in other contexts. Therefore one cannot always generalize beliefs across contexts (Ajzen 1991, Mathieson 1991). Venkatesh and Davis (2000a) found in their study that in mandatory settings the role of social influence was important. Empirical evidence has shown that social influence is partly dependent on gender. It is more significant among women (Venkatesh *et al*. 2000c), especially during the early stages of IS usage. Later, when the technology was more familiar, users were not influenced by it as significantly as earlier (Venkatesh & Morris 2000b, Venkatesh *et al*. 2003).

As discussed earlier, in the context of doctors and Internet use, doctors felt, partly because of social pressure, that they should use the Internet more in order to keep themselves up to date. Therefore, in this study we are interested in examining the importance of social pressure (normative beliefs) in the acceptance of personalized WISs. In general, norms guide individuals as to how to behave. Considering that the users of the given WIS are members of certain social systems – they are representatives of the medical field and members of Fimnet – normative beliefs could be expected to have an import role in the acceptance of new technology.

4.1.4 Innovation and compatibility

Understanding how individuals adopt new ideas and social practices and spread them within a society or from one society to another is an important element in explaining personal and social behavior (Bandura 1986). The process of spreading ideas and practices has been examined extensively by Rogers (1995) and presented in his book "Diffusion of Innovations". Diffusion of innovation can be seen as a social process in which subjectively perceived information about a new idea is communicated. According to Rogers, diffusion can be defined as "a process by which an innovation is communicated through certain channels over time among the members of the system" (Rogers 1995). This definition indicates that diffusion can be seen as communication: spreading messages concerned with new ideas, practices, or devices, in a social context (Rogers 1995).

Web Information Systems that are linked with different networked systems provide access to knowledge and act as communication mechanisms, providing a unique channel for disseminating information (Scharl 2000). This channel provides the advantages of mass media channels, organizational channels and personal channels combined. Over time, users will become less conscious of the medium and see the power of the text itself, instead of seeing a document or computer screen (Scharl 2000).

In communication processes, individuals create, share and process information with other individuals, in order to reach a mutual understanding. In the social context of diffusion of innovation, when new ideas are disclosed, diffused and adopted or rejected, social change takes place (Rogers 1995). This change can happen voluntarily or because of the influence or pressure of organizational, political or other factors. Communication is a two-way process in which messages are transferred, causing certain effects (Rogers 1995). Communication channels are facilities by which messages are transferred, for example the mass media channels of TV, computer and newspapers, or the interpersonal channels of face-to-face interaction (Rogers 1995). When diffusion occurs in a social environment, it may cause changes in the structure of the social system (Rogers 1995).

Rogers defines innovation as “an idea, practice or object that *is perceived as new* by an individual or another unit of adaptation.” The stress is one the wording “perceived as new”. An innovation may be perceived as new by some people, even if it was introduced some time ago. Rogers classifies technical innovations in two categories: hardware components – which consist of electrical components, for example relating to semiconductors, transistors or electrical connections – and software components – for example coded commands or instructions (Rogers 1995).

The analysis of the diffusion of innovations must take into consideration psychosocial factors relating to individual adoptive behavior and the impact of widespread adoptions on the society. Many modern Internet services demand registration. Furthermore, cookies and session files collect and record data about users’ tastes, habits, values and preferences. This recording of user information and invasion of personal privacy becomes a matter of social concern. Analyzing the recorded data enables one to determine how particular social influences affect human behavior. This may lead to adverse consequences (Bandura 1986).

Rogers (1995) sorts the characteristics of innovations which could promote IT usage and adoption decisions concerning new technology into five categories:

- relative advantages of the system compared to its precursor
- compatibility of the innovation with the individual’s existing world-view, values and experiences
- complexity: how easy it is to understand and use the innovation
- trialability: the degree to which the innovation may be experimented with on a limited basis
- observability, representing the visibility of the innovation to others.

Time is a critical element in the diffusion-decision process, in innovativeness and in innovation’s rate of adoption. In an innovative-decision process, the individual tends to formulate an attitude toward the innovation in order to make a decision to adopt or reject the implementation of the new idea and to confirm this decision. The decision process consists of five steps: 1) knowledge, 2) persuasion, 3) decision, 4) implementation, and 5) confirmation. The adoption of the innovation follows over time, normally following an S-shaped curve. The innovativeness variables of the S-shaped curve can be categorized in five adopters: innovators, early adopters, early majority, late majority and laggards (Rogers 1995).

4.1.5 Perceived behavioral control

An individual’s desire for control is an attempt to master their environment. They want to master their own acts and to know the causes and consequences of their own and others’ acts (Baronas & Louis 1988).

Rotter has used the concept of the perceived locus of control, classifying control beliefs as internal and external locus of control (Rotter 1966). The concept of locus of control is related to personal control beliefs – the extent to which individuals are able to control or influence outcomes. An individual with strong internal control believes that whether events are enacted or not depends on her/his own behavior or characteristics.

Individuals with strong external control believe that the enactment, which is caused by some other act and is not entirely dependent on the individual's behavior, is controlled by luck, chance, the actions of another person or the forces surrounding the individuals. If the perceived reinforcement, positive or negative, is dependent on the individual's behavior, the possibility of that behavior reoccurring in the same or a similar situation is strengthened or weakened accordingly (Rotter 1966). Individuals with an internal locus of control believe that success or failure is dependent on their own abilities. For example, if the user manages to find a Web site that satisfies her/his needs, or if (s)he feels that they have control over the user data supplied to the system, (s)he will revisit the site. User satisfaction may facilitate to perform of a certain behavior.

Self-efficacy beliefs differ from personal control beliefs in that self-efficacy beliefs emphasize the individual's ability or judgments of their ability to cope with the task ahead. Thus self-efficacy beliefs focus on one's ability to successfully carry out the behavior required, whereas personal control beliefs emphasize the individual's abilities to control outcomes (Bandura 1977).

Perceived behavioral control reflects perceptions of internal and external constraints on behavior. It tries to explain individuals' behavior in situations in which people do not have volitional control over the behavior of interest. When the situation is not under an individual's control – if, for example, it is dependent on the decisions of other people – human behavior cannot be predicted from intentions alone (Ajzen 2002). The more resources and opportunities individuals believe they possess, and the fewer obstacles they are expecting, the stronger their perceived control over behavior. It is likely that an individual with high behavioral control will also have a stronger intention or ability to perform a particular behavior (Ajzen 1991). 'Internal factors of perceived behavioral control' refers to the individual's beliefs in having enough resources such as skills, time and money. 'External factors' refers to self-efficacy, an individual's self-confidence in her or his ability to perform a behavior. As shown in Figure 18, Ajzen suggests that perceived behavioral control is comprised of perceived self-efficacy and perceived controllability. He concludes that these factors should be taken into consideration when measuring perceived behavioral control.

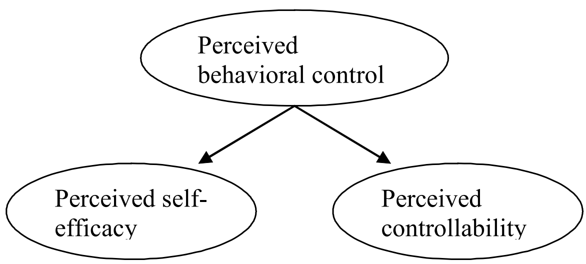


Fig. 18. Structure of perceived behavioral control (Ajzen 2002).

Both of these elements, perceived self-efficacy and perceived controllability, include beliefs about the presence of internal and external factors. This "extended" construct of perceived behavioral control suggests that assessing perceived behavioral control should take into consideration both determinants: perceived self-efficacy and perceived controllability (Ajzen 2002).

4.2 Technology acceptance research

Organizations invest in Web Information Systems for many reasons, for example to cut costs, to produce more without increasing costs, and to improve the quality of services or products (Lederer *et al*. 1998). On the other hand, research has concentrated on the development of better measures for the key determinants of user acceptance. Better measures for predicting and explaining system use would have a high practical value, both for vendors who would like to see users' reactions to new design ideas, and for information systems managers who would like to evaluate vendors' offers (Davis 1989a). According to Davis (1989a) perceived usefulness and perceived ease of use are especially important determinants in the question of whether users will accept or reject information technology. Davis asserts that the determinants of perceived usefulness and ease of use represent the beliefs that lead to user acceptance of information technology (Lederer *et al*. 1998). According to analysis by Rogers (1995), diffusion of innovation can be seen as a cognitive process in which the user's perceptions and understanding play a significant role in the adoption of new technology. The factor of relative advantage is positively related to the rate of innovation adoption, whereas complexity is inversely proportional to the rate of innovation adoption (Tornatzky & Klein 1982). Therefore it can be concluded that usefulness and ease of use are factors which have positive influences on the acceptance of new technology. Similarly, these are factors which are important elements in the diffusion of new innovation. If the user perceives that the system is useful or easy to use, the system is more likely to be adopted.

Davis's Technology Acceptance Model (TAM) is based on Fishbein and Ajzen's Theory of Reasoned Action (TRA) and specially tailored for modeling user acceptance of information systems. The idea of TAM is to explain computer usage behavior and to pay attention to the quality of measures used and how well they correlate with usage behavior (Davis *et al*. 1989b). TRA is composed of a theoretical basis for specifying the causal linkages between two sets of beliefs – perceived usefulness and perceived ease of use – and of users' attitude, intention and actual technology adoption behavior (Davis *et al*. 1989b).

The importance of TAM is in providing an explanation to computer use based on a simple set of determinants which are easy and cheap to measure. Moreover, TAM can be applied to user behavior across a broad range of end-user computing technologies and user populations. On the other hand, TAM could be useful for researchers and practitioners not only for prediction when planning a new system but also for explaining why a particular system may be unacceptable and need appropriate corrective actions to increase its acceptability (Davis *et al*. 1989b).

Development work for TAM was carried out in a student environment. Data was gathered from MBA students who used word processing software (WriteOne) (Davis, Bagozzi *et al*. 1989b). The use of the software was voluntary by nature. Moreover, the software used was partly familiar to the users. In terms of the model itself, a key purpose of TAM is to provide a basis for tracing the impact of external factors on internal beliefs, attitude and intention (Davis *et al*. 1989b).

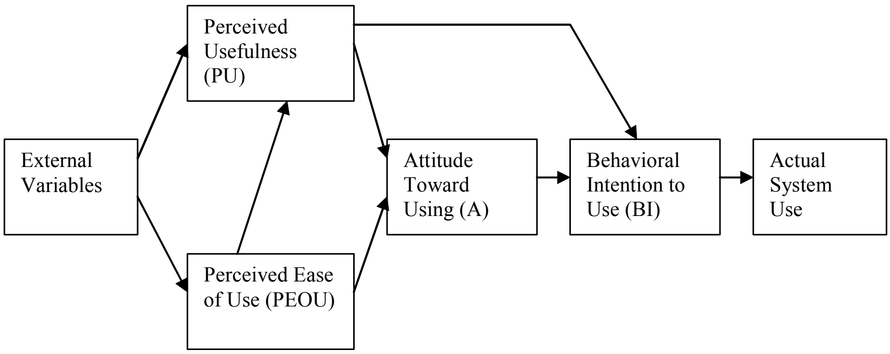


Fig. 19. Technology Acceptance Model (Davis, Bagozzi *et al.* 1989b).

TAM asserts that two beliefs, perceived usefulness and perceived ease of use, are relevant determinants and have a significant impact on computer acceptance behaviors (Figure 19). U is perceived usefulness, defined as an individual's subjective beliefs that using a specific application system will increase the user's job performance within an organizational context. As Figure 19 indicates, U can also be defined:

U = PEOU + External Variables

Hence, external variables may affect usefulness directly, or indirectly via perceived ease of use. In cases where similar systems are equally easy to operate, external variables may be the critical determinant of perceived usefulness. 'External variables' refers, for example, to system characteristics, demographic variables, user interface characteristics, user training, and user computer experience (Davis *et al.* 1989b).

PEOU is perceived ease of use, defined as the degree to which the individual believes that the target system would be free of physical or mental effort. External variables have a direct affect on EOU.

BI is behavioral intention, which differs from TRA in that it is defined as the result of the individual's attitude toward using the system (A) and the perceived usefulness (U) (Davis *et al.* 1989b)

BI = A + U

Davis did not include TRA's subjective norm determinant in TAM, because it is difficult to perceive the direct effects of determinant subjective norm on behavioral intention, from the observations of the indirect effects of determinant the subjective norm via attitude (Davis *et al.* 1989b). Instead of the concept of the subjective norm, TAM uses the determinant ease of use. PEOU can influence attitudes and behavior in two ways: self-efficacy and instrumentality (Davis *et al.* 1989b). TAM was assessed in order to examine its ability to predict and explain user behavior, in particular the impact of usefulness and ease of use on user acceptance.

The results indicated that (ibid.):

– Intention correlates reasonably well with people's computer use.
– Perceived usefulness is a major determinant of people's intention to use computers.

– Perceived ease of use is a secondary determinant of people's intention to use computers

The results indicated that in order to improve acceptance one has to pay attention to usefulness. The usefulness of the system is more important than objective, measurable, ease of use, or user-friendliness. In human-computer interaction research, objective ease of use is traditionally associated with the system's usability (Nielsen 1995). However, users may be willing to tolerate a (to some extent) inoperative system if the system performs functions and provides functionality that the user needs. Objective ease of use indicates the system's effectiveness and user performance whereas subjective ease of use may affect the decision to use or not to use the system (Davis 1989a, Davis *et al*. 1989b, Venkatesh & Davis 1996).

People accept or reject information technology based on the extent to which they believe it will help them perform their task better. Davis emphasizes that perceived usefulness and ease of use are people's subjective feelings of performance and effort. They do not necessarily reflect the objective reality (Davis 1989a). If the given application is objectively effective but, for example, if the potential users do not perceive it as useful or easy to use they will probably not use it (Davis 1989a).

Davis (1989a) defines perceived usefulness, as "the degree to which a person believes that using a particular system would enhance his or her job performance." This definition emphasizes the user's belief that certain systems will improve the user's job performance without having an impact on raises, promotions, bonuses or other rewards. Perceived ease of use refers to "the degree to which a person believes that using a particular system would be free of effort." Davis (1989a) asserts that an application perceived to be easier to use than another is more likely to be accepted by users. Although expertise is not one of TAM's variables, it may be represented indirectly via perceived ease of use, since a person with high expertise may consider a system easier to use than a person with low expertise (Mathieson *et al*. 2001).

According to Davis (1989a) the definition of perceived ease of use is similar to Bandura's (1982) definition of self-efficacy. Self-efficacy can be defined as the beliefs a person has about their capabilities to successfully perform a particular behavior or tasks. "Self-appraisals of operative capabilities function as one set of proximal determinants of how people behave, their thought patterns, and the emotional reactions they experience in taxing situations" (Bandura 1982). When people make judgments about their ability to cope with a task, they tend to avoid activities that they believe to be too overwhelming for their skills, but undertake activities and behave assuredly if they judge themselves capable of managing (Bandura 1977). Judgments of self-efficacy determine how much effort people will expend and how long they will persist with the obstacles: "High perseverance usually produces high performance attainments" (Bandura 1982).

Self-efficacy research supports Davis's definition of perceived ease of use. Self-efficacy theory distinguishes two types of expectations, self-efficacy expectations and outcome expectations. Outcome expectations are similar to perceived usefulness (Davis 1989a, Venkatesh & Davis 1996). Venkatesh and Davis showed in their empirical research that self-efficacy is associated with ease of use, and has a significant impact on the user's perceptions of ease of use about any computer system (Venkatesh & Davis 1996).

The variable of perceived behavioral control in the TPB model relates to internal and external constraints on behavior – the skills, self-confidence, opportunities and resources needed to use system. In TAM, the corresponding variable of perceived ease of use refers to internal constraints such as the match between the individual's capabilities and the skills required by the system; external control variables are not taken into consideration. (Mathieson 1991).

4.3 Extensions of technology acceptance research

In order to redevelop the Technology Acceptance Model, Davis (1989a) dropped some determinants which had been present in the above-mentioned model, paying attention to only two determinants: perceived usefulness and perceived ease of use (Figure 20). He performed two studies, a field study and a lab study. In the field study, data was collected from 112 users within IBM's development laboratory, using questionnaires. 40 volunteers were selected for the lab study, and all of these participants were MBA students. One of the most significant findings was that in both studies, perceived usefulness was significantly more strongly linked to usage than perceived ease of use. These results were concordant with earlier research. Davis argued that perceived usefulness correlates strongly with user acceptance and should not be ignored by those who are attempting to design or implement successful systems (Davis 1989a).

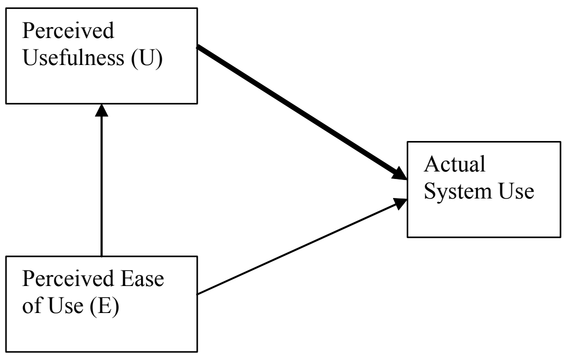


Fig. 20. Davis's TAM model (Davis 1989a).

In order to understand the antecedents of perceived ease of use better, Venkatesh and Davis conducted three experiments spanning 108 subjects and six different systems. They examined the impact of the determinants self-efficacy, objective usability and direct experience on perceived ease of use. Their findings supported their hypothesis that self-efficacy acts as an antecedent of perceived ease of use. Objective usability had an effect on ease of use only after direct experience with the system. Furthermore, Davis and Venkatesh suggested that self-efficacy can be explored and understood in the context of user acceptance of information technologies. (Venkatesh & Davis 1996).

Later, Venkatesh and Davis developed and tested a theoretical extension of TAM. They tested this extended model using longitudinal data, which was collected from four different systems at four organizations: two involving voluntary usage and two involving mandatory usage. They named the developed extension model TAM2 (Figure 21). In TAM2, the following "new" determinants were added: social influences (subjective norm, voluntariness and image) and cognitive instrumental processes (job relevance, output quality, result demonstrability and perceived ease of use). The main findings were that subjective norm has a significant direct effect on usage intention and an indirect effect via perceived usefulness and perceived ease of use on usage intention in mandatory systems but not in a voluntary usage context. The effects of social influence were consistent in both cases (Venkatesh & Davis 2000a).

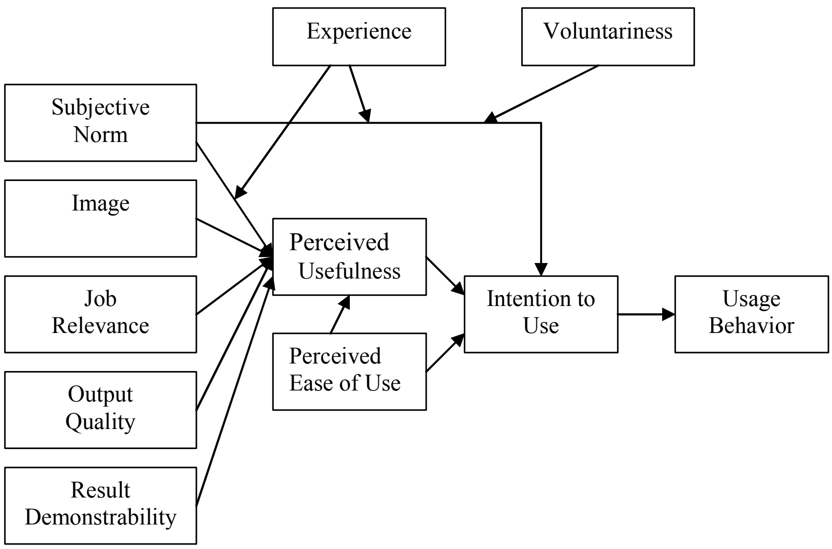


Fig. 21. Proposed TAM2 (Venkatesh & Davis 2000a).

4.3.1 Comparison of TAM, TPB and decomposed TPB

Taylor and Todd (1995a) compared TAM (Davis, Bagozzi *et al.* 1989b) and two variations of TPB, TPB as introduced by Ajzen (1991) and the so-called 'decomposed' Theory of Planned Behavior introduced by Taylor & Todd (1995a). The aim of the comparison was to assess which model best helps to understand information technology usage. They tested the models with data collected from a field study of 750 potential student users of a computing resource center, over a 12-week period, using structural equation modeling. Taylor and Todd (1995a) criticize that TAM has not been tested with actual measures of usage. Secondly they criticize the fact that TAM has not been tested as a whole; in fact, only various parts of the model have been studied separately using regression-based approaches. Therefore, it is important to carry out a complete assessment of TAM and to examine how the model can help to understand usage behavior (Taylor & Todd 1995a). The theoretical background for Taylor and Todd's research related to determinants of intention is partly consistent with Rogers' (1995) examination of the theory of diffusion of innovations. Diffusion of innovations examines the variables that are thought to be determinants of IT usage, which may promote the adoption decision.

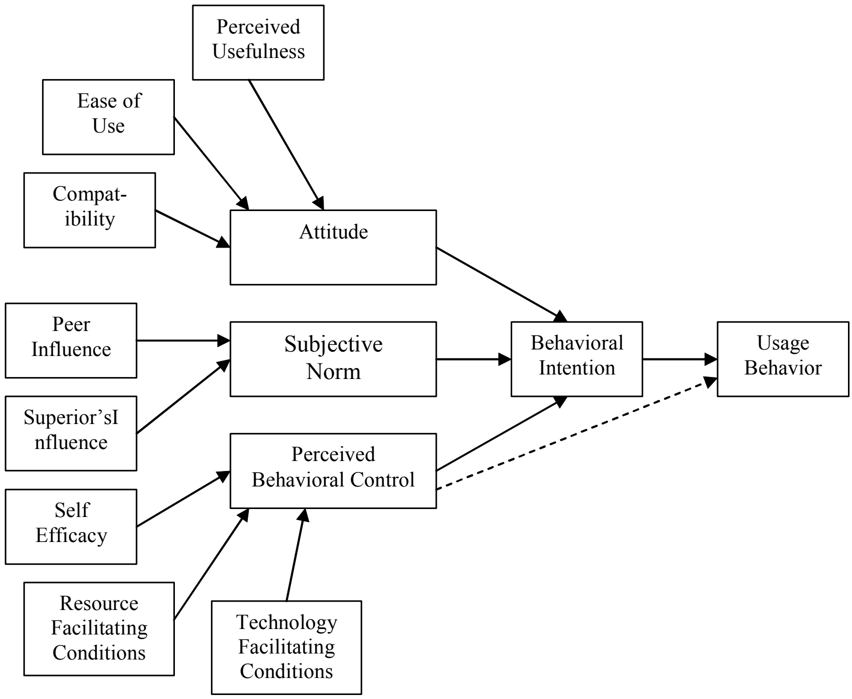


Fig. 22. Decomposed Theory of Planned Behavior (Taylor & Todd 1995a).

Taylor and Todd created a model, the decomposed model (Figure 22), which combines the best features of TAM and TPB. Their decomposed model includes 13 different factors. Researchers assert that the decomposed model can provide a stable set of beliefs, which can be applied across a variety of settings, but that by focusing on specific beliefs, the model becomes more controllable, pointing to specific factors that may influence usage. The three models were tested and compared in terms of how each model can be used to understand intention to use and subsequent usage of information technology (Taylor & Todd 1995a). Prior research has found that both TAM and TPB explain intention quite well (Mathieson 1991). However, TAM explained attitude toward using a system much better than TPB (Mathieson 1991). According to Taylor and Todd (1995a), decomposed TPB provides a deeper understanding of the antecedents of behavior than TPB. Although the decomposed TPB is a more complex model compared to TPB, it is a better one (Taylor & Todd 1995a). Taylor and Todd discovered that TAM predicted usage as expected on the basis of prior research; only the path from attitude to intention was not significant. The other model, the theory of planned behavior, was nearly as predictive as TAM. The third model, the decomposed TPB model, was slightly better at predicting usage compared to TAM and TPB. The research showed that attitude, subjective norms and behavioral control have significant indirect effects on behavior; however, the paths from perceived ease of use and compatibility to attitude, and the path from technological facilitating conditions to perceived behavioral control were not significant (Taylor & Todd 1995a). It should be noted that the predictive importance of behavioral intention on behavior depends on prior experience. Behavioral intention is more predictive of behavior when users have had prior experience of the behavior (Taylor & Todd 1995b). Behavioral intention was the most important determinant in all three models, and all models provided similar predictions of IT usage behavior. Moreover, both TPB models provided a more complete understanding of intention than TAM. In this research, attitude was not an important determinant of intention and usage in workplace settings, when compared to such determinants as usefulness. Taylor and Todd (1995a) supported this with the fact that students will use the computer resource center because they think it might help them to get better grades, even if they had a negative attitude towards the computer resource center. This finding was consistent with the findings of Davis *et al*. (1989b).

Which one of these models is best in terms of predicting and explaining behavior if the statistical fit and explanatory power are of equal importance? First of all, Taylor and Todd (1995a) emphasize that it depends on the purpose for which the model is used. Secondly they emphasize the importance of parsimony and the explanatory power of the model. If the primary goal is prediction then TAM is better. If the primary goal is a deeper understanding of usage and intention then the decomposed TPB is better. In assessing the findings one should remember that the three models were examined in a student setting, where subjective norms and perceived behavioral control may operate differently than in workplace settings (Taylor & Todd 1995a).

One of the most interesting and surprising findings was that the addition of the determinants 'subjective norm' and 'perceived behavioral control' to TAM did not increase its predictive power for IT usage behavior (Taylor & Todd 1995a). Hence Mathieson (1991) criticizes and questions the benefits of building a new model. TAM explained 34% of the variance in usage; the decomposed TPB explained 36%. TAM includes 5 variables, the decomposed TPB 13. This modest increase in predictive power is questionable because it will also greatly increase costs, because of the increase in complexity (Mathieson, Peacock *et al*. 2001).

4.3.2 Comparison of TAM and TRA

Davis *et al*. (1989b) compared TAM and TRA, focusing on the questions of how well intention can predict usage, how well these models explain intention to use a system and what role attitude plays in mediating the effect of beliefs on intention. Moreover they tried to find out whether there is any other theoretical construction that could better explain the data collected. Data was gathered from 107 full-time students during their first semester. The use of software was voluntary, and the software was fairly familiar to users. The results showed that behavioral intention was significantly correlated with usage. Perceived usefulness explained better intention than perceived ease of use. Both models proved that BI is the major determinant of usage behavior (Davis *et al*. 1989b). Within TRA, the link between attitude and behavioral intention was significant whereas the link between subjective norm and behavioral intention was weak.

4.3.3 Comparison of TAM and TPB

Mathieson (1991) in turn compared TAM and TPB's ability to predict an individual's intention to use IT. He compared these models using three criteria: the model's ability to predict users' intention to use an IS, the significance of the information that the model can provide, and the difficulty of applying the models in different cases. Data was collected from 262 students on a management course. Both models were tested in the same context, using subjects sampled from the same population, facing the same usage decision about the same types of systems. According to Mathieson, the main differences between TAM and TPB are 1) their different degrees of generality, 2) the way they take social variables into consideration, and 3) the ways they consider perceived behavioral control. The following differences can be distinguished:

- TAM suggests that beliefs relating to perceived usefulness and perceived ease of use are preceding determinants in predicting usage. These beliefs are not context-specific. The beliefs used in TPB, on the other hand, are mainly specific to the given situation. This means that TAM's constructs are easier to apply to different user contexts, whereas TPB requires a pilot study to identify the relevant outcomes, referent groups and control variables in the context in which it is to be used (Mathieson 1991).
- TAM does not include any social determinants. There could be social factors, for example social pressure from peers or groups that are not directly associated with TAM's outcomes, which improve work performance, such as perceived usefulness. The social variables of TPB may provide a more accurate explanation of user intention (Mathieson 1991).
- The third major difference, related to perceived behavioral control, refers to the skills, opportunities and resources needed to use the IS. TPB differentiates between internal factors that are characteristics of an individual, and external factors that depend on the situation (Ajzen 1991). TAM, on the other hand, does not explicitly include behavioral control variables. The variable ease of use refers to the match between the respondent's capabilities and the skills required by the system. It is similar to the internal factor of skill, but external factors are missing in TAM (Mathieson 1991).

The findings of the comparison showed that TAM explains attitude better than TPB. This finding was more significant than Taylor and Todd's (1995a) finding. Both models predicted intention well, but TAM explained variance slightly better than TPB; however, the difference was not significant. One important finding was TAM's ability to explain attitude towards using an IS. It was better than in TPB. Another interesting question is that of significance of information, that is, whether the models provide valuable information for researchers. According to Mathieson, TPB provides more specific information about the factors which have an effect on system use. At the same time it identifies factors that users feel might be barriers to system use (Mathieson 1991). TAM's ability to explain information related only to usefulness and ease of use stays at a very general level. The costs of using the models showed that TAM is easier to use than TPB. One important finding was that the measures of TPB's beliefs are context-specific, so this method usually requires a pilot study. This finding is consistent with the findings of Taylor and Todd (1995a). Mathieson suggests that using both models together could be effective. TAM enables one to identify dissatisfied users or groups and their complaints. Using TPB, one can find out more detailed information, specific to users or groups (Mathieson 1991).

4.3.4 TAM and perceived enjoyment

Igbaria *et al*. studied the motivating factors which may have an effect on computer usage in Finland (Igbaria, Iivari *et al*. 1995a). Research suggested that most studies, especially those relating to TAM, have been conducted in North America using American subjects, and do not necessarily take into consideration different cultural backgrounds. Furthermore, in most cases data has been collected among students. Therefore, one focus of the study was to test the extended TAM in a different cultural and organizational environment. The main focus of the study was to test the extension of TAM by adding to the model the external determinant 'enjoyment' and indirect variables related to demographics: age, education and gender (Figure 23).

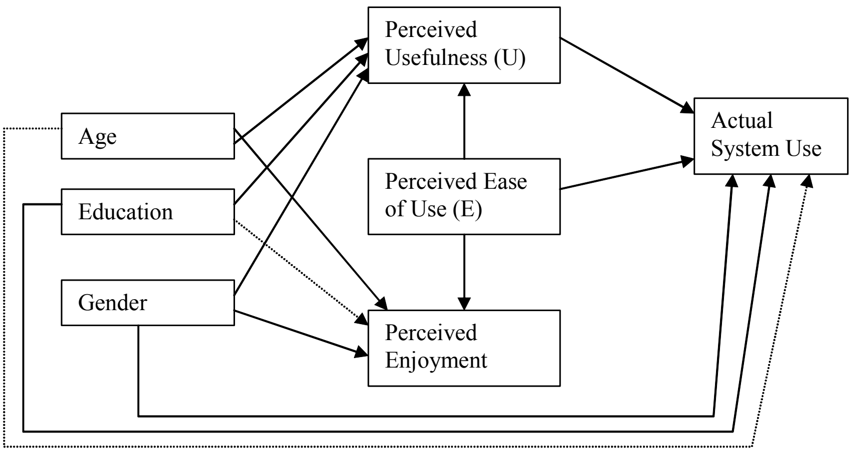


Fig. 23. TAM and Perceived Enjoyment (Igbaria *et al*. 1995a).

Data was gathered from 81 companies, targeting professional and managerial users. The findings were consistent with those of Davis (1989b). Perceived usefulness had a strong direct effect on system usage, and perceived ease of use had a strong direct effect on perceived usefulness and, moreover, a very strong indirect effect on usage, through perceived usefulness. In addition, education had a positive effect on perceived usefulness. Gender and age had negative effects on perceived enjoyment: males and older users enjoyed using the system less. Moreover, education had a strong positive effect on frequency of use: males used the system more extensively. Age did not have a significant effect on system usage. The effect of perceived enjoyment on system usage was not significant. However, Heijden (2003) suggested that perceived enjoyment has a positive impact on both attitude towards using a Web site and intention to use a Web site. Moon and Kim (2001) also found that perceived playfulness (enjoyment) had a significant effect on attitude and behavioral intention towards using the Web. Webster and Martocchio (Martocchio & Webster 1992, Webster & Martocchio 1992) suggest that playfulness has a positive impact on computer attitude. They also argue that individuals with higher cognitive playfulness have a positive attitude toward using computers and this may lead to long-term outcomes such as better learning experiences and satisfaction.

Empirical evidence has demonstrated that factors associated with extrinsic motivation and rewards (e.g., usefulness) are more important than factors associated with intrinsic motivation (e.g., enjoyment) (Davis *et al*. 1992, Igbaria *et al*. 1995a, Teo *et al*. 1999, Moon & Kim 2001). Intrinsic motivation is related to the performance of an activity without a specific reason – users perform an activity because it causes satisfaction – while extrinsic motivation emphasizes the performance of a behavior to achieve a specific goal (Deci & Ryan 1980, Davis *et al*. 1992, Venkatesh & Smith 1999). Moon and Kim (2001) found that if the system is used for entertainment purposes, perceived playfulness has a more significant effect on intention to use the system than perceived usefulness. On the other hand, if the system is used for work purposes, perceived usefulness has a more significant effect on intention. However, perceived playfulness has a more significant effect on attitude than perceived usefulness. Davis *et al*. (1992) found in their study that output quality and ease of use have a positive effect on usefulness and enjoyment, although prior research has demonstrated that systems which are easy to use and produce high quality output will be rejected if they are not useful with respect to the user's work.

4.3.5 TAM and diffusion of innovation

According to Tornatzky and Klein (1982), there are three attributes of innovation – relative advantage, complexity and compatibility – which are related to innovation adoption. Taylor and Todd (1995a) suggest that relative advantage, "the degree to which an innovation is perceived as better than the idea it supersedes" (Rogers 1995), is compatible with the determinant 'perceived usefulness' in TAM's structure. Relative advantage differs from perceived usefulness in that it incorporates the concept of technology assessment – comparing the innovation with the technology that is currently in use (Chin & Gopal 1995). Relative advantage can consist of economic, social and other similar issues. Both variables, relative advantage and perceived usefulness, have been defined in similar ways associated with improved performance. Complexity has been defined as "the degree to which an innovation is perceived as difficult to understand and use" (Rogers 1995). This definition is in turn compatible with TAM's determinant 'ease of use', with the opposite meaning (Taylor & Todd 1995a).

The theory of diffusion of innovation focuses on describing how the adoption process of an innovation evolves over time. As opposed to TAM, the diffusion of innovation theory does not pay attention to the acceptance factors of the new technology – users' attitude and intention towards the new technology or their differing ability to adopt new technology, relative to their background, skills or expertise.

4.3.6 TAM and computer anxiety

'Computer anxiety' refers to computer users' emotional apprehension and resistance to the use of computer technology (here, resistance to personalized WISs). It describes the individual's internal fear or phobia of making mistakes or causing damage when using computers (Sievert *et al*. 1988). Self-efficacy affects both emotional reactions and behavior (here, computer usage). This concerns anxiety especially. The self-efficacy theory suggests that the relationship is reciprocal. In other words, the higher the computer anxiety, the lower the computer self-efficacy. Furthermore, an increase in one's computer self-efficacy level may lead to a decrease in computer anxiety (Bandura 1977). Igbaria and Chakrabarti found a significant correlation between computer anxiety and attitude towards computers (Igbaria & Chakrabarti 1990). They did not find significant correlation between education and age and computer anxiety or between education and age and attitude toward computers. In their study, Igbaria and Iivari (1995b) did not find a significant direct effect between anxiety and computer usage. However, they found that anxiety had a significant overall effect on usage, through ease of use. Hackbarth *et al*. (2003) and Venkatesh *et al*. (2000a) also concluded that anxiety is a significant antecedent of ease of use. According to Compeau *et al*. (1999) anxiety does not have a significant effect on computer usage. Thatcher and Perrew (2002) carried out research on the effects of anxiety on self-efficacy. Their findings indicate that computer anxiety has a significant negative effect on computer self-efficacy. Their sample consisted of university students, as in the Igbaria and Chakrabarti study.

According to the literature, users' psychological states may affect the adoption of technology. As discussed earlier, anxiety was one of the reasons doctors were doubtful about using the Internet (Isotalus & Mäki 2001). Thus, it can be hypothesized that anxiety may form a barrier to using personalized WIS and this was included in our study's hypothetical model.

4.3.7 Research on TAM and the Web

Heijden (2003) introduced the extension of TAM in order to study user acceptance of a Web site. In his extension of TAM, as explanatory factors he used ease of use, usefulness, enjoyment and perceived visual attractiveness. The empirical research was executed by examining the users of a free Dutch portal site with over 300 000 users. The sample size of the survey was 828 users. The findings showed that the predictive factors of usage had a positive influence on the intention to use the Web site. Furthermore, the role of perceived usefulness and perceived enjoyment were mediating factors towards the use of the portal.

Lederer *et al*. (1998) discussed the acceptance of Web technology. Their survey was conducted by e-mail. The number of e-mail respondents was 163. Their study was based on TAM, paying particular attention to perceived usefulness and perceived ease of use. Number of items of variable perceived ease of use was twenty and the number of items of variable perceived usefulness was twenty-three. The findings were consistent with TAM.

They showed that usefulness and ease of use have positive influences on the use of a Web site.

Moon and Kim (2001) extended TAM to include the factor 'perceived playfulness'. They studied the importance of user's intrinsic motivation on the acceptance of the World Wide Web. Their findings showed that playfulness is an important factor that has an effect on the user's acceptance of the World Wide Web. Ease of use, usefulness and playfulness had significant effects on an individual's attitude towards use of the World Wide Web. The researchers concluded that practitioners have to pay more attention to user interface design by adding features exploiting 'playfulness' when developing systems. Moon and Kim (2001) suggest that considering playfulness will increase the usability of the World Wide Web. In more general terms, they emphasize that IS practitioners should understand the importance of extrinsic and intrinsic motivation in interface design.

4.4 Stickiness

Stickiness is a concept which has recently come into use in the area of e-commerce. There are many definitions of stickiness, depending greatly on the context in which it is used. Generally, stickiness is associated with duration of Web site visit or enjoyability of Web site visit. In a Web environment, 'stickiness' is associated with brand loyalty, user satisfaction and personalization (Holland & Baker 2001). Holland and Baker (2001) define stickiness as "the sum of all the Web site qualities that induce visitors to remain at the site rather than move on to another site". It is suggested that stickiness is a good measure of site performance. If users revisit the site and their visits last a long time, it may indicate that users are committed to that site. From the point of view of the service provider, it is essential to try to get users to visit the site, to keep the user on the site and to get the user to revisit the site. Service providers should offer services or information which is interesting, topical and easy and quick to find. Navigation should also be clear and consistent (Rosen 2001). A personalized system may help the service provider because it can recognize users and their preferences. This will allow the user to receive relevant rather than unwanted information, accurate searches and speedy transactions (Holland & Baker 2001). In the Web environment, personalization has been seen to increase satisfaction, loyalty and user retention (Holland & Baker 2001, Zemke & Connellan 2001). Thus, using personalization, companies try to attract users and increase their involvement level for the site. Gillespie *et al*. (1999) define stickiness as "positive characteristics of a Web site, that maximize the duration, frequency and depth of a user's visit. Stickiness drives loyalty. Loyalty drives success." As noted above, duration of visit, loyalty and brand are all associated with stickiness. However, duration of visit (for example) is a complicated measurement because the reasons for the visit's duration may remain unclear. Was the user on the phone at times? Could there be a flaw in the system's functional features? Likewise, repeat visits may indicate that the user is lost in hyperspace, or that the user is merely browsing the Net. In this study we will base our stickiness measurement partly on prior loyalty studies by Methlie and Nysveen (1999) and Pedersen and Nysveen (2001). Our instrument will measure how users assess the reputation of the given information system, how they assess their expectations toward the system, and how they assess their current and future system usage. All in all, stickiness will be an effective indicator when assessing the appeal of the system.

4.5 Research model and hypotheses

The hypothetical research model is based on TAM's construction where attitude toward using the system, intention to use system and actual system usage (Figure 24) are the dependent variables of the user acceptance of IS. The research model is based on the findings of prior research and the experiences we gained during the OWLA project. Moreover, the results of Isotalus and Mäki's (2001) research (discussed more in chapter 5.1) raise questions which lead to the hypothesis of this study. According to the results, medical staff felt that they should use the Internet more in their work because the available amount of medical information on the Internet was tremendous. Some respondents felt that they should also use the Internet because their workmates use it. Respondents regarded easy and quick access to relevant information relating to their work duties and ease of use of the IS as the most important criteria for Internet use. As preventive factors they mentioned lack of resources, expertise and computer usage skills, among others.

We are interested in the question of whether beliefs about one's own capabilities – in this research, self-efficacy beliefs – have a significant role in terms of actual use of a personalized system. Self-efficacy beliefs indicate the degree to which a user believes in her/his own ability to cope alone with future challenges. Secondly, the results of Isotalus and Mäki's (2001) research bring up the question of anxiety, which indicates a fear or phobia about using the system. Often this fear is a consequence of prior negative experiences. Moreover, ease of use, usefulness and perceived behavioral control are all focuses of this research. Perceived behavioral control refers to external or internal constraints related to behavior in using Information Systems, for example skills, time or opportunities. The possible impact of normative beliefs, for example peer or management pressure, is also interesting because people working in a hospital are members of different social systems.

In this study perceived relevance (Figure 24) is viewed as having two aspects: information quality and stickiness. DeLone and MacLean (1992) suggest that information quality is a factor which has an effect on user information satisfaction and IS usage. Users appreciate accuracy, relevance and timeliness of information. If the users do not trust the system and its information, their behavior against the system can be negative. On the other hand, if the Web site does not offer information which satisfies user's expectations, the user will leave the site in spite of its being entertaining or its search services being easy to use (McKinney *et al*. 2002). Information is produced by the system. Prior research has paid attention to both information and specific features of a system when studying ISs' effectiveness, ISs' success or user satisfaction. In this study, the researcher has tried to take a wider view of the information quality aspect. Stickiness reflects the user's feelings toward the provided information and the user's perceptions and feelings toward the system itself. Perceived relevance assesses the system's ability to satisfy users' expectations, the system's reputation among the users, and the users' future use of the system. We can hypothesize that users appreciate personalized information provided by the system and they have a positive attitude toward the system. Thus, we can expect that perceived relevance will have a significant influence both on attitude toward using the WIS and the actual use of the WIS.

Perceived expectancy is viewed as having two aspects: perceived usefulness and compatibility. The target IS is specialized to offer specific information to certain user groups aiming to enhance users work performance. The information system is expected to be "capable of being used advantageously" (Davis 1989a). Thus, perceived usefulness is system specific; by improving functionality of the system, it enhances the system's usefulness (Davis 1993). The compatibility of the innovation (here, the personalized WIS) reflects "the degree to which an innovation is perceived as consistent with the existent values, past experiences, and needs of the potential adopter" (Rogers 1995). The definition of compatibility is wide. It implies what people feel or think about a technology, but on the other hand it implies compatibility with what people do (Tornatzky & Klein 1982). In their study, Moore and Benbasat (1991) found that compatibility and relative advantage, "the degree to which an innovation is perceived as better than the idea it supersedes" (Rogers 1995), did not loaded as separate factors although they were conceptually different. Moore and Benbasat (1991) suggest that reference "needs" may link compatibility and relative advantage. Considering Taylor and Todd's (1995a) suggestion that relative advantage is compatible with the determinant perceived usefulness of TAM, both perceived usefulness and compatibility are included in perceived expectancy.

Perceived expectancy indicates users' extrinsic motivation to use the system. If the users believe that the system will improve their job performance and the system will support their working methods, the users will probably accept the system. Both of these demands are salient goals of personalized systems. Thus, based on the prior TAM research, we can conclude in the personalized WIS context that perceived expectancy has a significant influence on both behavioral intention to use and actual WIS usage.

Perceived ease of use emphasizes a person's belief that using a particular system does not demand extra effort. Perceived ease of use is not necessarily dependent on a person's expertise. However, Mathieson and Chin (2001) suggest that although expertise is not a variable of TAM, it may be represented indirectly via ease of use, since a person with high expertise may feel that a system is easier to use than a person with low expertise. Davis (1989a) asserts that an application perceived to be easier to use than another is more likely to be accepted by users. Personalized systems try to make users' computer usage easy by modifying functionality and presentation according to the individual user. Based on the TAM literature discussed earlier, we can expect perceived ease of use to have a significant impact on actual WIS usage.

Enjoyment reflects an individual's intrinsic motivation. Individuals who are intrinsically motivated to use new technology do not avoid possible obstacles related to usage compared to individuals with lower intrinsic motivation (Venkatesh *et al*. 2002). Individuals with high intrinsic motivation may spend more time with the computer, which may lead to better quality output, and it may enhance work performance, learning and satisfaction (Webster & Martocchio 1992, Venkatesh *et al*. 2002). Considering the wide variety of services the system may offer, from leisure time sites to work-specific sites, it is important to examine the impact of enjoyment on system acceptance. Thus, considering the prior research, we can hypothesize that perceived enjoyment will have a positive impact on attitude toward using the WIS.

Perceived behavioural control is a determinant of TPB. The primary objective of the Theory of Planned Behavior is to predict intention and explain human behaviour (control beliefs) (Ajzen 1991). PBC reflects perceptions of internal and external constraints on behavior, for example with reference to the skills, self-respect, time, opportunities, co-operation with others and resources needed to use the system. It is obvious that medical staff have limited time resources for using computers during their working day. Therefore their computer use is occasional because of different interruptions, which may have an effect on their motivation toward the IS. We can expect that perceived behavioral control will have a significant influence on intention to use the WIS.

Computer anxiety refers to computer users' apprehension and resistance to use of technology (here, resistance to personalized WIS). It describes the individual's internal fear or phobia of making mistakes or causing damage when using computers (Sievert *et al.* 1988). According to the literature, the user's psychological state may affect the adoption of technology. Thus we can expect that anxiety will have a negative influence on actual use of the WIS.

Normative beliefs reflect the normative expectations of peers or colleagues (Fishbein & Ajzen 1975, Fishbein 1980). As discussed earlier, the pressure of others may have an influence on the acceptance of the information system. According to the prior research related to doctors and Internet use (Isotalus & Mäki 2001), peers' behavior has an influence on the behavior of other users. Aydin and Rice (1991) suggest that individuals create their behavior toward the system based on the interaction with each other. Membership of a social environment may also have an influence on the adoption of the information system. Karahanna *et al.* (1999) found that normative beliefs have an influence on the intention to adopt information technology. Considering that the given system is quite a new application with personalized features it offers an interesting opportunity to study how the social pressure affects the acceptance of the system. Thus, we can hypothesize that normative beliefs will influence users' intention to use the WIS.

In a computer environment, two kinds of control can be identified: people can control their own beliefs and behavior or they can control their environment. The self-efficacy theory (Bandura 1977) suggests that, if organizations can increase employees' self-efficacy – their judgment about their abilities to cope successfully with the tasks ahead – this can improve their efficiency. Thus self-efficacy emphasizes a human's ability to perform a certain behavior in order to achieve a certain outcome (Bandura 1977). Self-efficacy could have a positive impact on acceptance because users feel more comfortable with the computers and the actual use of computers (Venkatesh & Davis 1996). Moreover, self-efficacy can be a strong and significant predictor of use over a lengthy time period, even when users have gained more experience (Compeau *et al.* 1999). Based on the literature discussed earlier we can expect self-efficacy to have a significant effect on actual use of the WIS.

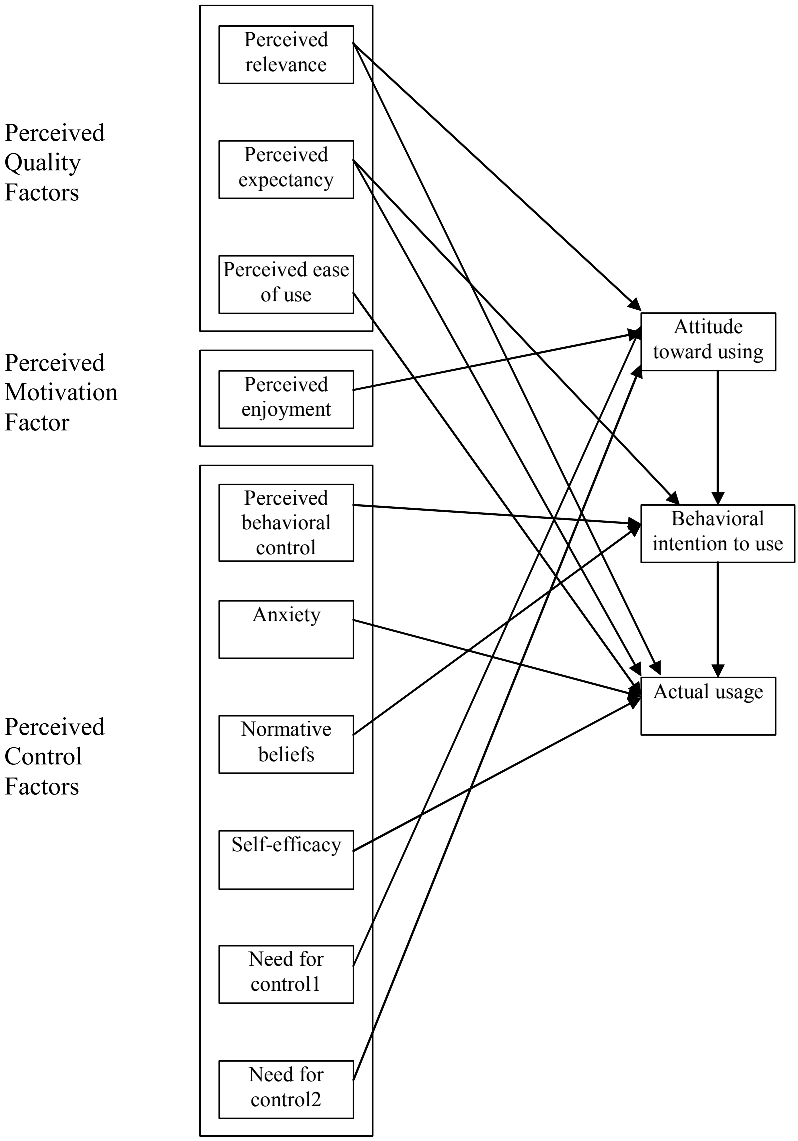


Fig. 24. Hypothetical research model.

The 'need for control' variables indicate users' concern about the security of the system and their concern about their individual information. The nature of a personalized system is paradoxical: the personalization of the system is more accurate when the system has more information about the individual. Thus, it is not feasible to implement personalized systems without some loss of privacy (Chellappa & Sin 2005). This may concern individuals. Individuals feel that they do not have control over the use of their personal information (Foxman & Kilcoyne 1993, Hoffman *et al*. 1999b, Culnan 2000). This will lead to a lack of trust toward service providers (Hoffman, Novak *et al*. 1999b). Hoffman suggests that the lack of trust, which primary result from users privacy concerns, is the most important barrier to the successful commercial development of the Web (Hoffman *et al*. 1999a). Prior research has indicated that users have need a for control concerning their individual information (1997, Kehoe *et al*. 1999). Chellappa and Sin (2005) found in their study that consumers' positive attitude toward personalization affected their decisions to use personalized services but usage had a negative impact on consumers privacy concerns.

Individuals consider it to be important that they are aware and that they have direct control over their personal information (Malhotra *et al*. 2004). Culnan (2000) suggest that if the individuals are told fairly about information practices, individuals may be willing to give personal information if they will get something useful in return. Based on the earlier discussions, we can expect the need for control variables to have an impact on behavioral attitude toward using the WIS.

5 Field study

This chapter consists of seven sections describing the research methodology of the dissertation. These sections depict how the research data was gathered and how the data was analyzed.

5.1 Doctors and Internet usage

In this section we will highlight the background to our field study, showing some statistics related to Finnish doctors and these doctors as Internet users. The many technical improvements in the area of communication and information technology, together with the challenges and possibilities presented by the area of medical informatics (Hasman 1997, Haux 1997, Zvárová 1997) have increased doctors' motivation towards the usage of information technology. Thus, in this section we will highlight the impacts that the Internet will have on the medical staffs' work.

According to statistics from the Finnish medical association (2004), at the beginning of 2003 there were 19 764 doctors in Finland. The gender spread was balanced; 51% of the doctors were male. The number of working-age doctors at the beginning of 2003 was 17 410. Most Finnish doctors (42%) work in hospitals, and 20% work in health centers. The rest of the doctors work in other medical centers, in occupational health centers and in teaching, research and administration. About 60% of doctors have specialized and 20% have published a doctoral thesis. Doctor density in Finland is on average quite similar to that in other European countries: one doctor per 269 inhabitants (2004).

Highlighting the background of the field study, we present some of the essential findings of the scrutiny, which was focused on the doctors' Internet usage. These findings are compared with Isotalus and Mäki's work (2001), which studied the same system. The reason for taking their work as a reference point was that the potential users of the Internet examined there were representatives of the same professional field as in this work. Isotalus and Mäki suggest that doctors felt use of the Internet to be professionally essential, even though they have few opportunities to make use of the Internet during the working day. According to the researchers, the general opinion among the doctors was that they should use the Internet more in their daily work. Therefore it was partly social pressure that made the doctors feel that they should use the Internet in order to keep themselves up to date.

Isotalus and Mäki suggest that the doctors' occupation requires them to follow developments in the medical field constantly, and try to keep themselves up to date in relation to drugs, medical treatments and research. One major difficulty is that the medical information flow is tremendous. There are many authorities, pharmaceutical plants and research institutes, providing different services. The doctors felt that managing and controlling this information flow is nearly overwhelming. In studying doctors' Internet use, Isotalus and Mäki refer to research results which indicate that the most important criteria which might affect doctors' Internet use are: ease of use, speed of the application, age, prior experience in computer use, and provision or lack of appropriate content and services. In their master's thesis, Isotalus and Mäki also studied factors that may prevent Internet use among doctors. Their findings were consistent with the prior research they refer to. They found issues that have been experienced as preventive factors, such as lack of personal computers, lack of one's own workroom and especially lack of time. Those who did not use the Internet in their work were uncertain of their Internet skills and considered Internet usage difficult. Some respondents had tried to use the Internet but had encountered failures, as a consequence of which they had become uncertain about their ability to use the Internet. Most of the failures were encountered when trying to find appropriate information related to work, and the use of search engines was considered difficult. Moreover, the results indicated that most of the difficulties related to Internet usage were based on the doctor's feeling or belief that they did not have sufficient capabilities to use the Internet efficiently. When studying factors which may motivate doctors to use the Internet, Isotalus and Mäki found that doctors who used the Internet frequently felt that the Internet had facilitated their work by simplifying time-consuming routines. Moreover, doctors felt that using the Internet had made it easier for them to keep up to date. In particular, the greater the specialization of the field in question the greater the need for Internet use. In general, benefits issues were seen as more important in Internet use than enjoyment issues. Other factors that facilitated Internet usage were the ease of use and speed of the services provided, and access to versatile information. When assessing which kind of Internet services were most popular among the doctors, Isotalus and Mäki found that a clear majority of the respondents were interested in special field, work-related information, and also in the search services offered by different search engines. The researchers also surveyed respondents' attitude towards personalized services, assuming the future existence of an Internet service that could remember a user's previous choices the next time the user visits the site. The results indicated that the majority of the respondents had a positive attitude towards potential personalized services.

5.2 Factors influencing attitude, intention and actual use

According to the field study conducted by Isotalus and Mäki (2001), users' (doctors') attitudes towards Internet use depend upon the users' belief in their own skills or abilities to manage on their own with the computer and the Internet. This was one of the main reasons for users not wanting to use the Internet. When asked in the field study about obstacles in Internet use, users talked about their fear and lack of time and skills. Therefore it is interesting to study users' self-efficacy beliefs, anxiety and perceived behavioral control concerning personalized Web Information Systems because personalized systems aim to reduce the user's workload, give easier access to information, and remove the obstacles which prevent usage. 'Perceived behavioral control' is affected by a user's access to resources, for example time, money or computer resources. It is also influenced by a user's self-confidence about her/his capabilities to perform the behavior. It could be that in hospitals and health-care environments there is a lack of various resources for example time or opportunity to use computers, which may have an effect on attitude and behavior toward ISs.

The theoretical basis of the chosen factors is based on prior research, which has suggested that TAM can explain why people accept or reject new information technology. TAM argues that individuals may have a positive attitude towards using information systems if they believe that using the system may lead to positive results. Perceived ease of use and perceived usefulness are powerful TAM determinants in predicting usage intention. Likewise, diffusion of innovation is focused on beliefs about the technology, and outcome expectations. On the other hand, TAM and the diffusion of innovation theory do not take into consideration individuals' feelings and beliefs in their own capabilities, that is, self-efficacy beliefs (Compeau *et al*. 1999). Self-efficacy has been found to play a significant role in predicting information system usage (Compeau & Higgins 1995, Compeau *et al*. 1999). Individuals' fear or rejection of information systems may derive from anxiety (Sievert *et al*. 1988). There is also a significant correlation between self-efficacy and computer anxiety (Igbaria & Chakrabarti 1990, Compeau & Higgins 1995, Compeau *et al*. 1999). As mentioned earlier, perceived behavioral control is related to the use of resources in order to achieve the desired goal.

The system examined in this study can be characterized as an information delivery channel. It provides context-specific occupational information which is adapted according to the user. 'Information quality' reflects how well or badly the system fulfills users' everyday information expectations and aids work practices in the organizational setting. Isotalus and Mäki (2001) found that doctors appreciated the Internet because it helped them keep up to date. 'Information quality' also reflects the success of the information system (DeLone & MacLean 1992, DeLone & MacLean 2002). Therefore, in this study we will examine the importance of information quality in acceptance of the system.

Previous research has indicated that enjoyment is an important factor in the acceptance of computer systems (Davis *et al*. 1992, Webster & Martocchio 1992, Igbaria *et al*. 1995a) and the Internet (Teo *et al*. 1999, Moon & Kim 2001, Heijden 2003). Extrinsic motivational factors – for example, perceived ease of use or usefulness – and the intrinsic motivational factor of enjoyment both encourage users to adopt the IS because they feel that the IS's results will be of benefit to them, and that the IS is enjoyable to use (Davis *et al*. 1992). Therefore, in this study we will also examine the importance of enjoyment in the context of personalized WISs.

5.2.1 Selecting the research case

The selection of the field study subject was based on work done in the OWLA research project in 2000–2002. As mentioned above, during the project our aim was to develop the existing system by adding new features, for example universal acceptability, making use of the results of the latest scientific research. The main goal of the field study was to evaluate the acceptability of the developed system. The selection of the hypothesis and model was based on prior experience of development work, and the literature. The model presented here is therefore based on field studies previously carried out in the target organization.

5.2.2 Data gathering

We performed a field study in which data was collected using a Web questionnaire, which was designed and developed in cooperation with experts in the IT field and the target company. A Web questionnaire was chosen instead of a paper questionnaire because the target company had previously carried out many Web-based studies for their own needs and so had good experience of this kind of data-gathering process. We also had good experience, from carrying out a Web questionnaire study for the OWLA research project in 2002. When conducting a Web survey the researcher should take into consideration selection bias, which has effect on the generalizability of the results. In this research, the target system was a medical IS, the target group was mostly medical staff and the target information system was not public. It requires registration in the national medical network. The majority of the questions were based on validated questions. The survey tool used enabled the checking and removal of possible multiple responses from the same participant. Although these issues are important aspects with respect to minimizing bias (Wyatt 2000), it is quite obvious that the selection bias has to be taken into consideration as a limitation in generalizing the results of the study.

Because the questions were mostly based on our review of the English literature, they were translated into Finnish with the cooperation of the University of Oulu Language Center and IT experts. Most of the questions chosen were based on validated questions used in prior research adapted to different IS studies. By using validated questions we aimed to strengthen the reliability of the study. According to Straub (1989), Boudreau *et al*. (2001) and Alkula (1994), using validated and tested questions will improve the reliability of results. They suggest that researchers should use validated instruments wherever possible; this may also lead to greater confidence in findings.

After the questions were translated, we went through them with IT experts and senior managers in the target company. They gave feedback on the content, terminology, format, length, answer time and instructions, and on the basis of this we made the necessary modifications to the questionnaire. The use of experts in the field to evaluate instruments accurately may increase the content validity of the instrument (Straub 1989). After these modifications, the target company senior managers rechecked the questionnaire. Our aim was to design as clear, easy-to-read and attractive a questionnaire as possible, in order to maintain respondents' answering motivation. The paper version of questionnaire appears quite long, but on the Web, respondents saw the questionnaire one page at time when answering the questions. We thought that the translation of the questions would help respondents to understand the meaning of the questions better, and a successful layout was important to maintain respondents' motivation to answer all the questions carefully. The final questionnaire was then sent to the target company and the experts within the company converted the Word-based questionnaire into HTML format using a specialized form tool of their own. Some of the questions (seventeen of them) were exactly the same as ones we had used in the field study carried out for the OWLA project. These questions were related to respondents' attitude toward personalization. By repeating the same questions, our aim was to study possible changes in attitude during 2002–2003. Thus these questions were piloted during the OWLA -project in 2002.

The questionnaire tool used forced certain requirements in terms of layout, so the questionnaire was checked in the real Web (medical portal) environment, with some small improvements being made. The questionnaire was launched on the Web on 06.10.2003, and closed on 15.10.2003. During that time, 209 responses were submitted. The respondents' answers were collected in the target company's database. Later, the numeric data was converted into Excel spreadsheet format and sent to the researcher for analysis. In the next phase, the textual material of the responses was encoded in a numeric form suitable for statistical analysis.

Altogether, the questionnaire consisted of 35 questions, most of which included some subquestions (items). The questions were related among others to demographic variables, attitude towards personalization, and acceptance of the system. The scale used was mainly the Likert scale, with some questions being based on the Osgood semantic differential scale. The Likert scales used were seven-point scales, with 1 being the negative end and 7 the positive end. For example, perceived usefulness (seven-point Likert scale):

1. Using the medical portal increases my task productivity

Fully disagree						Fully agree
1	2	3	4	5	6	7

The scale items used were based on prior studies and the literature. Perceived ease of use (PEOU), perceived usefulness (PEU), attitude (ATTIT) and behavioral intention (INTENT) are based on Davis' (1989a) studies. These are measured using seven-point scales. Measuring actual use (USE), comprising of three constructs, is also based on Davis' (1989a) study. Computer self-efficacy (SE) was measured using the item scale developed by Compeau and Higgins (1995). The scale used was the ten-point Guttman scale. Items measuring information quality (INFQ) were based on the questionnaire items developed by Larcker and Lessig (1980). Computer anxiety (ANXIE) was measured using a seven-point scale based on the research of Igbaria and Chakrabarti (1990). Perceived behavioral control (BEHCONT) was measured using the item scale developed by Taylor and Todd (1995a). Items measuring compatibility (COMPA) were based on the scales developed by Moore and Benbasat (1991). Enjoyment (ENJOY) was measured using items based on the work of Igbaria *et al*. (1995a). The normative beliefs (NORMBEL) scale was adapted from Karahanna *et al*. (1999). Need for control (NFC) items were generated by asking respondents about how concerned they feel when giving demographic information to a system or filling out registration forms, and how they feel about the way their individual information is collected, used and processed. The item ‘stickiness’ was generated based on loyalty research. All the variables and items are examined more closely in Appendix C.

5.2.3 Data analysis

The aim of this section is to describe the data analysis techniques that were used and to describe in short their essential features. When we use the term technique, a feature in methodology, it means the way of doing a particular activity. It can also include phases and sub-phases (Avison & Fitzgerald 1995). In this study, two kinds of analysis methods can be separated: quantitative and qualitative. Quantitative research tries to answer the questions “how much”, “how many”, “who” or “what”, trying to discover correlations between concepts or phenomena by using numerical measurements. Qualitative research tries to answer the questions “how” and “why”, trying to explain the causes of behavior. According to Yin (2003), if the research questions are mainly “what” questions, the research is likely to be exploratory by nature. Essentially, Yin emphasizes the importance of identifying what kinds of research questions are being asked. Paying attention to these questions will be helpful because they may define possible research strategies, which will guide the researcher’s working process.

These aforementioned analysis methods are not mutually exclusive; both of them can be used in the same research or in the analysis of the same research. Therefore it can be said that quantitative and qualitative methods can complement each other. In fact, when using both quantitative and qualitative methods together may result in a deeper insight into the findings. One cannot simply divide a research field into quantitative and qualitative methods; rather, one can separate two research models – one related to scientific experiments (quantitative research) and the other related to problem solving (qualitative research) (Alasuutari 1999). Equally Marcus (1989) emphasizes that one cannot make distinctions in terms of rigor between quantitative and qualitative research and classify them as different, separate methods. The way in which these methods are used or which one of the methods is better, depends on the research questions and the goals of the research. Kaplan (1988) refers to Marcus and Robey (1988) when assessing the use of qualitative and quantitative methods in information systems research, stating that “although qualitative methods provide less explanation of variance in statistical terms than quantitative methods, they can yield data from which process theories and richer explanations of how and why processes and outcomes occur can be developed”. In the field of information systems, studies that combine both qualitative and quantitative research methods have become more general.

5.2.4 Validity and reliability

In order to reduce and assess measurement error, the researcher should pay attention to the validity and reliability of the measurement tool. By minimizing these errors the, explanatory power of the measures will increase. Because validity and reliability together constitute the overall reliability of the measure, the main questions when assessing the results of the measurements are: how to ensure that the measure is free from casual and irrelevant errors, and how to ensure that one can reach definite interpretations or solutions (Nummenmaa *et al*. 1997). Generally, low reliability is considered one condition for validity; it decreases the validity of the measure and of the results of the study. However, this does not work the other way around; validity does not have an effect on reliability (Alkula *et al*. 1994).

5.2.4.1 Validity

Validity can be traced back to the concept of operationalization, which refers to the development of appropriate measurements based on the theory, concepts and hypotheses of a study. Essentially, the study's validity reflects the researcher's skills, abilities and knowledge concerning the research domain and prior studies, and her/his mental skills when formulating measures (Nunnally 1978). Nunnally states that, in a very general sense, validity indicates whether the instrument is useful scientifically. He argues that "validity is usually a matter of degree rather than an all-or-none property, and validation is an unending process" (Nunnally 1978).

Validity can be defined as a measurement's (including questions or items) ability to prevent systematic or non-random error (Hair *et al*. 1998). Thus validity is dependent on how accurately and well the content of the measure represents the concept of the study we are measuring. There are different kinds of points of view concerning validity. Normally, a distinction can be drawn between predictive validity, content validity and construct validity (Alkula *et al*. 1994). These points of view on, or approaches to, validity aim to ensure the appropriateness, meaningfulness and feasibility of the conclusions of the measurements (Nummenmaa *et al*. 1997). In order to take validity issues into consideration, in this study we have mainly used measures (instruments) which have already been used in prior studies. By using validated measures, the validity and reliability of the results will be increased (Straub 1989, Alkula *et al*. 1994). In summary, we have tried to take validity issues into consideration, from the early phases through to the analysis of the study, in an attempt to strengthen the measures' ability to produce valid results.

Predictive validity refers to a measure's ability to forecast or predict phenomena which are outside of the given measure. If the predictive validity of two measures used for measuring the same phenomenon is good then the results of the measures are similar to each other (Nunnally 1978, Alkula *et al*. 1994). High predictive validity (high correlation) is a useful and significant aid when making decisions or when predicting possible future phenomena (Nunnally 1978). In this study we have exploited measures with predictive validity by measuring and assessing the correlation of the variables. The results confirmed the existence of predictive validity.

Content validity describes how well the content of the measure matches with the conceptual definition of the phenomena under study. This requires the researcher to try to ensure that the measure used (including items, questions etc.) will measure what it is intended to (Hair*et al*. 1998). Good content validity ensures that the phenomenon in question is measured extensively. Content validity aims to eliminate several errors related to, for example, the sampling, measurement or analysis of the variables. Content validity may have an important influence on the interpretation and generalization of the results. In this study we have tried to ensure content validity by using measures which are derived from theory and assessed by experts in the information technology field and in the target company, in an attempt to ensure that the content of the measure is consistent with the concept we are studying. As discussed earlier, most of the measures employed in this study are based on the literature and on prior research done in the field of IS and other disciplines. Content validity was also tested statistically by measuring inter-item correlation. All the inter-item correlation values were positive, suggesting that the measures have good content validity.

The construct validity of the measure is good if the results match with expectations, or are consistent with prior research (Nunnally 1978, Alkula *et al*. 1994). Thus construct validity can show how well a selected measure matches with the suggested hypotheses, and can indicate whether the measure behaves as expected (Nummenmaa *et al*. 1997). Construct validity may be based on prior research and the assumption that the concept under study is linked to some other well-known and measurable concept (Erätuuli *et al*. 1994). Nunnally (1978) emphasizes that when ensuring construct validity one should take care that the measures of the model measure the same thing. In this research, the selected measures described the represented model of the study very well. Factors incorporated into the model were also tested using factor analysis, which is a powerful method when studying the interrelationships of the factors and when analyzing the developed model. Moreover, item-to-total correlations of the variables were carried out. Both statistics suggested good construct validity.

5.2.4.2 Reliability

Reliability can be generally defined as a variable's ability to accurately measure what it is supposed to measure. Hair *et al*. (1998) argue that "reliability is an assessment of the degree of consistency between multiple measurements of a variable". In practice, reliability indicates the measurement's ability to yield consistently non-random results, but this does not mean that reliability is related to randomness. On the contrary, it is related to repeatability. This may cause some difficulties, especially in studies examining individuals' beliefs, attitude, intention or behavior. These are highly dependent on human behavior, mood or environmental factors. Reliability differs from validity in that reliability concerns how a phenomenon is measured whereas validity concerns what should be measured (Hair *et al*. 1998). Common and natural mistakes which may occur and have an influence on reliability, are, for example, typing errors when recording data, or errors in data analysis.

One method for assessing reliability is test-retest. If the measurement is free from errors then when the measurement is repeated the results should be same. This can be executed in an alternative way by measuring the same phenomenon across the time period, using different measures (Alkula *et al*. 1994). One of the most-used measures of reliability is to assess the internal consistency of the items of the scale used. Three types of internal consistency can be assessed:

– Item-to-total correlation, which assesses the internal consistency of each of the items with the total scale. Item-to-total correlation indicates whether the item and the test measure the same thing. The better the separate items correlate with the whole test, the better the items will correlate with each other (Hair *et al*. 1998).
– Inter-item correlation, which assesses correlation among all the test items. This will indicate if certain items differ from other items for some reason; they may perhaps test something else (Hair *et al*. 1998).
– Cronbach's alpha reliability coefficient. When measuring the internal consistency or homogeneity of the entire scale, one of the most used measures is Cronbach's alpha reliability coefficient (Hair *et al*. 1998).

In this study, we have ensured and assessed the reliability of the measurements by using Cronbach's alpha reliability coefficient.

5.3 Demographic profiles

Our target group was all the doctors and medical students who are registered in the Finnish medical network, and who are users of the medical IS. Potential users of the target IS are geographically spread all over Finland. Our preliminary goal was to get about 200 responses, after which the questionnaire window would be closed. During the period 06.10–15.10.2003, when the questionnaire was available on the Web to all registered users, 209 responses were returned. After checking the responses we noticed that some of the respondents had responded twice (due to a technical error). Moreover, one response had to be discarded entirely because the answers were not relevant (the responses followed a clearly arbitrary pattern of ascending and descending numbers). After these corrections, the total sum of reliable responses was 197. The potential number of the target IS users in total was about 9500 including specialists, doctors, medical students and the group "other". This means that the response rate was 2.2 % (responses/potential users).

5.3.1 Occupation distribution

We received 112 respondents from the category "specialists", which was 56.9 % of all responses. We received 54 respondents from the category "doctors", which was 27.4 % of all responses, and from the combined group "medical students/other" we received 31 respondents, which gives us a response rate of 15.7 %. The initial groups "medical students" and "other" were combined for the statistical analysis because of the low response frequency of the “other” group; the frequency of the group “medical student” was 28, and of the group “other” 3. These frequencies are presented in Table 4.

Table 4. Occupation distribution of the respondents.

Occupation	Frequency	Percentage
Specialist	112	56.9
Doctor	54	27.4
Medical student/ Other	31	15.7
Total	197	100

5.3.2 Age and gender distribution

The age of the respondents was grouped into the classes “less than 22”, “22–31”, “32–41”, “42–51” and “52 and over”. The number of respondents in the “less than 22” class was two, and in the “22–31” class it was 49. Because of the low response rate of the class “less than 22”, we decided, for the statistical analysis, to combine the two lowest classes into the class “31 and under”. The age frequencies were very uniformly distributed between the “42–51” class (46 respondents) and the “52 and over” class (47 respondents). The gender of the respondents was distributed quite uniformly; there were 100 male respondents and 97 female. These figures are presented in Table 5.

Table 5. Age and gender distribution of the respondents.

Age	Frequency	Percentage
≤31	51	25.9
32–41	53	26.9
42–51	46	23.4
≥52	47	23.9
Total	197	100
Gender:	Male 100 (50.8 %)	Female 97 (49.2%)

5.3.3 Gender and occupation distribution

Table .6 presents the distribution by gender and occupation. One should note that, in this table, the classes “medical student” and “other” are combined as mentioned earlier. The table shows that most of the male respondents, 66 percent, belong to the class “specialists”. The number of males in the “doctor” class is 22 percent, and in the combined “medical student/other” class 12 percent. Correspondingly, the percentages of females are: in the “specialist” class 47.4 %, in the “doctor” class 33 %, and in the combined “medical student/other” class 19.6 %.

Table 6. Gender and occupation distribution of the respondents.

Gender	Occupation			
	Specialist	Doctor	Medical student/Other	Total
Male	66	22	12	100
% within gender	66.0	22.0	12.0	100
% within occupation	58.9	40.7	38.7	50.8
Female	46	32	19	97
% within gender	47.4	33.0	19.6	100
% within occupation	41.1	59.3	61.3	49.2
Total	112	54	31	197

5.3.4 Gender and age

Figure 25 depicts the gender and age distribution of the respondents. As most of the respondents belong to the "specialist" class, one can expect the age distribution to tend towards the older age classes, especially in the case of the males. 35 (35 percent) of the males are 52 or over. The average age ascends quite smoothly from the age group "31 and under", with 18 respondents (18 percent), to the age group "52 and over".

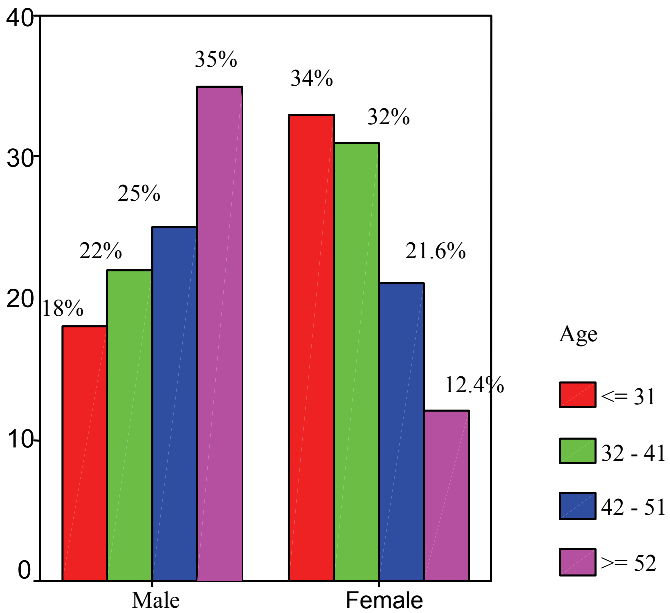


Fig. 25. Gender and age distribution of the respondents.

On the other hand, the age distribution of the females is surprisingly different from that among the males. The number of respondents in the age group "52 and over" is the smallest – 12 respondents (12.4 percent) – ascending to the age group “31 and under”, which includes 33 respondents (34 percent).

5.3.5 Computer expertise distribution by occupation, gender and age

We also asked respondents to evaluate their computing skills. When analyzing computer expertise and occupation distribution, we can see (Table 7) that all the groups estimate their skill level mostly as average. In all, the majority of the respondents estimated their computer expertise as average, fairly good or very good. Respondents from the “medical student/other” group estimated their computer skills as above average more frequently than those in the “doctor” and “specialist” groups. This is quite consistent with the age distribution in the occupation groups. The age distribution in the “specialist” group is weighted towards older age groups. Within the “doctor” group, age is weighted towards the middle groups, and in the “medical student/other”, towards younger age groups. It is obvious that younger respondents have used computers from an early age, therefore they are perhaps more confident with their skills than older ones.

According to cross tabulation followed by a Pearson Chi-Square test, there was a relationship in the combination gender and computer expertise (χ^2 = 10.709; p-value = 0.030). However, this conclusion is not necessarily reliable because 25% (maximum 20) of expected frequencies are less than five. Therefore, in order to examine closer whether there is dependence between gender and computer expertise, Fisher’s exact test was conducted. Fisher’s exact test confirms that gender and computer expertise are dependent on each other (Pearson χ^2 =10.478; p = 0.014). In other combinations there was no dependence between the groups. As presented earlier (Figure 25), age distribution is quite different for males and for females, therefore, perhaps due to this, significant differences cannot be distinguished.

Table 7. Occupation, gender, age and computer expertise distribution.

Computer expertise	very/fairly weak		average		fairly good		very good	
	N	%	N	%	N	%	N	%
Occupation								
Specialist	10	8.9	62	55.4	33	29.5	7	6.3
Doctor	3	5.6	26	48.1	20	37.0	5	9.3
Medical student/Other	0	0.0	14	45.2	13	41.9	4	12.9
Gender								
Male	10	10.0	43	43.0	35	35.0	12	12.0
Female	3	3.1	59	60.8	31	32.0	4	4.1
Age								
≤31	2	3.9	23	45.1	20	39.2	6	11.8
32–41	1	1.9	25	47.2	22	41.5	5	9.4
42–51	4	8.7	27	58.7	12	26.1	3	6.5
≥52	6	12.8	27	57.4	12	25.5	2	4.3

5.3.6 Usage of different services

We asked respondents to evaluate their usage of some services of the given system. We selected nine services, of which most were personalized services, on the grounds of the field study we had carried out in the OWLA project (2002). Thus we repeated the same question, partly aiming to compare possible changes in users' usage behavior. The selected services refer to different areas of interest: topics related to expertise and work, and topics related to study and leisure time. We asked respondents to estimate their activity using a five-point scale of measurement. For example, respondents were asked:

To what extent do you use the following medical portal services:

	never	rarely	seldom	often	very often
a) special field news	1	2	3	4	5
b) special field articles	1	2	3	4	5

The name of each service refers to a link which is visible on the portal's page. Figure 26 shows responses that indicate frequent use (often/very often used) of the given services. The distribution of results indicates that search services (28.2 %) and special field news (26.4 %) are the most frequently used services. One should consider that search services comprise both medical (e.g., PubMed) and general search services (e.g., Google). Special field services are distributed according to the specialist, presenting up-to-date information concerning their special field. This may indicate that respondents regularly follow the development, e.g., research and science, of their profession. The popularity of search services may indicate that users wish to find solutions to their problems quickly. Similarly, special field articles (19.4 %) are considered important. More leisure-related services (20.3 %) were also popular among regular users. One should take into consideration that this item included many usually popular services, such as weather and news. "Drugs" (11.8 %) refers to drug information, and "congresses" (9.9 %) involves information related to forthcoming special field congresses. "Forms" (4.1 %) includes, among others, different precompleted forms which the doctors need concerning their work.

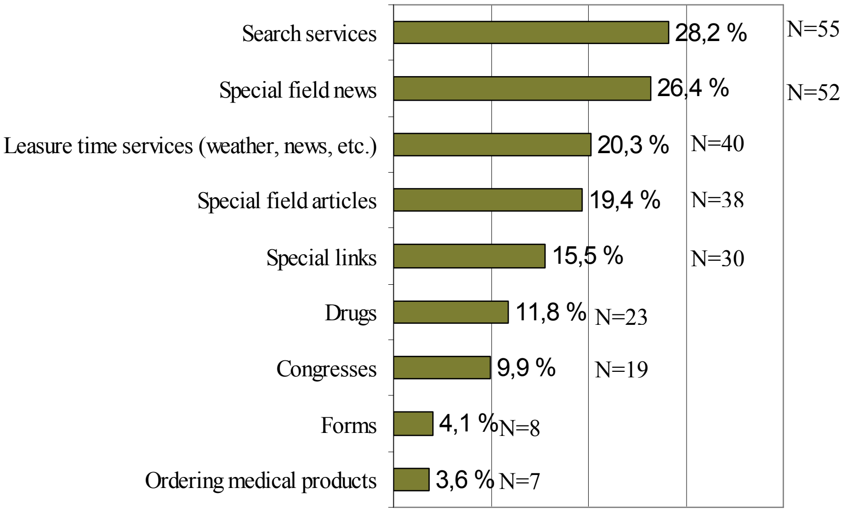


Fig. 26. Usage of medical portal services including “often” and “very often” responses.

Essentially, the respondents appreciated services which provide information that is clearly related to their work activities.

5.3.7 System usage frequency

System usage was studied by asking the frequency of weekly use, the usage time in hours during the week, and the regularity of system use. Usage measures were based on measures used in previous studies e.g., Moon and Kim (2001). Respondents were asked about the frequency of weekly use with a seven-point scale ranging from “not at all” to “several times a day”. Usage time in hours during the week was measured using an eight-point scale ranging from “less than 30 min” to “more than 25 hours”. The regularity of their system use was measured using a seven-point scale ranging from “extremely infrequent” to “extremely frequent”. As depicted in Figure 27, a majority of the respondents (36%) use the system about once a week. In general, most respondents use the system more than once a week. There were no respondents who do not use the system at all.

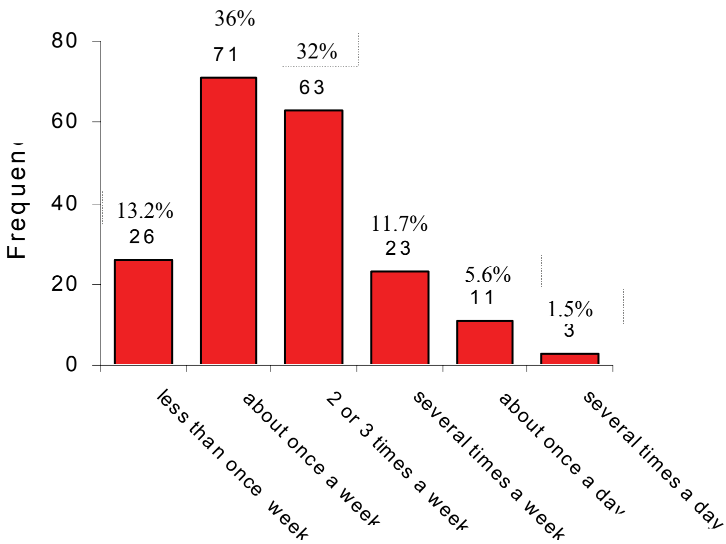


Fig. 27. Frequency of medical IS weekly use.

Respondents were also asked to evaluate their usage time in hours during the week. This was measured using an eight-point scale. The results are presented in Figure 28. There were no responses in the categories 10–15 hours, 15–20 hours, 20–25 hours and more than 25 hours. Most respondents (41.1 %) evaluated their weekly use as less than 1 hour. It could be possible that respondents do not have the opportunity, because of lack of time or other resources, to use a computer during the working day.

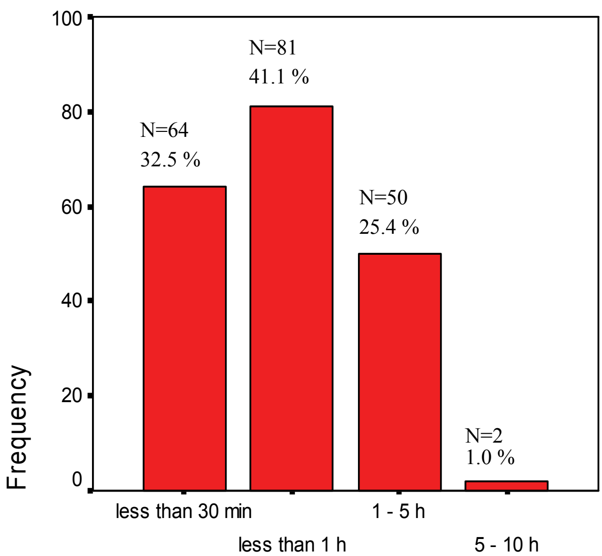


Fig. 28. Usage time of medical IS in hours during the week.

Generally, the majority of the respondents use the medical system frequently; more specifically, most of them use the system quite frequently N = 79 (40.1 %). Taking into consideration the weekly use in hours (Figure 28) and the regularity of system usage (Figure 29), the view may be suggested that respondents use the system frequently, but do not spend very much time per session.

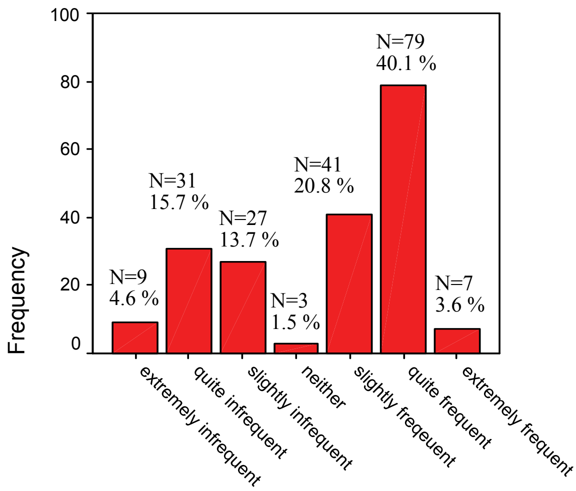


Fig. 29. Regularity of usage.

The respondents may only use the system to check whether there is any updated information.

5.3.8 Respondents' behavior toward personalization expectations

Personalization expectations were studied by setting three questions which started with "Would you like…", and using a three-point scale, with the options "No", "I do not know" and "Yes". First we asked the question "Would you like the medical portal to adapt automatically according to the services you have used?" Figure 30 shows that, in general, the responses were quite uniformly distributed between "No" and "Yes". The number of "Do not know" responses was also quite high. This may denote that respondents want to control the system and make their own choices. As Figure 30 shows there was a slight difference between males and females. The majority (39 %; N=39) of the male respondents answered "Yes", and 34 % (N=34) answered "No". Similarly 35.1 % (N=34) of females answered "No", and 34.5 % (N=32) answered "Yes". In age group there was a slight difference between the groups that are under 41 and those 42 and over. The Pearson Chi-Square test is used to assess the association of column and row variable in tabular data. The null hypothesis states there is no association between the age group and automatic adaptation. According to cross tabulation followed by a Pearson Chi-Square test, there was an association between the variables expertise and automatic adaptation; hence automatic adaptation is dependent on expertise (χ^2-value = 20.567, p-value

= 0.002). This conclusion was not necessarily reliable because 33.3 % of expected frequencies were less than five (allowed maximum 20 %) and the expected minimum was 3.83 (maximum more than 1). Therefore, the difference was also tested using Fisher's Exact test (Fisher's Exact test value = 21.438; p-value = 0.001). The tests indicate that respondents' attitude towards automatic adaptation is statistically significant and dependent on expertise. Surprisingly, respondents with fairly good or very good expertise would like automatic personalization more than respondents with weak or average expertise. Even though the differences between these expertise groups are quite minor, one would think that people with good expertise would like to adapt and control the system themselves more than respondents with weak expertise. According to our analysis, there were no differences between the groups in other combinations.

Overall, considering the whole data, 34.5 % (N=68) of the respondents responded "No" to this question, 29.4 % (N=58) answered "Do not know" and 36 % (N=71) of the respondents answered "Yes". Thus, No and Yes responses toward automatic adaptation were quite equally distributed; respondents' opinions about the question was quite neutral.

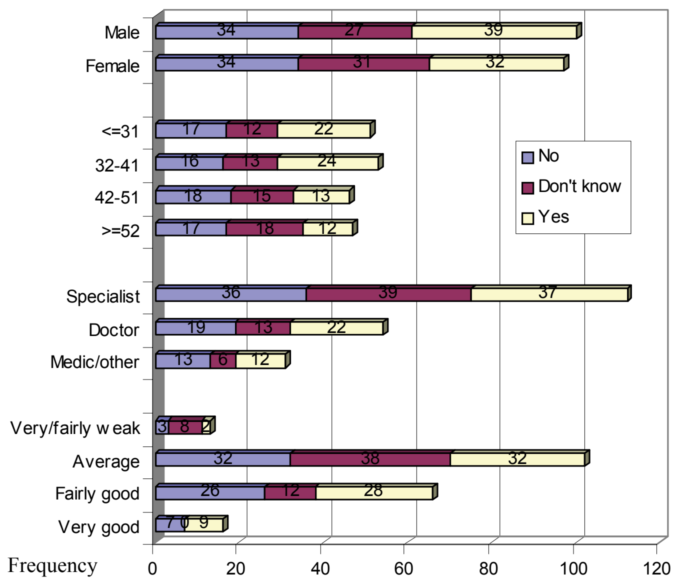


Fig. 30. Respondents' expectations regarding automatic personalization.

Secondly, we asked the respondents the question "Would you like the most regularly-used services concerning your special field to be displayed?" Figure 31 shows that the majority of respondents in every group agree that the most regularly-used services related to their special field should be on view. This may indicate that willingness to receive information increases if the respondent feels that the information on offer is related to their work and tailored to their work requirements. On the other hand, this may indicate that respondents rely on collaborative recommendations; they use the same services their colleagues have used. According to cross tabulation followed by a Pearson Chi-Square test, there was no association between the variables gender, age, occupation, expertise and displaying the most regularly-used services concerned to one's own special field.

Overall, considering the whole data, 16.8 % (N=33) of the respondents answered "No" to this question, 14.7 % (N=29) answered "Do not know", and 67 % (N=132) answered "Yes". Thus, most of the respondents have the positive view that the most regularly-used services relating to their special field should be on view.

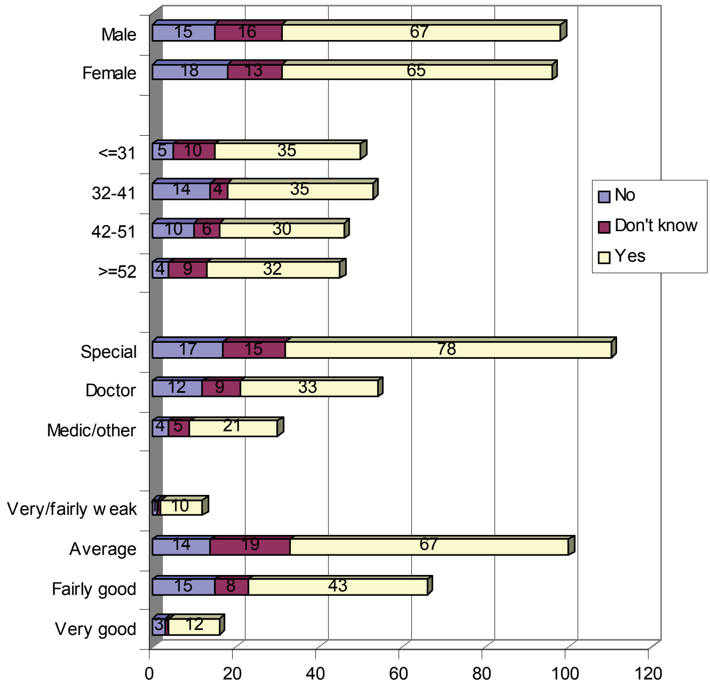


Fig. 31. Respondents' expectations concerning the most regularly-used services relating to their special field.

Thirdly, we asked the respondents: "Would you like the most regularly-used services of all special fields to be displayed?" Figure 32 shows that some respondents in different classes would appreciate the most regularly-used services of all special fields being displayed. However, the degree of interest is clearly lower than in the previous case (Figure 31). It is interesting that in some classes the results were negative. For example, in the age group 32–41 most of the respondents (N=24) would not like these services to be displayed. Similarly, most of the specialists (N=42) would not like the most used services to be displayed. The results below confirm the finding, discussed earlier, that respondents are more interested in tailored services which are related to their job and familiar to them. Cross tabulation analysis followed by a Pearson Chi-Square test indicated that there was association between the age group and the displaying of the most regularly-used services of all special fields (Pearson χ^2-value = 15.160, p = 0.019). There was also a relationship between the group occupation and question posed (Pearson χ^2-value = 9.775, p = 0.044), and the expected frequencies were 0%, expected minimum 8.81. According to our analysis there was no correspondence between other combinations.

Overall, considering the whole data, 30.5 % (N=60) of the respondents answered “No” to this question, 28.4 % (N=56) answered “Do not know”, and 41.1 % (N=81) answered “Yes”. Thus, most of the respondents have the positive view that the most regularly-used services relating to all special fields should be on view.

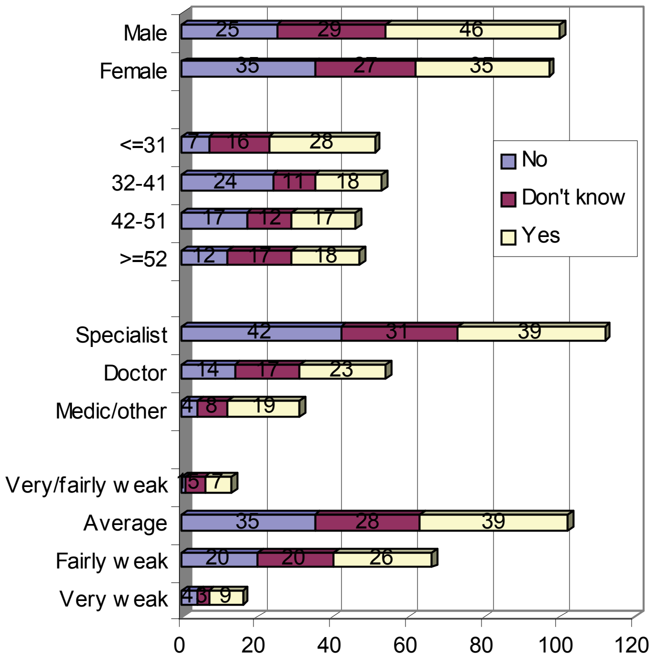


Fig. 32. Respondents’ expectations concerning the most regularly-used services relating to all special fields.

Considering the above figures, Figure 31 and Figure 32, respondents hope for easy and quick access to personalized work-related information, and clearly appreciate depth of information (their own special field) more than breadth of information (all special fields).

5.3.9 Respondents’ attitude toward personalization

The analysis described in this section is twofold. First we analyze the differences between the selected groups toward the presented hypotheses by using T-tests and analysis of variance. Secondly, we assess responses to the presented hypothesis, from all of the data.

Respondents’ attitudes towards personalization were studied by setting four hypotheses starting with “In my opinion…”, using Likert seven-point scales where 1 was “fully disagree”, and 7 “fully agree”. The hypotheses below were aimed at examining the users’ willingness to be involved in the personalization process; that is, whether they want to personalize the system themselves, or have automatic personalization carried out by the system. We were also interested in respondents’ attitude towards personalization techniques: whether the respondents like to personalize layout and/or content or not. Thus, respondents' attitudes towards carrying out layout adaptation themselves were examined by setting the hypothesis "In my opinion, it is important that I can make the site more personal by editing the appearance (layout) of the service, such as the color of the display". The same questions were asked in the field study executed during the OWLA project at the beginning of 2002. Comparative analysis of these two studies is presented later.

The selected variables we were interested in included gender, age, expertise and occupation. In the case of gender, we analyzed the responses by using a T-test. This is used when assessing the statistical significance of the difference between two independent sample means (Hair *et al.* 1998). The null hypothesis states that there is no difference between the variables. A prerequisite for using a T-test is that the variable is normally distributed. By using Levene's T-test, we confirmed that the variances were equally distributed. The results in Table 8 show that there is not a significant difference between male and female in attitude toward the appearance of the service. Alike there is not a significant difference between male and female in attitude toward adapting the content of the service.

Table 8. Gender distribution regarding adaptation of layout and content.

Attitude toward personalization	Gender	N	Mean	Std. Dev	t value	Sig
In my opinion, it is important that I can make the site more personal by editing the appearance (layout) of the service, such as the color of the page.	Male Female	100 97 Total 197	3.99 3.61	1.617 1.396	1.771 1.775	.078
In my opinion, it is important that I can make the site more personal by adapting the content of the service, such as by selecting and deleting content according to my own preferences.	Male Female	100 96 Total 196	4.46 4.23	1.540 1.395	1.098 1.100	.273
In my opinion, it is important for the site to become more personalized automatically according to my usage, by adapting the appearance (layout) of the service, such as the color of the page.	Male Female	99 95 Total 194	3.75 3.39	1.561 1.339	1.711 1.717	.089
In my opinion, it is important for the site to become more personalized automatically according to my usage, by adapting the content of the service, such as by selecting and deleting content according to my own preferences.	Male Female	100 97 Total 197	3.78 3.73	1.541 1.425	.227 .227	.821

The significance of the variables age, occupation and expertise was tested using one-way analysis of variance (One-Way ANOVA). The prerequisites for using ANOVA are that the variables are normally distributed and that the variances of the variables are equal. Table 9 shows that there are no significant statistical differences between the attitudes toward personal adaptation of site layout and the age, occupation and expertise groups. However, in the expertise group, $F(3.193)=2.266$, $p=.082$, it seems that respondents with better computer expertise are more willing to adapt the layout themselves than respondents with weak expertise. This may indicate that users with higher expertise may have stronger beliefs concerning their abilities and skills needed to execute the tasks ahead (referred to earlier as self-efficacy) than users with weaker expertise.

Overall, considering the whole data, 45.7 % (N = 90) of the respondents have a negative (fully disagree, disagree, disagree to some extent) attitude regarding user adaptation of layout, 15.2 % (N = 30) answered "Do not know", and 39.1 % (N = 77) have a positive (agree to some extent, agree, fully agree) attitude toward the hypothesis. Total N = 197, mean 3.80 and standard deviation 1.521. Thus, according to all of the data, most of the respondents do not consider the ability to adapt the appearance of the site themselves to be important.

Table 9. Age, occupation and expertise distribution regarding user adaptation of layout.

Attitude toward personalization	N	Mean	Std. Dev	Mean square	F value	Sig
In my opinion, it is important that I can make the site more personal by editing the appearance (layout) of the service, such as the color of the page.						
Age						
≤31	51	3.61	1.443	3.081	1.339	.263
32–41	53	3.79	1.668			
42–51	46	4.17	1.198			
≥52	47	3.66	1.685			
Occupation						
Specialist	112	3.89	1.544	2.370	1.025	.361
Doctor	54	3.81	1.480			
Medical student/Other	31	3.45	1.502			
Expertise						
Very/fairly weak	13	2.92	1.320	5.142	2.266	.082
Average	102	3.75	1.431			
Fairly good	66	3.92	1.512			
Very good	16	4.31	2.024			

Respondents' attitudes towards content adaptation carried out themselves were examined by setting the hypothesis "In my opinion, it is important that I can make the site more personal by adapting the content of the service, such as by selecting and deleting content according to my own preferences." Table 10 shows that there was no significant statistical difference between the groups. However, in the expertise group, the result F (3.192) = 3.540, p = .016 indicates that there could be a significant association between the row and column variable. Therefore, in order to examine the expertise group more closely, paired comparison within the group expertise was conducted using a post-hoc test following Scheffe's (Hair *et al*. 1998) method. Using a t-test is inappropriate in this case because we need to conduct several comparisons. Thus, there is a possibility that we may find significant differences erroneously, because a t-test considers several comparisons; as a consequence, we may accept an incorrect hypothesis (Type 1 error). The results of Scheffe's test showed that the differences were not statistically significant. As above we can conclude that the higher the expertise, the more respondents like to adapt content themselves.

Overall, considering the whole data, 28.6 % (N = 56) of the respondents have a negative (fully disagree, disagree, disagree to same extent) attitude toward user adaptation of the content, 13.2 % (N=26) answered "Do not know", and 58.2 % (N = 114) have a positive (agree to some extent, agree, fully agree) attitude toward the hypothesis. Total N = 196 (one missing), mean 4.35 and standard deviation 1.472. Thus, according to the whole data, most of the respondents consider it important to make sites more personal by adapting the content of the service themselves.

Table 10. Age, occupation and expertise distribution concerning user adaptation of the content.

Attitude toward personalization	N	Mean	Std. Dev	Mean square	F value	Sig
In my opinion, it is important that I can make the site more personal by adapting the content of the service, such as by selecting and deleting content according to my own preferences.						
Age						
≤31	50	4.24	1.479	3.775	1.763	.156
32–41	53	4.51	1.489			
42–51	46	4.63	1.181			
≥52	47	4.00	1.655			
Occupation						
Specialist	112	4.38	1.466	4.000	1.863	.158
Doctor	53	4.53	1.310			
Medical student/Other	31	3.90	1.700			
Expertise						
Very/fairly weak	13	3.62	1.609	7.381	3.540	.016
Average	101	4.15	1.345			
Fairly good	66	4.67	1.461			
Very good	16	4.88	1.821			

The next hypothesis examined respondents' attitude towards automatic adaptation related to appearance. As Table 11 below shows, there were no significant statistical differences between the groups.

Overall, considering the whole data, 47.9 % (N = 93) of the respondents have a negative (fully disagree, disagree, disagree to same extent) attitude toward the hypothesis, 21.2 % (N = 41) answered "Do not know", and 30.9 % (N = 60) have a positive (agree to some extent, agree, fully agree) attitude toward the hypothesis. Total N = 194 (three missing), mean 3.57 and standard deviation 1.472. Thus, according to the whole data, most of the respondents do not consider automatic adaptation of a site's appearance to be important.

Table 11. Age, occupation and expertise distribution concerning automatic adaptation of the layout.

Attitude toward personalization	N	Mean	Std. Dev	Mean square	F value	Sig
In my opinion, it is important for the site to become more personalized automatically according to my usage, by adapting the appearance (layout) of the service, such as the color of the page.						
Age						
≤31	49	3.57	1.568	2.654	1.244	.295
32–41	53	3.26	1.347			
42–51	45	3.73	1.468			
≥52	47	3.77	1.463			
Occupation						
Specialist	111	3.68	1.402	1.715	.799	.451
Doctor	52	3.37	1.521			
Medical student/other	31	3.55	1.588			
Expertise						
Very/fairly weak	13	4.15	1.537	3.202	1.507	.214
Average	100	3.61	1.302			
Fairly good	66	3.33	1.611			
Very good	15	3.87	1.642			

Finally, we examined respondents' attitude towards automatic personalization, a process that is executed automatically by the system. Table 12 shows that there are no significant statistical differences between the groups in terms of attitude towards automatic content adaptation. The hypothesis below is consistent with the question analyzed in Figure 30, where the question began "Do you like…" The results of both analyses are consistent: respondents take quite a neutral view of automatic content personalization.

Overall, considering the whole data, 45.2 % (N = 89) of the respondents have a negative (fully disagree, disagree, disagree to same extent) attitude toward the hypothesis, 15.7 % (N = 31) answered "Do not know", and 39.1 % (N = 7) have a positive (agree to some extent, agree, fully agree) attitude toward the hypothesis. Total N = 197, mean 3.76 and standard deviation 1.482. Thus, according to the whole data, most of the respondents do not consider automatic adaptation of content according to user preferences to be important.

Table 12. Age, occupation and expertise distribution concerning automatic adaptation of the content.

Attitude toward personalization	N	Mean	Std. Dev	Mean square	F value	Sig
In my opinion, it is important for the site to become more personalized automatically according to my usage, by adapting the content of the service, such as by selecting and deleting content according to my own preferences						
Age						
≤31	51	3.53	1.554	2.122	.966	.410
32–41	53	3.96	1.581			
42–51	46	3.89	1.449			
≥52	47	3.64	1.309			
Occupation						
Specialist	112	3.79	1.417	6.014	2.789	.064
Doctor	54	4.00	1.505			
Medical student/Other	31	3.23	1.586			
Expertise						
Very/fairly weak	13	4.15	1.405	2.006	.912	.436
Average	102	3.85	1.262			
Fairly good	66	3.55	1.684			
Very good	16	3.69	1.922			

5.4 Attitude toward personalization: Comparison between the 2002 and 2003 field studies

The objective of this section is to compare respondents' responses from two field studies. The questions that we are interested in were identical in both field studies, and related to the desire for automatic personalization and the level of personalized information available to the respondent. We carried out the comparison by studying the differences between the "Yes" and "No" responses, taking into consideration male responses, female responses and total responses.

A two-sample Z-test of proportion was used on the 2002 and 2003 field studies, to reveal differences in respondents' attitudes toward personalization. The statistical formula used in the two-sample Z-test for proportion to compute the Z-test statistic (Vasama & Vartia 1973, Zou *et al*. 2003) can be presented as follows:

$p_c = (x_1 + x_2)/n_1 + n_2$,

and the test statistic Z can be presented as:

$$Z = \frac{p_1 - p_2}{\sqrt{p_c(1-p_c)(\frac{1}{n_1} + \frac{1}{n_2})}},$$

where the observed numbers of successes are $p_1 = x_1/n_1$ (relating to the 2002 field study) and $p_2 = x_2/n_2$ (relating to the 2003 field study).
x_1 (the 2002 field study) and x_2 (the 2003 field study) are the numbers of successes and n_1 (the 2002 field study) and n_2 (the 2003 field study) are the sample sizes.

When the test statistic Z is normally distributed, the interpretation of statistical significance is based on the location of the p value within the normal distribution table (Herva *et al*. 1983) of Z. The null hypothesis assumes that there is no difference between the group gender and in attitude toward adaptation compared with the 2002/2003 field studies. The null hypothesis is rejected at the significance level $p<0.05$ if the test statistic Z exceeds the critical values below -1.96 or above +1.96.

In the Web-based field study executed in 2002, the number of respondents was limited to 144. The number of male respondents was 87 and female respondents 57, ranging from 22 to 67 years of age. The majority of the respondents (56.3 %) belonged to the age group 30–50 years of age. Most of the respondents (64 %) were medical students, followed by the groups “specialist” (10%), “other” (24%), and “researcher” (2%). The results of the two-sample Z-test of proportion are presented in Table 13. With regard to the first question, Table 13 shows that there is a significant difference ($p \leq 0.01$), when comparing all the responses, between the 2002 field study and the 2003 field study. There is no difference in the attitude of the male respondents, whereas there is a significant ($p \leq 0.01$) difference in the “No” responses of the female respondents between the 2002 and 2003 field studies. As Table 13 shows, there are changes in the female and total groups in terms of the “Yes” and “No” answers. In 2002, respondents’ opinions about automatic adaptation were more positive than in 2003. When the field study was conducted in 2002, the degree of personalization of the system was not so sophisticated, therefore it could be that respondents did not have a precise mental impression of what adaptation or personalization really meant. Thus in 2003, respondents were more familiar and skilful with the system, and they were more able to interact with the system.

Table 13. Two-sample Z-test of proportion.

Question	Gender	Response	X_1	n_1	p_1	x_2	n_2	p_2	Z
Would you like the medical portal to adapt automatically according to the services you have used?	Male	Yes	41	81	.506	39	100	.390	1.565
	Female	Yes	27	56	.482	32	97	.330	1.864
	Total	Yes	68	137	.496	71	197	.360	2.479*
	Male	No	20	81	.247	34	100	.340	-1.361
	Female	No	8	56	.143	34	97	.351	-2.773**
	Total	No	28	137	.204	68	197	.345	-2.797**
Would you like the most regularly-used services concerning your special field to be displayed?	Male	Yes	56	82	.683	67	98	.684	-.011
	Female	Yes	39	56	.696	65	96	.677	.248
	Total	Yes	95	138	.688	132	194	.680	.154
	Male	No	9	82	.110	15	98	.153	-.851
	Female	No	6	56	.107	18	96	.188	-1.311
	Total	No	15	138	.109	33	194	.170	-1.568
Would you like the most regularly-used services of all special fields to be displayed?	Male	Yes	50	82	.610	46	100	.460	2.013*
	Female	Yes	34	56	.607	35	97	.361	2.950**
	Total	Yes	84	138	.609	81	197	.411	3.559***
	Male	No	12	82	.146	25	100	.250	-1.729
	Female	No	8	56	.143	35	97	.361	-2.889**
	Total	No	20	138	.145	60	197	.305	-3.373***

*$p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$

With regard to the second question, there are no significant differences between responses in the 2002 and 2003 field studies. Generally, changes in behavior over a one and a half year period are minimal. On the other hand, when considering the third question, there is significant statistical difference in the male group in “Yes” responses ($p \leq 0.05$), when comparing the 2002 and 2003 field studies. There are also statistically significant differences in female responses, both “Yes” ($p \leq 0.01$) and “No” ($p \leq 0.01$). The most important difference is in total responses; both “Yes” ($p \leq 0.001$) and “No” ($p \leq 0.001$) are statistically very significant. The direction of the change is consistent with the first question. In 2002, respondents’ attitude toward the most-used services of all special fields was more positive than in 2003. Considering the two preceding questions, these findings support the hypothesis that there exist some changes in respondents’ attitude towards more tailored and focused information services. It could be that as the flow of information is increasing all the time, people are willing to think what kind of information they are willing to receive.

5.5 Summary

Data analysis of demographic variables was carried out using distributions, T-tests and ANOVA. According to the results of this analysis, respondent age and gender was quite uniformly distributed among the examined groups. The majority of the respondents were "specialist" by occupation. Most of the users assessed their computer expertise as average. The respondents use the system regularly (64.5 %), mostly one to three times (68 %) a week, and mostly less than one hour (73.6 %) a week. In general, the respondents appreciate information which is linked to their work activities. Search services, special field news, leisure-time services and special field articles are the most used services, in that order. When examining respondents' attitudes towards personalization, three questions were formulated starting with "Would you like…" and four more questions were formulated starting with "In my opinion…"

Most of the respondents would prefer the system to be adapted automatically according to the services used. However, the difference between the distribution of "No" and "Yes" responses was quite minor. Moreover, respondents would like the most used services of their special field displayed. This may indicate that respondents like to follow current topics arousing public interest. This was clearly distributed in a positive direction in every examined group (gender, age, occupation and expertise). However, when examining respondents' attitude towards whether they would like to see the most used services of all special fields, responses were quite equally distributed between the negative and positive end ("No" and "Yes"). There was significant statistical difference only in terms of the age group. It is obvious that respondents prefer focused information services to general information services.

The next four hypotheses were formulated "In my opinion…" According to the results there was no significant statistical difference between the four groups in terms of the question of making the site's appearance more personal. Considering the whole data, most of the respondents do not consider adapting the appearance themselves to be important. When analyzing the respondents' willingness in terms of content adaptation, the results indicated that there were no significant statistical differences between the four groups. Considering the whole data, most of the respondents (58 % positive attitude) considered it important that they could adapt the content themselves. Results related to the automatic adaptation of the system's appearance indicated that there were no significant statistical differences between the four groups. Considering the whole data, the results revealed that the respondents have a negative attitude (47.9 %) towards automatic adaptation of site appearance. The percentage of positive responses was 30.9 %. When analyzing respondents' attitude towards automatic content adaptation, no differences were found between the groups. With respect to the whole data, the respondents have a negative attitude (45.2 %) towards the hypothesis. The percentage of positive responses was 39.1 %. As described above, the same question was put, starting with "Would you like…" instead of "In my opinion…"

The results were consistent in both cases. The results indicated that respondents considered it important that they could adapt system content themselves. Interpretation of the above results is twofold. Respondents accept automatic content personalization, but at the same time they indicate a strong desire to modify the content which they consider appropriate for themselves. According to the results, when designing user interfaces for personalized WISs, it seems that designers should allow or offer users the opportunity to affect content selection.

5.6 Statistical tests of the variables

The first step when choosing a suitable test is to decide whether to use a parametric or non-parametric test. Therefore, one has to find out first that the prerequisites of the given test are met, for example, issues related to the measurement scale and the shape of the distribution. As stated earlier, the goal of the study was to find out the significance of intention concerning personalized WIS use. Secondly, the aim of the study was to find out the role of predictive factors of intention in predicting usage. The variables which were chosen for the hypothetical model were based partly on prior study and partly on experience from the research project. In this section, the variables are studied using a correlation matrix, and the hypothetical model is explored using factor analysis and structural equation modeling analysis. The number of variables in the model was 13. The measurement scale of the variable items was the seven-point Likert scale, with 1 being the negative end and 7 being the positive end. The use of Likert-type scales is often discussed among researchers because it is, in a purely statistical sense, categorized as a non-parametric ordinal scale, but in behavioral research it is commonly treated as a parametric scale, similar to an interval scale. An ordinal scale does not indicate the exact difference between the points on the scale. When researching beliefs and attitude it is difficult to define the exact distances between the points. It can be presumed that the distance between, for example, points 1 and 2 describes a similar difference in the phenomenon under examination as the difference between points 6 and 7. In particular, when the number of respondents is adequate, and distances between the points are proposed to be regular, the scale reminds one of an interval scale (Agresti 1990, Erätuuli *et al.* 1994). In this research, which is related to respondents' attitude and beliefs, the Likert-type scale is treated as an interval scale. As mentioned earlier, the questions used in this research are based on the literature and an on prior research; the questions have been validated in other research, and in most prior research the measurement scale is treated as an interval scale. In general, identification of the measurement scale is meaningful because it helps to separate non-metric data from metric data; secondly, the measurement scale used influences the selection of an appropriate method for analysis of the data (Nummenmaa *et al.* 1997, Hair *et al.* 1998).

5.6.1 Factor analysis

As already discussed, a correlation matrix shows the intercorrelation between two variables. However, it is often essential to try to explain phenomena with the minimum number of original (measured) variables. There could be, in the background, latent variables, consisting of a set of original variables which are representatives of different facets of the studied phenomenon. These latent variables could be unknown to the researcher, so by identifying these factors, new insight into the phenomenon under study may be revealed. Factor analysis is a correlation-centered method, which assists in reducing the number of variables and concepts by identifying a set of new dimensions (factors), which are linear combinations of original variables. Essentially, factor analysis aims to define the underlying structure of a data matrix (Hair *et al.* 1998). For example, in this research there are various different variables which explain users' attitude and intention towards using a personalized WIS.

When we use a factor-analytic approach, we are interested in knowing whether these variables constitute new dimensions. We have the impression, based on prior research, that there could be some underlying dimensions, but we do not know what these dimensions are, or the possible number of dimensions. In this case we can use factor-analytic techniques to confirm our hypotheses. This is referred to as confirmatory factor analysis (Kim & Mueller 1990). If the researcher does not have a distinct idea about the dimension, (s)he can use the factor-analytic approach in an exploratory way. The basic principle of this technique is "take what the data gives you" (Hair *et al*. 1998). Thus, exploratory factor analysis begins with no clear view about the model, whereas in confirmatory factor analysis the researcher's view about the model, and about relations between the variables, is based on literature or prior research (Hoyle 1995). There have been discussions over which of the techniques, confirmatory or exploratory factor analysis, is appropriate. In general, the researcher's preconceived idea about the structure of the data affects the selection of the appropriate factor analysis method. Exploratory factor analysis is recommended as a precursor to confirmatory factor analysis if the researcher does not have a distinct view about the model (Gerbing & Hamilton 1996, Schumacker & Lomax 2004). In this study we use concepts and/or variables which are borrowed from other constructs and from other contexts or derived from other disciplines. We do not have a distinct view of the structure. Therefore, in this study exploratory factor analysis is applied, letting the methods and data define the relationships between the variables.

Eigenvalues indicate a factors' ability to explain variance. They can be defined by measuring squared loadings for a factor and then by calculating the column sum of these loadings. When interpreting the results, the higher the eigenvalue the better the factor's explanatory power. Values greater than 1 are significant in terms of the model, and values less than 1 should be suppressed (Hair *et al*. 1998).

Factor analysis is used to reveal the latent structure of the independent variables. It can be used as an instrument for the reduction of variables. By means of factor analysis we can confirm our anticipation that some factors are unique and some are common to two or more variables.

The distribution of all the variables of the structure was analyzed, which showed that all the variables included in the structure were normally distributed. The number of factors was extracted using Kaiser's criterion, that is, factors having eigenvalues greater that 1 were accepted in the solution. Moreover, Cattle Scree test results were used for the acceptance of the solution. According to the Cattle Scree test, the optimum number of factors can be found at the turning point of the downward curve where the curve first begins to straighten. When the curve is nearly a straight line, the variance is mostly random variance (error variance) (Hair *et al*. 1998). Analyses were executed using the principal component extraction method followed by Varimax rotation. As in the extraction method, principal component analysis tries to account for variance in the data as much as possible. Basically, when executing principal component analysis, first defined combination of variables explains most of the total variance. Then, as a result of the next iteration, the second component explains as much residual variance left unexplained by the first factor as possible, and so on. Varimax rotation is a widely used method partly because it separates factors clearly (orthogonally) from each other, and because its interpretation is straightforward (Kim & Mueller 1991, Hair *et al*. 1998). After examination of several trial solutions, we came up with a solution including ten variables. Originally, according to Kaiser's criterion, thirteen factors was the acceptable minimum, but, taking into consideration the assumptions of the Cattle Scree test, ten factors were chosen (Figure 33).

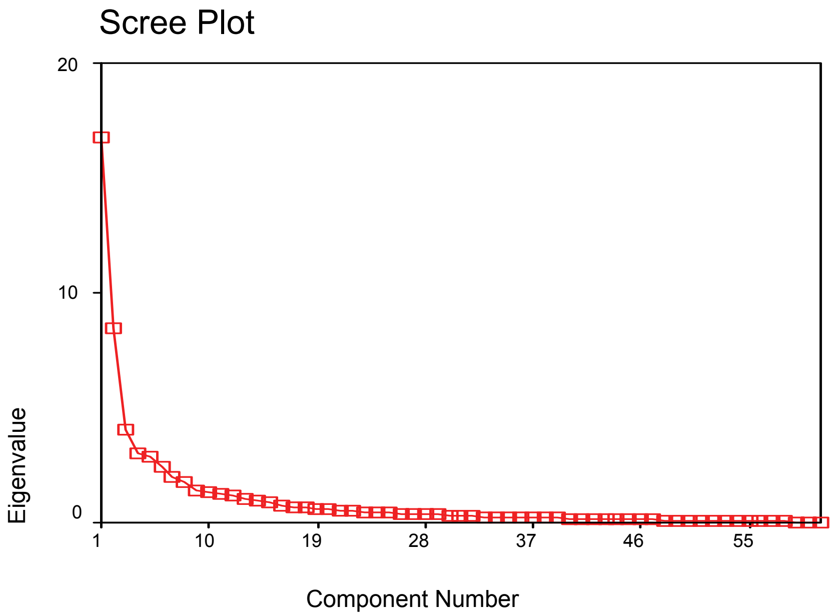


Fig. 33. Cattle Scree test for regression variables.

The eigenvalues of the ten chosen factors were greater than 1.3 and the accounted total sum for variance was 72.301 percent (Table 14). The eigenvalue of the first main component was 16.78. It explained 27.51 percent of total variance. The eigenvalue of the second component was 8.46 and it explained 13.88 percent of total variance.

As Table 14 shows, perceived usefulness (PEU) consists of six items, and compatibility (COMPA) consists of three items, and so on. The variables perceived usefulness and compatibility loaded to the same factor. Similarly, information quality (INFQ) and stickiness (STICKI) loaded to the same factor. Two anxiety items (ANXIE2 and ANXIE5) were suppressed during the trial solution because of low reliability and weak factor loadings. Thus the number of anxiety items was reduced to three. Factor loadings less than .30 are suppressed because lower values are insignificant in practice. For example, if the factor loading is .30 then it explains about 10 percent of the variance. In practice, the presence of low loadings that are dispersed over two or more factors means that they are measuring the same phenomena and thus they correlate with each other.

Table 14. Factor loadings, extracting ten factors using principal component analysis with Varimax rotation.

Scale items	Factors									
	1	2	3	4	5	6	7	8	9	10
SE6	.911									
SE4	.890									
SE9	.888									
SE7	.870									
SE8	.866									
SE5	.855									
SE3	.851									
SE2	.782									
SE1	.762							.385		
SE10	.645									
INFQ4		.769								
STICKI2		.722								
STICKI1		.713			.349					
INFQ3		.705	.350							
INFQ1		.701	.315							
STICKI5		.694								
INFQ2		.676								
STICKI4		.633						.304		
STICKI3		.629								
STICKI8		.623								
STICKI6		.602								
STICKI7		.559			.328					.322
PEU4			.870							
PEU3			.862							
PEU1			.817							
PEU2		.333	.805							
PEU5			.796							
PEU6		.403	.653							
COMPA2		.370	.623							
COMPA3		.400	.582					.357		
COMPA1		.396	.460							
NORMBEL4				.919						
NORMBEL3				.907						
NORMBEL2				.898						
NORMBEL1				.891						
NORMBEL5				.848						
NORMBEL6				.845						
PEOU3					.795					
PEOU4					.755					
PEOU1					.745					
PEOU6					.729			.350		
PEOU2		.374			.703					
PEOU5	.316	.304			.588					
NFC2A						.864				
NFC2B						.845				

Table 14. Continued

NFC2D						.695				
NFC2C						.669				
NFC2E						.635				
ENJOY3		.312					.762			
ENJOY2							.751			
ENJOY1							.710			
ENJOY4							.576			
ENJOY5		.425	.327				.490			
BEHCONT3	.301				.303			.698		
BEHCONT2					.327			.628	.393	
BEHCONT1	.360				.321			.593		
ANXIE1									-.776	
ANXIE3									-.759	
ANXIE4					-.312				-.355	
NFC1B										.826
NFC1A										.741
Eigenvalue (sum of squares)	16.778	8.464	4.030	3.032	2.836	2430	2.014	1.765	1421	1.333
Cumulative % of explained variance	27.505	41.381	47.987	52.958	57.607	61.591	64.893	67.786	70.115	72.301

Note: Rotated factor loadings with values less than 0.30 suppressed

The factor consisting of the variables perceived usefulness and compatibility represents the respondents' beliefs that the personalized IS is useful because it will improve her/his job performance. Compatibility refers to the respondents' belief that the IS is consistent with her/his existent experiences and values (or simply the respondents' beliefs that the IS will help them in their work). This finding is consistent with our preconception and with prior research as discussed earlier. The new factor was given the name performance expectancy. By examining the rotated loadings of this factor more closely, we noted that variables related to perceived usefulness have higher loadings than the variable compatibility. In particular, the items related to perceived usefulness that measure the effectiveness and productivity of the system in terms of work have higher loadings than the items of compatibility.

The factor consisting of information quality and stickiness was given the name performance relevance. This factor denotes respondents' opinion that the personalized IS offers information that reflects their expectations. Respondents were satisfied with the system and they appreciated the system's good reputation. This may encourage them to visit system more often. Items which measure the significance of in-depth information, appropriate and up-to-date information had higher loadings.

Reliability analysis was used to assess the consistency of the factors performance expectancy and performance relevance (Table 15 and 16). According to Hair (1998), the widely accepted lower limit for item-to-total correlation is 0.50, and for Cronbach's alpha 0.70. As shown below, Cronbach's alpha has high coefficients. Although the item-to-total correlation of compa1 is low it exceeds the limit (0.50). On the other hand, the effects of deleting the item compa1 on Cronbach's alpha are insignificant. Thus, item-to-total correlation confirms that the items constitute an appropriate measure of the given concept.

Table 15. Item-total correlation statistics for the factor performance expectancy.

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
COMPA1	31.4767	92.5320	.5782	.4157	.9365
COMPA2	30.7720	87.6248	.7274	.7750	.9287
COMPA3	30.8549	86.7288	.6905	.7549	.9310
PEU1	31.1036	83.4371	.7999	.6687	.9244
PEU2	31.0622	84.1211	.8274	.7348	.9228
PEU3	31.5440	85.0202	.8086	.8319	.9240
PEU4	31.3938	83.9170	8185	.8437	.9232
PEU5	30.9585	83.5399	.8051	.7380	.9240
PEU6	30.2953	85.2613	.7347	.5861	.9284

Alpha = .9347 Standardized item alpha = .9341

Reliability analysis for the factor performance relevance (Table 16) shows that item-to-total correlations are quite high. Deleting lower correlation(s) does not have a significant effect on Cronbach's alpha, thus this factor is fine for future analysis.

Table 16. Item-total correlation statistics for the factor performance relevance.

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
INFQ1	51.1937	89.2307	.7187	.6687	.9181
INFQ2	51.3874	91.4702	.6932	.6701	.9192
INFQ3	51.3351	88.2871	.7386	.6401	.9172
INFQ4	51.5654	87.8786	.7725	.6779	.9157
STICKI1	51.4084	90.9166	.7043	.5500	.9187
STICKI2	51.5916	90.1797	.7399	.6510	.9172
STICKI3	51.5759	96.7929	.5784	.5966	.9236
STICKI4	51.7592	96.6364	.5865	.6166	.9233
STICKI5	51.8743	88.3525	.7137	.5820	.9185
STICKI6	51.7696	91.9361	.6519	.5402	.9208
STICKI7	50.7644	94.2337	.6233	.4848	.9219
STICKI8	51.3874	90.0070	.6993	.5275	.9189

Alpha = .9257 Standardized item alpha = .9255

Correlation summaries for the remaining independent variables are presented in Table 17. The values of standardized item alpha are all relatively high. When using standardized item alpha, all the items are then standardized, in other words the mean is fixed to zero and deviation is fixed to one. Standardization facilitates comparison between variables. According to these results, all the presented variables are valid for future analysis. When comparing alpha values, one should take into consideration that the comparison is not straightforward because the coefficient of correlation is dependent on the number of items.

Table 17. Correlation statistics for other independent variables.

Variable	Number of items	Alpha	Standardized item Alpha
PEOU	6	.9279	.9288
ENJOY	5	.8535	.8549
BEHCONT	3	.9147	.9154
ANXIE	3	.7712	.7824
NORMBEL	6	.9681	.9695
SE	10	.9555	.9560
NFC1	2	.6366	.6374
NFC2	5	.8383	.8379

Communality indicates the proportion of variance of the variable which the variable shares with other variables (squared line sum of the variable) in factor analysis (Hair, Anderson *et al*. 1998). It can be interpreted as an underestimation of the reliability coefficient (Yliluoma 2000). Interpretation of the communalities shows that all variables are within the range .503 (item compa1) to .933 (item normbel5). High communality usually indicates significant loadings in factor analysis.

For future analyses, on the basis of factor analysis is comprised average variables by summarizing the items which have loaded on the factor. Then the sum is divided with the number of the items. The same principle was used for comprised variables attitude (ATTIT) and intention (INTENT). Variable use (USE) is comprised from three indicators of system usage: frequency of weekly use, usage time in hours during the week and regularity of usage. From this point onwards, the factor consisting of the variables information quality and stickiness is named as perceived relevance (PEREL). Similarly, the factor consisting of the variables perceived usefulness and compatibility is named as perceived expectancy (PEEXP). From here onwards, means are used in analysis. Table 18 describes the descriptive statistics of all the independent and dependent variables.

Table 18. Descriptive statistics of the variables.

	Mean	Standard Deviation	N	Minimum	Maximum
USE	3.376	1.017	197	1.33	5.67
INTENT	5.126	1.060	196	1.33	7.00
ATTIT	4.805	0.969	196	1.00	7.00
PEREL	4.665	0.906	197	1.50	6.83
PEEXP	3.880	1.165	197	1.00	6.56
PEOU	4.892	1.071	197	1.00	7.00
ENJOY	4.026	0.960	196	1.00	6.40
BEHKO	5.218	1.122	195	2.00	7.00
ANXIE	1.633	0.748	197	1.00	4.00
NORMB	3.538	1.144	196	1.00	6.00
SE	6.360	1.867	192	1.40	10.00
NFC1	4.845	1.339	193	2.00	7.00
NFC2	4.149	1.227	195	1.00	6.20

5.6.2 Demographic variables and acceptance of WIS

In order to identify whether attitude, intention and actual use of personalized WIS differs among the demographic variables gender, age and occupation, an independent-samples t-test and one-way ANOVA tests were conducted using the previously-introduced factor loadings. According to the independent-samples t-test there were no significant differences between women and men in terms of attitude, intention and use at the level $p<0.05$. When examining differences in means in terms of attitude, intention and use among different age groups, one-way ANOVA was carried out, using Scheffe's test as a post-hoc test. According to this analysis, there were no differences between age groups. Similarly, when examining differences in terms of expertise, one-way ANOVA followed by Scheffe's test was again conducted. The results indicate that there were no significant differences between expertise groups. A comparison of the differences between independent variables and demographic variables was not included in this research, because the research questions were focused on the importance of dependent variables.

5.6.3 Correlation matrix

Coefficient of correlation indicates a) if any correlation (or linear association) exists between two variables. If such correlation does exist, coefficient of correlation indicates b) the direction of correlation and c) the strength of correlation. Thus, coefficient of correlation reveals only the existence of linear association between two interval scale variables, not the causality of the variables.

A correlation matrix table indicates the intercorrelations between all variables therefore it can be used as a basis for further statistical methods. A correlation matrix is a commonly-used technique for separating variables. Pearson's correlation coefficient is traditionally applied to measure linear association in parametric tests.

Intercorrelations among the variables are described in Table 19. It seems that the dependent variables correlate significantly with each other, and the factors perceived relevance and perceived expectancy correlate relatively strongly with attitude, intention, enjoyment and perceived ease of use. According to Table 19, system use is strongly associated with intention ($r = .570$; $p \leq .001$). Use is also correlated significantly with perceived relevance ($r = .331$; $p \leq .001$), perceived expectancy ($r = .355$; $p \leq .001$) and attitude ($r = .292$; $p \leq .001$). Similarly, intention correlates significantly with attitude ($r = .600$; $p \leq .001$), perceived relevance ($r = .697$; $p \leq .001$) and perceived expectancy ($r = .533$; $p \leq .001$). Correlations between attitude and perceived relevance ($r = .765$; $p \leq .001$), and attitude and perceived expectancy ($r = .568$; $p \leq .001$) are also significant.

Table 19. Intercorrelations among the variables.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1. USE												
2. INTEN	.570(***)											
3. ATTIT	.292(***)	.600(***)										
4. PEREL	.331(***)	.697(***)	.765(***)									
5. PEEXP	.355(***)	.533(***)	.568(***)	.664(***)								
6. PEOU	.244(***)	.492(***)	.484(***)	.597(***)	.507(***)							
7. ENJOY	.273(***)	.496(***)	.705(***)	.639(***)	.478(***)	.497(***)						
8. BEHKO	.225(**)	.383(***)	.240(***)	.278(***)	.213(**)	.536(***)	.207(**)					
9. ANXIE	-.218(**)	-.268(***)	-.181(*)	-.249(***)	-.174(*)	-.457(***)	-.136	-.551(***)				
10. NORMB	.216(**)	.391(***)	.359(***)	.393(***)	.419(***)	.234(***)	.348(***)	.070	.062			
11. SE	.098	.153(*)	.182(*)	.178(*)	.130	.403(***)	.163(*)	.410(***)	-.272(***)	.047		
12. NFC1	.024	.187(**)	.193(**)	.180(*)	.084	.135	.080	.188(**)	-.115	-.002	.151(*)	
13. NFC2	.139	.243(***)	.293(***)	.267(***)	.242(***)	.175(*)	.261(***)	.094	-.003	.202(**)	.166(*)	.201(**)

***$p \leq 0.001$, **$p \leq 0.01$, *$p \leq 0.05$

When interpreting the correlations of the independent variables one has to take into consideration the effect of multicollinearity, which indicates the strength of correlation among the independent variables. This is important in the next stage of analysis because it may have an effect on explanations and estimations of the results (Hair *et al.* 1998). If the variables correlate strongly with each other, the predictive power of the dependent variable decreases. On the other hand, a strong correlation between two independent variables may have reciprocal effects on each other's contributions.

Table 19 shows that the independent variables are quite highly correlated with the dependent variable intention (and intention with the dependent variable use). On the other hand, the independent variables do not correlate too strongly among themselves. All the correlation coefficients are less than .80, which is normally considered as a critical value (Hair *et al.* 1998). If the value of correlation coefficient is high, this denotes that the variables have a strong linear association with each other. Thus the variables are measuring the same phenomenon, and one should then consider whether one independent variable should be deleted. According to our results, it seems that the problem of multicollinearity does not occur, and the results do not have negative effects on future analyses (SEM analysis) and do not require any action with respect to independent variables.

5.6.4 Structural equation model

The use of a structural equation model (SEM) should be based on theory and on the researcher's clear view about the suggested model, because SEMs do not include sophisticated methods for model specification. SEMs do not set obstacles to different model proposals. The advantage of a SEM is that it offers a unique method for the researcher to assess and test different relations between the variables simultaneously. Schumacker (1996) describes the relevance of different analysis techniques as follows: factor analysis confirms a hypothetical model constructed of different variables; in multiple regression analysis, independent variables explain a proportion of the variance in a dependent variable based on the single relationship; path analysis simultaneously identifies complex relationships among the variables. In other words, regression analysis is predictive by nature (it shows the details), whereas path analysis is explanatory (it shows the whole scenery).

In this study, the assessment of associations between variables is based on the use of the AMOS structural equation modeling software. Figure 34 (a) presents one possible causal combination, where the variables X and Y are causally independent (exogenous) variables (rectangles in AMOS), Z is a dependent (endogenous) variable and a is a residual or error variable (an ellipse in AMOS). The endogenous variable could also act as a mediating variable. In path diagrams, associations between the variables are marked with two kinds of arrow. A curved, two-headed arrow indicates a correlation between the variables. The fact that it is a two-headed arrow reveals that there is an association, but that it is not causal, because the direction of the arrow is not explicitly defined. A one-headed arrow indicates a causal relationship between two variables. The variable at the tail of the arrow has an influence on the variable at the head of the arrow. Thus, the variable X has a causal relationship with the variable Z, as does Y.

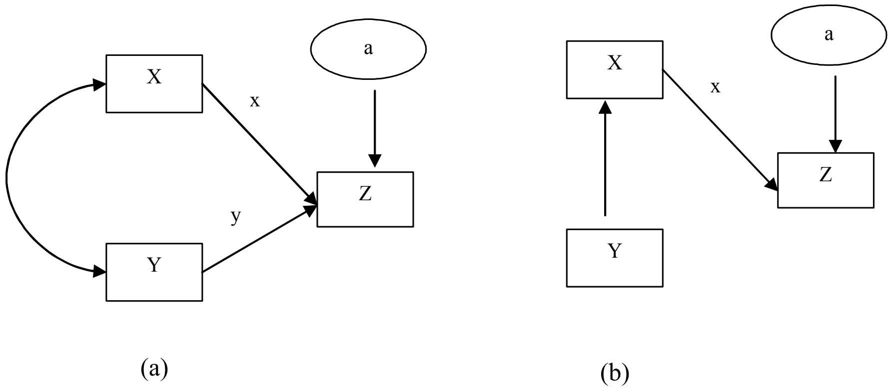


Fig. 34. A simplified version of a path diagram.

Associations between the variables can be divided into direct and indirect causal effects. Figure 34 (b) shows variable X with a direct causal effect on variable Z. Variable Y does not have a direct effect on Z, but it does have an indirect causal effect through variable X. The power of the relationship is indicated by the standardized beta coefficient.

In Figure 34, x and y are the standardized beta coefficients. Standardization denotes that the mean is fixed to zero and deviation is fixed to one. The residual or error variable accounts for different errors related to measurement, for example the formulation of the questions, the precise definition of the different concepts, or the correctness of the responses, as discussed earlier in the context of validity and reliability.

5.6.4.1 Goodness of fit indexes

A critical issue when assessing the power of the model is the conformability between the model and the data. The fitness of the model is tested in structural equation modeling using goodness-of-fit criteria, which in practice indicate the degree of compatibility between the proposed model and the observed covariances and correlations. Because SEM does not have unambiguous measurement for assessing goodness-of-fit or unambiguous acceptable level of fit, the researcher has to assess appropriate acceptance level (Hair *et al.* 1998). Thus, selecting the appropriate model which fits the data best means looking for the balance between the researcher's theory and statistical analysis.

There are numerous different fit-criteria, partly because there is no mutual understanding among researchers in terms of the best fit-criteria, therefore three or four fit indexes are usually reported in studies. Defining unambiguous measurement is not appropriate because measurements are to a certain extent case-specific as the validity of the measurement is dependent on, for example, sample size. The fit indexes chosen for this study are based on the literature, and represent three different fit characteristics: absolute fit, comparative fit and model parsimony. The chi-square test (χ^2) with degrees of freedom, p-value and sample size is commonly used for absolute model fit criteria (Hoyle 1995, Schumacker & Lomax 1996). The Tucker-Lewis Index (TLI) and Comparative Fit Index

(CFI) are recommended for model comparison, for comparison between the hypothesized and independent models (Hoyle 1995, Schumacker & Lomax 1996). The Tucker-Lewis Index takes into consideration the complexity of the model by means of degrees of freedom:

$$TLI = [(\chi^2_{null}/df_{null} - \chi^2_{proposed} / df_{proposed})] / [(\chi^2_{null}/df_{null}) - 1]$$

TLI indicates the degree to which the researcher's model improves the fit, compared with the null model. Typical values may range from 0 (poor fit) to 1 (perfect fit) (Kline 1998). CFI also indicates the degree to which the researcher's model improves the fit compared with the null model. If the CFI is .90, the hypothesized model improves the fit by 90% compared to the null model. CFI is commonly used because it is less sensitive to sample size. CFI values may range from 0 (no fit at all) to 1 (perfect fit); the recommended value is 0.90 or greater (Kline 1998).

The Akaike Information Criterion (AIC) is used for assessing model parsimony and model fit. The AIC assesses the complexity of the models under comparison:

$$AIC = \chi^2 - 2df$$

The smaller the AIC values are, the more parsimonious the model (Schumacker & Lomax 1996). The absolute value of AIC is not important; the relative AIC values of different models should be compared. The smaller the relative value the lower the loss of information in the model.

Maximum Likelihood is a commonly used estimation method in structural equation modeling. It cannot be considered as a goodness-of-fit test although it tests the discrepancy or fit between the data and SEM model by using the chi-square test. The Maximum Likelihood method for model estimation is also used in this study.

The chi-square of the model indicates the discrepancy between the estimated covariance matrix and the observed covariance matrix. If the chi-square value is not significant there is a good model fit. On the other hand, if the chi-square value is significant (<0.05) then the null hypothesis is rejected, that is, the model has a poor fit and the researcher's model is rejected. Using a chi-square test in SEM differs from the traditional use. The aim of using a chi-square test in this context is to strive for an acceptable null hypothesis. Thus, the minimum significance level is 0.05.

When using a chi-square test one has to take into consideration that it is problematic in terms of sample size, complexity of model and interpretation. The larger the sample size, the more likely the rejection of the model. Similarly, a small sample may lead to an incorrect acceptance of the model in question. Generally, small sample sizes (below 100) and large sample sizes (above 200) are critical. A sample size of between 100 and 200 is appropriate for the use of a chi-square test. Complex models tend to skew chi-square values: the more complex the model, the more likely it is that the chi-test will show a good fit. The interpretation of chi-square in a standardized way is also problematic because its value has no upper limit (Hair *et al.* 1998, Kline 1998). The sample size of this study is 196, which can be regarded as adequate for a chi-square test.

The goal of SEM is to find out to what extent the hypothesized model represents or fits the underlying data. Assessment of appropriate model fit was performed by comparing different hypothetical path models. One commonly used method is the comparison of different hierarchical models. Models are hierarchical if one model is a subset of the other.

Modified hierarchical models are usually called nested models (Kline 1998). Two models are nested when single paths are added or eliminated from another model. A comparison of the different models was carried out between the three nested models: null model (or independence model), saturated model and hypothesized (or default in AMOS) model. The null model is a simplified "skeleton model" with a minimum of paths. The null model is a starting point for building a hypothesized model, adding one new path at a time. The saturated model is a full model including all the possible paths between the variables. The saturated model is a starting point for model trimming, deleting the paths until an acceptable fit with the data is achieved (Kline 1998). The significance of individual paths was assessed using critical ratios (CR). Paths for which the CR is less than 1.96 are non-significant at the 0.05 level. However, one should take into consideration that deleting paths is not only determined by the statistical basis, but must also be consistent with the theory and validity criteria.

5.6.4.2 Goodness of fit of the models

In structural equation modeling, variables are tested all at once in order to evaluate the model's fit to the data. All the variables which were originally comprised in the factor analysis were included in the hypothesized model. When evaluating model fit we have to assess whether a) the parameter estimates are acceptable and b) the whole model is acceptable (Byrne 2001). In terms of parameter estimates all the correlations and coefficients were less than 1. Variances were positive, standard errors were not significant, and standard errors were neither exceptionally small nor exceptionally large. All the correlation coefficients were less than 0.80, which is acceptable in terms of multicollinearity. Assessment of the statistical significance of the path coefficients was based on the CR values, which need to be $>\pm 1.96$ at the 0.05 level.

As discussed earlier, the SEM analysis was executed using the AMOS 5.0 program. Four different models were generated and the evaluation of the fitness of each model was based on the goodness of fit indexes. The fit indexes used were chosen considering the constraints of different fit indexes. Moreover, the chosen indexes represent three different fit categories: absolute model fit, model comparison and model parsimony. According to Table 20, the null model does not fit the data because the test yielded a chi-square value of 305.677, with 31 degrees of freedom and the p value less than 0.001 ($p<.0001$). The values of TLI = 0.186, CFI = .723 and AIC = 451.677 also indicate poor fit and parsimony.

Chi-square statistics for the saturated model show that the model fits the data: chi-square value .252, with 1 degree of freedom and $p = .616$ indicates no significant difference between the model and the data. The value of TLI = 1.069 and CFI = 1.000 indicates an extremely good fit. The value of parsimony index AIC = 206.252 is also clearly smaller than the corresponding value of the null model.

Table 20. Goodness of fit indexes of the models.

Model	χ^2	df	p	TLI	CFI	AIC
1. Hypothesized	14.997	16	.525	1.006	1.000	190.997
2. Trimmed model	7.247	15	.950	1.047	1.000	185.247
2. Saturated	.252	1	.616	1.069	1.000	206.252
3. Null	305.677	31	.000	.186	.723	451.677

The hypothesized research model (shown in 24) yielded a χ^2 of 14.997 with 16 degrees of freedom, with a p value of 0.525. The trimmed model yielded a χ^2 of 7.247 with 15 degrees of freedom. The p values of both models indicate that the model fits the data. The trimmed model TLI value (1.047) is slightly higher than the corresponding value for the hypothesized model. TLI's recommended value is near 1. The CFI value of the trimmed model = 1.000 is the same as the corresponding value for the hypothesized model. The value of the Akaike information criterion AIC of the trimmed model (185.247) is lower than the corresponding value for the hypothesized model. Thus, considering chi-square statistics, TLI and AIC, the trimmed model fits the data better than the hypothesized model. The trimmed model also fits the data better than the saturated model and the null model.

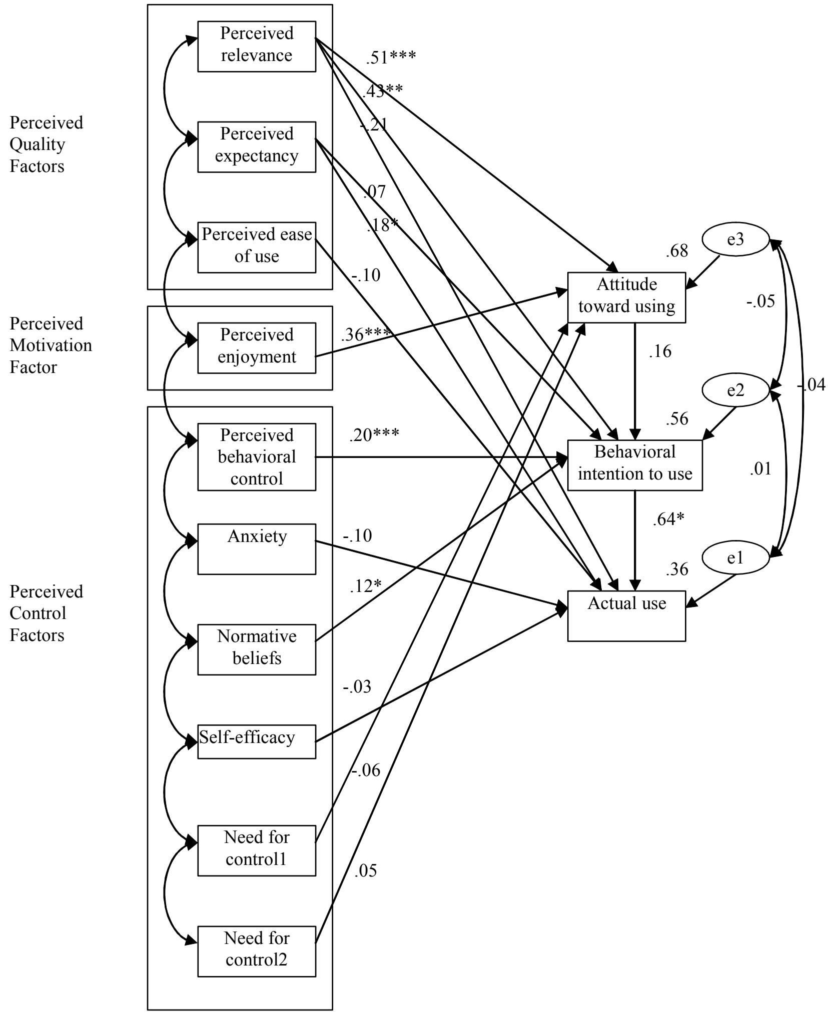
5.6.4.3 Analysis

In SEM analysis, all the variables are tested together in one model. The standardized beta coefficients and squared multiple correlations of the SEM analysis are shown in Figure 35. The exogenous variable perceived relevance has a very significant direct effect on attitude (beta=0.51; $p \leq .001$) towards using WIS. The significance of perceived relevance may indicate that respondents felt that the personalized information provided satisfied their needs – that the information offered was compatible with their prior experience and existing values, and useful in terms of accomplishing work. Thus, perceived relevance is an indicator of knowledge transfer which will enhance respondents' productivity. This finding is not surprising per se: the more relevant the respondent feels the system to be, the more likely they are to accept it. The direct path from enjoyment to attitude is also very significant (beta=0.36; $p \leq .001$). The impact of enjoyment on attitude is consistent with the findings of Heijden (2003). It seems that if the IS manages to generate a feeling of pleasure and satisfaction in the users, acceptance will be enhanced. On the other hand, the direct paths from need for control1 to attitude and from need for control2 to attitude are not significant. In all, the model accounts for 68 % (R^2 = 0.68) of the variance in attitude.

In interpreting the variables affecting intention to use the personalized WIS, the effect of the direct path from perceived relevance to intention is significant (beta = 0.43, $p \leq .01$). The correlation between perceived relevance and intention was high (0.697). Thus, perceived relevance alone explains about 49 % of the variance in intention to use. Perceived behavioral control also has a significant direct effect on intention to use the system, as does normative belief. The impact of normative belief on intention, included in subjective norms in TRA, is to some extent inconsistent with the prior studies e.g., Venkatesh and Davis (2000a). Venkatesh and Davis found in their study that in mandatory settings the role of social influence was significant, especially in the early stages of IS usage, but later, when the technology was more familiar, the role of social influence was insignificant. Mathieson (1991) and Venkatesh *et al*. (2003) also found that social influence is important but mostly in the early stages of experience/adoption. Taylor and Todd (1995a) found in their study that social influence had a significant influence on intention in a voluntary context. In this study, normative beliefs has a significant effect on intention in a voluntary context. Our results support the findings of Isotalus and Mäki (2001) related to doctors and Internet use. Doctors felt that they should use computers more because their peers use computers. The effects of other variables on intention are not significant. In all, the model accounts for 56 % ($R^2 = 0.56$) of the variance in intention, and the standardized beta weight (β) from attitude to intention = 0.16.

The direct paths from perceived expectancy to actual use and from intention to actual use were significant. On the other hand, perceived relevance, anxiety, perceived ease of use and self-efficacy do not have a considerable direct effect on actual use. The model accounts for 36 % ($R^2 = 0.36$) of the variance in use. Standardized beta weight (β) from intention to actual use was 0.64; $p \leq 0.05$. The correlation between intention and use was also high (0.570). This denotes that intention alone explains about 33 % of the variance in use. Thus, these findings indicate that intention is a significant mediator between attitude and intention, and is an important predictor of actual use. These findings are consistent with prior TAM studies, e.g., Davis (1989a), Taylor and Todd (1995a) and Venkatesh *et al*. (2003).

The trimmed model's correlations of the exogenous variables (two-headed arrows in Figure 35) are presented in Table 21. As Table 21 shows, most of the exogenous variables are correlated significantly with each other. Perceived relevance (information quality + stickiness) correlates strongly with perceived expectancy (perceived usefulness + compatibility), perceived ease of use and enjoyment.



***p≤.001, **p≤.01, *p≤.05

Fig. 35. Structural equation model for personalized WIS.

Furthermore, perceived expectancy correlates strongly with perceived ease of use, enjoyment and normative beliefs. Moreover, perceived ease of use correlates strongly with enjoyment, behavioral control, and self-efficacy, and negatively with the variable anxiety. Anxiety also correlates strongly with behavioral control. In addition, self-efficacy correlates strongly with the variable behavioral control. Correlations between the error variables e1, e2 and e3 were not significant, as Figure 35 shows.

Table 21. Correlations of the exogenous variables.

	1	2	3	4	5	6	7	8	9
1. Perel									
2. Peexp	.664***								
3. Peou	.597***	.507***							
4. Enjoy	.646***	.486***	.505***						
5. Behko	.286***	.220**	.538***	.212**					
6. Anxie	-.249***	-.174*	-.457***	-.144	-.552***				
7. Normb	.398***	.423***	.241***	.352***	.075	.056			
8. Se	.183*	.136	.403***	.165*	.408***	-.271***	.054		
9. Nfc1	.196*	.100	.143	.101	.173**	-.109	-.001	.162*	
10. Nfc2	.271***	.246***	.180*	.265***	.098	-.005	.205**	.162*	.216**

***p≤.001, **p≤.01, *p≤.05

The exogenous variables attitude and intention may act as mediators in the direction of endogenous variables. Therefore both the direct and indirect effects of the exogenous variables were tested, although they were not modeled, because the goal of the research was to examine the significance of intention, the role of predictive factors of intention and the factors that have effects on actual use of personalized ISs. However, by examining the impacts of different factors more comprehensively, new light may be shed on the subject. Total effects, direct effects and indirect effects are presented in Table 22. Some variables may act indirectly as mediator variables transmitting causal effects of preceding variables onto subsequent variables (Kline 1998). Although the direct effect of perceived relevance on actual use was not significant, the value of the indirect standardized beta coefficient indicates that perceived relevance has a distinct indirect impact (0.324) on actual use, mainly through attitude and intention. Moreover, the correlation between perceived relevance and actual use was high (0.331), explaining alone about 11 % of the variance in actual use.

Table 22. Total effects, direct effects and indirect effects of the variables.

Exogenous variable. Standardized effects	Attitude (*)	Intention(*)	Actual use(*)
Perceived relevance			
Total effect	.511	.509	.117
Direct effect	.511	.427	-.207
Indirect effect	.000	.082	.324
Perceived expectancy			
Total effect	.000	.072	.225
Direct effect	.000	.072	.180
Indirect effect	.000	.000	.046
Perceived ease of use			
Total effect	.000	.000	-.101
Direct effect	.000	.000	-.101
Indirect effect	.000	.000	.000
Enjoyment			
Total effect	.361	.058	.037
Direct effect	.361	.000	.000
Indirect effect	.000	.058	.037

Behavioral control			
Total effect	.000	.202	.129
Direct effect	.000	.202	.000
Indirect effect	.000	.000	.129
Anxiety			
Total effect	.000	.000	-.102
Direct effect	.000	.000	-.102
Indirect effect	.000	.000	.000
Normative beliefs			
Total effect	.000	.123	.078
Direct effect	.000	.123	.000
Indirect effect	.000	.000	.000
Self-efficacy			
Total effect	.000	.000	.026
Direct effect	.000	.000	.026
Indirect effect	.000	.000	.000
Need for control1			
Total effect	.063	.010	.006
Direct effect	.063	.000	.000
Indirect effect	.000	.010	.006
Need for control2			
Total effect	.049	.008	.005
Direct effect	.049	.000	.000
Indirect effect	.000	.008	.005

The results indicate that, in addition to a direct effect on intention, perceived behavioral control has a small indirect effect on use, mainly through intention. Attitude also has a small indirect effect on use, mainly transmitted via intention and perceived relevance. In considering the effects of the exogenous control variables of the model, there is no evidence of their significance towards attitude, intention and actual use. The impact of indirect effects was not important on endogenous variables.

The non-significant effect of need for control1 and need for control2 on attitude was surprising. It could be that when respondents have received relevant information and content, they become confident about the system. Thus, if the system is proved to be a reliable information channel then the users are more ready to reveal private information in order to get services which satisfy their needs. It could also be that respondents, as members of a given social system, rely on a system which originates from the same social environment. Maybe the most important reason is related to Finnish medical network registration. Access to the system is based on registration in Fimnet. It can be supposed that Fimnet creates confidence among the registered users. Thus, according to their responses related to need for control1, most of the respondents were not concerned about the security of the system; moreover, most of the respondents answered that security features do not have any effect when choosing whether or not to use the system.

The aim of the variable need for control2, on the other hand, was to study respondents' attitude in general towards giving personal information on the Internet. The responses relating to nfc2 indicate that most of the respondents would give personal information on the Internet if they are informed about what information is being collected and how the information is going to be used, and as long as they are given a statement that their information will not be abused. Respondents do not want to give personal information as in exchange for access to the pages on the Web site. Most respondents have a positive attitude towards giving personal information as long as they will receive value-added services. These findings are consistent with prior research. However, although people are concerned about the use of personal information, this does not necessarily create a barrier in attitude toward actual usage of the system. Attitudes toward the collection of personal information reflect the users' subjective feelings. They may, to a certain extent, agree to provide personal information to Web sites if it is a condition of access to information which will satisfy the user's expectations.

In general, privacy issues are not unambiguous; they are linked to social context, position, social relations between the user and the organization, the technical implementation of the IS, and, in particular, people's awareness of the issues related to the use of personal information (Hine & Eve 1998). To sum up, respondents are concerned with privacy issues but the overall effect of the variables nfc1 and nfc2 on the acceptance of the personalized IS was not significant.

5.7 Summary

The fitness of the models was assessed using SEM analysis. Intention to use the system is a significant predictor of actual system use, whereas the importance of attitude as a predictor of intention is insignificant. The relationship from perceived relevance to attitude and the relationship from enjoyment to attitude were statistically significant. Therefore, respondents' attitudes indicate that they have a strong belief that use of the system will increase their work performance and that use of the system supports their working methods. In all, perceived relevance has a significant influence on respondents' attitude towards using the system. As discussed earlier, the importance of enjoyment as a motivator for the acceptance of the IS has been the subject of debate in prior research. However, in this study, the results indicate that enjoyment, as an intrinsic motivator, enhances respondents' pleasure and acceptance of the system.

Perceived relevance has a significant influence on attitude toward using the IS and intention to use the system. Perceived expectancy has a significant impact on actual use. Thus, the respondents' subjective appraisal that the system has a positive impact on performance and effort has a positive influence on their decision to use the system. Perceived behavioral control has a significant impact on intention to use system. Normative beliefs have a significant influence on intention to use the system. The importance of perceived relevance indicates that the users appreciate the information that the system provides. Although the degree of attraction is difficult to assess, respondents have positive beliefs concerning the system, in any case. If the respondents are satisfied with the information content of the IS and the IS attracts them, they will probably use the system in the future.

Perceived behavioral control is not focused on technical issues or technical benefits; it indicates individuals' perceptions about themselves. The significance of perceived behavioral control shows that respondents believe themselves to have the abilities necessary to use the system, and that they have the ability to gain from the system. This finding is partly linked with expertise. As discussed earlier, most of the respondents assessed their expertise to be "average" or "fairly good". In this sense they are to a certain extent confident that they can get along with the system. The respondents' belief in their abilities to use the system's features is a positive sign for the designers and developers of the system.

The effect of normative beliefs on intention was significant; social influence has an effect on respondents' intention to use the system. This finding is consistent with the findings of Aydin and Rice (1991). They suggest that individuals create their behavior based on interaction with each other. Membership of a social environment may also have an influence on the adoption of the IS. It could also be that when the system is quite new for the users, as the medical portal was in this case, normative beliefs affect users' behavior, but over time, when users become familiar with the system, social influence does not play a significant role (Karahanna *et al.* 1999). Thus, both of the variables, perceived behavioral control and normative beliefs, were important predictors of intention supporting prior research, e.g., Ajzen (1991).

Enjoyment, which indicates intrinsic motivation toward the WIS, has a significant impact on attitude. Although the system in question is mainly an information channel, it also includes services related to entertainment. This may partly explain the link between enjoyment and attitude (Moon & Kim 2001). Furthermore, easy access to relevant information due to personalization and successful user interface design may create positive feelings toward the IS among the users. A sense of enjoyment is connected to the usability features of the IS. Overall, it is important that the developers of the WIS pay attention to issues that will enhance the feeling of enjoyment. Considering the correlations of the exogenous variables (Table 21), enjoyment correlates significantly with perceived relevance, perceived ease of use and perceived expectancy. The indirect effects of enjoyment on intention and on use were insignificant.

In the SEM structure, anxiety has an insignificant negative direct effect on actual use of the system. This is consistent with the findings of Igbaria and Iivari (1995b) and Compeau *et al.* (1999), among others. The indirect effects of anxiety on the endogenous variables were also insignificant. Anxiety correlates negatively and significantly with behavioral control, perceived ease of use, self-efficacy, perceived relevance and perceived expectancy. In all, these results indicate that fears, phobias or uneasiness towards the system do not prevent acceptance of it. As mentioned above, the majority of the respondents assessed their computer expertise as "average" or "fairly good". This may provide a partial explanation for the insignificant effect of anxiety on actual use. On the other hand, anxiety is dependent on emotional and environmental aspects, thus familiarity with the system also has an influence on the insignificance of anxiety.

Perceived ease of use also demonstrates the usability features of the IS. The results of the SEM analysis indicated that the direct effect of perceived ease of use on the actual use of IS was insignificant. Although perceived ease of use does not have significant influence on usage, it may have an important effect on individuals' decisions to adopt IS, as the prior TAM research has shown. Respondents' expertise could partly explain the insignificance of perceived ease of use (Mathieson *et al.* 2001); respondents with high expertise are more likely to assess the IS as being easy to use than respondents with lower expertise. Respondents who have used the system longer might also assess the IS as being easier to use than respondents with less experience. Negative correlation may also indicate that the actual use has an influence on perceived ease of use. Another explanation could be that other exogenous variables mask the effect of the variable perceived ease of use.

As discussed earlier in Sections 5.1 and 5.2, prior studies indicated that medical staff were uncertain about their abilities to use the Internet, especially after they had encountered failures. As a result of this self-efficacy was included in the research model. According to the SEM analysis, self-efficacy beliefs do not have a significant direct influence on actual use. Thus, respondents belief in their capabilities to successfully use the IS is not an important issue. Although need for control1 and need for control2 do not have a significant direct effect on attitude, the importance of these variables should not be ignored. According to prior research, people are concerned about their personal information. However, they are interested in providing personal information if they are informed about how their information is going to be used (Hoffman *et al*. 1999a, Hoffman *et al*. 1999b, Alpert *et al*. 2003). Future research should include more extensive study of control issues in the personalized WIS context.

6 Discussion of the results

The starting point of this research is the IS development project carried out in 2001–2002. The researcher's role in that project was as facilitator, providing the development project with research knowledge on universal accessibility and personalization. Because personalization was a relatively new area within the field of WIS research, it aroused the researcher's interest. Personalization is also interesting as a research area because it arouses varied impressions and feelings among system users for various reasons.

6.1 Theoretical implications

The field study in 2002 assessed the development work performed, in order to achieve a more sophisticated system. Moreover, the researcher's goal was to study user attitudes toward a new adaptable version of the system under development. These experiences created interest for further research, in particular for the study of factors affecting the decision to use or not to use the system.

The second focus of the study dealt with the evolutionary approach for developing Web information systems. The researcher's goal was to develop an approach which could interact with the users and the environment constantly, and could achieve results rapidly. The researcher's expectations were not achieved on this. In a real, active business environment there are necessarily not enough opportunities and time for the researcher to examine, test and evaluate different alternatives. However, the proposed approach for developing WISs is feasible and offers guidelines for carrying out the development work. Future research should apply the development approach presented in a long-term study, in order to elicit more specific information about the appropriateness of the approach.

The Technology Acceptance Model was used in this thesis for the prediction and explanation of the usage of the system. The primary reason for selecting TAM was not the model itself but its ability to explain IS usage. TAM is a widely used and accepted model, and its predictive power is evident. It is relatively easy to apply in different cases and its efficiency is good. However, it does not offer detailed information as to why users accept or reject an information system. TAM's outcome measures, perceived ease of use and perceived usefulness, provide general information about interest (Mathieson 1991). Therefore, in this case, TAM offered an applicable base model for studying user behavior. However, on the basis of prior research related to the given IS, the aim was to investigate more thoroughly the effect of external variables on the attitude, intention and actual use. Thus, the selected external variables were added to TAM to increase the explanatory power of the model and to aim at a better understanding of usage behavior. The main areas of interest which emerged from prior research and were considered important for this research were questions related to quality issues, control issues and the issues of motivation. This research provides some support for prior research. Intention was a significant predictor of system usage, whereas attitude was an insignificant predictor of intention. Perceived relevance, which combines aspects derived from information system success and loyalty research, is one of the most important factors which have a significant effect both on attitude and intention. It seems that respondents greatly appreciate information which relates to specific tasks in their work environment. It shows that respondents are satisfied with the information and they have a positive impression of the IS concerning the effects its reputation has on perceptions of the IS. Perceived expectancy, which combines perceived usefulness and compatibility aspects of TAM and Innovation Diffusion Theory, has a direct significant effect on usage. Perceived expectancy indicates how the respondents perceive the usefulness of the system and the compatibility with what people do. Considering the importance of perceived relevance and perceived expectancy it seems that extrinsic and intrinsic motivational factors, benefits or rewards have a significant influence on respondents' behavior. They are also important factors for future development with respect to user retention and loyalty.

Enjoyment has a significant effect on attitude. Given that the system is primarily an information channel, it is obvious that enjoyment indicates a longer-lasting intrinsic motivational state, rather than an occasional state. Enjoyment is a relatively stable characteristic, which relates positively with satisfaction and computer involvement (Webster & Martocchio 1992). Thus, this positive feeling may encourage respondents to use the system more often. The importance of enjoyment emphasizes the importance of considering user interface and usability issues when designing a WIS. Therefore it is surprising that perceived ease of use does not have a significant effect on user acceptance of the personalized IS. It could be that the effect of other variables masks the impact of perceived ease of use on endogenous variables. This may partly explain the insignificance of perceived ease of use. It could also be that personalization, which improves navigability and ease of access to information, reduces the importance of ease of use.

Perceived behavioral control and normative beliefs (representing in this study verbal pressure from peers) are aspects from the Theory of Planned Behavior (Ajzen 1991). In this study, both of these aspects have a significant statistical effect on intention in the SEM analysis. However, perceived behavioral control has a more significant effect on intention than normative beliefs do. Thus, respondents' beliefs in their own abilities to control the environment guide their behavior more than verbal pressure from their peers. Although the significance of normative beliefs is low, it indicates that social pressure has some influence on the acceptance of an information system. Self-efficacy partly reflects the same aspects as perceived behavioral control. The impact of self-efficacy on intention was found insignificant. It is probable that respondents rely on their expertise to cope with possible difficulties when using the IS. The impact of anxiety was statistically insignificant in the SEM construct. It has a negative direct insignificant effect on use. The insignificance of anxiety is to some extent consistent with the insignificance of self-efficacy because both variables reflect emotional states. The impact of the variable need for control1 on attitude was insignificant. Thus, the respondents trust on the system's ability to ensure responsible use of their personal information. The insignificance of the variable need for control1 was a surprise. It could be that the explanation, considering both the variables (need for control1 and need for control2), is partly related to system authentication, and partly to the IS's good reputation. Furthermore, it could be that users trust that the service provider will not use their personal information to contact them for marketing or other irrelevant purposes and will not use their personal information in any inappropriate way. One should note that the IS owner informs users that the personal information will not be given to third parties outside the company. Moreover, the IS owner provides access to individual users so they can check and correct their own information records.

6.2 Empirical implications

The main objective of this study was to examine how to design and evaluate the acceptance factors that affect intention to use and actual use of the information system. Moreover, the objective of the study was to examine the role of predictive factors of intention in predicting usage of personalized hypermedia systems.

We also identified whether attitude, intention to use and actual use of the system differ among the demographic variables gender, age and occupation. Therefore we analyze, for example, whether there is any difference between gender and attitude toward using the IS, between gender and intention to use the system and between gender and actual use. The results revealed that there are not significant differences between these variables. The findings of the study also indicate that perceived relevance, which consists of the factors information quality and stickiness, is an important factor in the acceptance of a personalized system. Users will accept an IS which is able to provide information which supports their work. On the other hand, users appreciate the system because it is known among the group of users; it has a good reputation. According to the field study, it seems that relevant, accurate, thorough and timely information is one of the key aspects which has an effect on acceptance of the system. 'Relevant' means that the provided information helps users in their work, accurate denotes that the information is reliable, that is, free from errors, and concise. Thorough means that the provided information is complete, and timely indicates that the information is provided in time to be useful. The significance of perceived relevance indicates that designers should pay attention to users, their preferences and background, and above all the designer should pay attention to the presentation of the content. The importance of perceived relevance also indicates that the good reputation of the IS may affect user retention, and send users further into the system.

Users appreciate focused, segmented information. This became particularly evident when we compared the two field studies, executed in 2002 and 2003. The findings revealed that respondents' attitude had changed. One significant change was toward more tailored and focused information services. Thus, users are looking primarily to use services which are closely adapted to their occupation. This is consistent with the previous finding: users appreciate relevant information, personalized according to their responsibilities. When asking about the services they used most in the system, the results indicated that these were closely linked to respondents' own special fields.

The results of the study suggest that users do not consider automatic content adaptation and automatic layout adaptation to be important. Nor do they consider it important to be able to adapt the layout themselves. It was surprising that the users did not set great store by the visual impact of the WIS. This shows that users appreciate content above visual impact. Overall, the respondents accept personalization but they want to adapt and personalize the content themselves. Thus, users want to control the system themselves, rather than allow the computer to do so. This is referred to in earlier chapters as "locus of control". It could be proposed that designers should construct the user interface with an "opt-in" function, determining whether the users would like the system to provide personalized services or not. If users want personalized services, there should also be an opt-in concerning whether they would like automatic personalization or to select interesting topics themselves.

This study also showed that intrinsic motivation enhances acceptance of personalized WISs. In a work setting, "enjoyment" may refer to the feelings of pleasure when users have managed to reach their goal or managed to solve a problem using the WIS. As the 26 indicated, leisure time services including, among other things, several links relating to entertainment are popular among the respondents. Thus, those who design and develop information systems should not ignore the importance of enjoyment.

The importance of perceived behavioral control indicates that if users have the ability to use the IS, they have a strong intention to use the system. In a workplace setting, this means that organizations should pay attention to the availability of training and resources. This is especially important considering the rapid development speed of information technology. Systems and applications are in a state of continuous change; users may resist changes and reject the system if they do not believe in their ability to control the system.

The significance of normative beliefs reveals that verbal pressure from others has an impact on individuals' behavior. If peers have positive experiences of using the system, this will have positive effects, over time, among the other members of the social system. This diffusion of innovation (Rogers 1995) also sets challenges for information providers: both good and bad word-of-mouth has effects on users' behavior and the acceptance of the system. Perceived expectancy was, in addition to intention, the other factor which has a direct significant impact on actual use. Perceived expectancy reveals that extrinsic motivation is also an important aspect to consider when developing personalized systems. This study indicates that if the system enhances work productivity and is consistent with the users' working methods, the users will be more likely to accept the system. The insignificance of the direct effects of the variables perceived ease of use, anxiety and self-efficacy on use was partly a surprise. The insignificance of the direct effects of the variables need for control1 and need for control2 on attitude was also surprising and somewhat puzzling considering prior research and users' concern about the usage of their personal information in the World Wide Web context. Possible explanations were discussed earlier, but more detailed information is needed. Therefore, future research should examine these aspects, considering possible causalities among the exogenous variables. The intercorrelations suggest that there could be causalities among the variables. These causalities have been studied in prior research but the aim of this study was to examine direct effects on endogenous variables.

Results indicate that medical staff are knowledge oriented. They valued up-to-date information, which may help them in their daily work. Although most of the respondents use the medical IS frequently, their weekly usage time is not outstanding. Moreover, the majority of the respondents assess their computer expertise as average. The aforementioned findings suggest it is important to pay attention to the issues which could encourage medical staff to utilize the system more efficiently. The researcher's recommendation is that practitioners should concentrate on information: its quick and easy access, timeliness, effective utilization and, especially, reliability. It is obvious that medical staff will not be allowed in the future, even less than at present, to make mistakes. With respect to expertise, organizations should encourage individuals to use computers. In particular, organizations should facilitate skills which will help employees in information acquisition and management. Considering the rapid development of information technology and the potential of the World Wide Web in the medical environment, it is important to emphasize the importance of training. This will enhance users' information technology experience and strengthen successful IS usage. Service providers should allow the user to affect information content and presentation – that is, they should increase the user's feeling that (s)he has control over the information. Building trust between the service provider and the user will have a positive impact towards a successful relationship in the future. In a more general sense, when the medical staff have positive experiences concerning the medical information system, and if they are experienced in utilizing the system's features, it may also have consequential effect on health care. Medical staff could exploit their knowledge and advice the patient as to where to search for relevant health care information concerning their complaint. This may improve patients' ability to manage their health more actively and, on the other hand, reduce the load on the current health service. The results also suggest on interesting extension of the target IS in the direction of virtual communities. Virtual online communities promote individuals' mutual communication regardless of time and place. Teo *et al*. (2003) conclude that personalization of the community has a significant positive impact on the perception of usefulness and behavioral intention. Thus, it could be useful for both the users of the IS and the service provider to enhance medical staff's mutual interaction by making possible the development of virtual communities. This may denote, for example chatting, during which users from the same professional field could share experiences or knowledge.

7 Conclusions

This research was interested in the factors which have an effect on the acceptance of a personalized Web Information System. We have also identified an approach for developing such systems. In this chapter, the main findings of the study are summed up. We also discuss the limitations of the study, and further research proposals.

7.1 Summarizing the results

Personalization is quite a new research area in the field of Web information systems. Therefore there are very few studies which have focused on user acceptance of personalized Web information systems. In this study we have highlighted issues which will help to understand the importance of individuals' needs, expectations and preferences towards use of personalized information systems.

First, the study presents the background to personalization, some essential concepts and techniques such as hypermedia, user modeling, personalization and personalization techniques. This forms the basis for the subsequent sections of the study. Second, the study presents an approach for developing Web Information Systems. The main objective of the presented approach was to react on the fly to user feedback and different environmental changes, as quickly as possible. Traditional process models are often too inflexible or they do not make it possible to react to system feedback quickly enough. These experiences suggest interesting continuations to this research work, especially to the study of factors which have an effect on the decision to use or not to use an information system. The success of the development work was in a way assessed in the third section of the study.

Third, the research includes the main objective of the study. It includes the literature review related to a Technology Acceptance Model for measuring user acceptance. The aim of the study was not to test the Technology Acceptance Model itself; TAM was applied because of its ability to explain system usage. Based on the findings of our prior study, we applied an extended Technology Acceptance Model. The results of the field study revealed that the respondents accept personalization but they like to and want to adapt and personalize the content themselves. This was one of the most important findings of the study. Respondents do not want the system to provide content automatically; they want to control the content themselves. The results of the 2003 field study are, furthermore, consistent with the previous findings; respondents considered it important that they can adapt the content themselves. The results also indicated that respondents do not consider layout adaptation, whether automatic or manual, to be important or desirable.

Perceived relevance, which is related to information quality, reputation and loyalty, is one of the most important aspects that have an effect on attitude and intention to use IS. The factors perceived behavioral control and normative beliefs also have a significant effect on intention to use the system. Enjoyment has a significant effect on attitude. Perceived expectancy and intention to use the WIS are significant antecedents of actual use.

Overall, in this study we have identified some significant factors which will provide useful information to IS practitioners studying the voluntary adoption of specific personalized systems. The results will also provide useful information for systems designers, for example, and will contribute towards assessing possible individual barriers to the use of personalized information systems.

7.2 Limitations

This study examined user acceptance of a personalized WIS, and extended the Technology Acceptance Model. There are several issues raised by the study which should be noted. Firstly, the field study was conducted on the World Wide Web using a fill-in form. In total, 209 responses were returned. The potential number of the population was about 9500 including specialists, doctors, medical students and the group “others”. The major concerns which are often mentioned in context with the World Wide Web surveys are the reliability and validity of the questions and the selection bias. Reliability and validity concerns were discussed earlier. Prior research has shown that the validity and reliability of the data collected in online research are comparable with the data collected in traditional research (Eysenbach and Wyatt 2002). Selection bias occurs when the respondents of the study are not “real” or relevant representatives of the sample (Eysenbach and Wyatt 2002). Selection bias is important to consider because it has an effect on the generalizability of the results. In this scrutiny, the target system was a medical IS, the target group was medical staff, and the information system was not public. It requires registration with the national medical network. With respect to gender and age groups, respondents were quite equally distributed. Moreover, respondents covered a wide geographical are. Although these issues are important aspects with respect to minimizing bias (Wyatt 2000), it is quite obvious that the selection bias has to be taken into consideration as a limitation in generalizing the results of the study.

Secondly, IS systems are usually used in different contexts by different people. The data used in this study was gathered mainly from medical staff, concerning a single system. Although the results of this study are valid in this system, they are not necessary valid in other study settings. Moreover, some beliefs may be generalizable for different contexts, for example perceived usefulness and perceived ease of use; some beliefs may not, for example normative beliefs and perceived behavioral control (Mathieson 1991).

Thirdly, it would have been better if the population had included a wider variety of different kinds of users in terms of their expertise and occupation. The terminology and concepts of the system were mostly familiar for the respondents because the target group for the system is mostly specialists, doctors and other medical workers.

Fourthly, the system under study did not include an opt-in for whether users wanted to access personalized information or not. In our target system, personalized services were provided to all IS users segmented according to specialty. Thus, we did not have the opportunity to compare findings between two different user groups – with those who want personalized services and those who do not. It is quite natural to believe that this comparison would have shed new light on our findings relating to user behavior towards the system.

The fifth limitation is related to the variables used in this study. These variables are borrowed from other constructs and other contexts. This may have negative effects on the data analysis process, and on the results of statistical analysis. The number of variables that are related to internal beliefs may also reduce the explanatory power of Structural Equation Modeling. There were some results which differed from prior research, for example, the insignificance of ease of use. Thus it could be that the effects of certain variables mask some other variable.

The sixth limitation is related to the part of the study, in which we presented an approach for developing personalized Web information systems. We did not manage to test our approach thoroughly. In order to get more appropriate information about the functioning of the model, a longer-term testing period is required. Moreover, it is difficult to show and evaluate unambiguously how the work we did in the OWLA research project appeared in the results of 2003 field study. However, in our own judgment the achieved experience indicates that the approach is appropriate for developing WISs. Taking these limitations into account, we can regard the presented model as a preliminary approach offering guidelines for future research and development.

The seventh limitation is related to the need for control variables. The results show that the effects of the control variables need for control1 and need for control2 on attitude toward using the IS were insignificant. The variable need for control1 measured whether the respondents' concern about the security of the medical IS has an effect on the acceptance of the system. It could be that the registration system, which is associated to the national medical network, inspires confidence among the respondents. It could also be that when the respondents see that the offered information is relevant and useful for their purposes they are not concerned about the security issues because they may trust that the system provider will use respondents' information for fair purposes. It is obvious that this finding is context specific and cannot be generalized. With respect to the Finnish medical network, we did not examine security concerns related to Fimnet registration itself. The variable need for control2 measured whether surrendering demographic information on the Internet has an effect on the acceptance of the medical IS. The results are inconsistent with prior research. According to prior research, users avoid using the World Wide Web if they are not informed as to how the information is going to be used, what purposes the information is being collected for, and in what processes the information is going to be used. Privacy concerns are complex. Therefore, measuring them is problematic. Even if validated instruments are used, they may act differently from study to study.

7.3 Future research

Firstly, as we have pointed out earlier, future research should apply the presented development approach in a long-term study, in order to attain more specific information to use in refining the approach. It would also be practical to test the development approach in software development processes of different sizes (small and medium).

Secondly, in order to identify more detailed information about the factors that have effects on user acceptance of personalized information systems, further studies should carry out field studies with wider user populations and different kinds of users. Moreover, it is important to extend the field study to consider more than one personalization application. This study focused on a single user environment, and the target group of the system was too heterogeneous to some extent. Therefore, improving on both of these aspects will increase the generalizability of the findings.

Thirdly, it would be interesting to extend future study to systems which include opt-in features concerning whether the user wants personalized services or not. It is very likely that this kind of study would highlight important information about the factors which have an influence on the user's decisions to use or not to use a personalized system.

Fourthly, future research should also study factors related to need for control more carefully and, in particular, factors related to privacy. Personalization is based on user modeling: the information system collects, records and processes personal information, which can include sensitive data. Therefore, future studies should extend to different contexts including both voluntary personalized systems and involuntary systems, for example banking or insurance systems.

Fifthly, as the results revealed, there were some factors which prior TAM research has found to be significant but which were insignificant in this research. As the intercorrelations suggested, there could be causalities among the variables which may have effects on the results. Therefore, future research should examine the effects of exogenous variables on acceptance more extensively, and consider the possible causalities of these variables.

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Appendices

Appendix A The front end of the medical system.

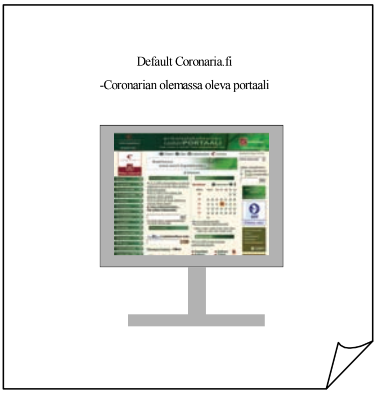
Left frame.
Dropdown menus including personalized services, e.g. congresses, special field links, special field journals, etc.

Middle frame.
Including updating special field news, special field news search service, calendar, news and weather, etc.

Right frame. Selection of the special field, selection of the search engine, advertisements

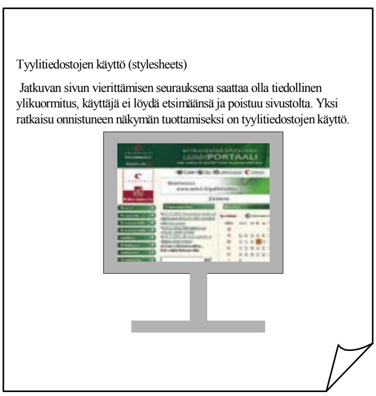
The front end of the system is divided into three frames. The left frame offers links related to selected special field or links related to different authorities, etc. For example, congresses can be selected according to special field, the user can select all the congresses, congresses according to special field situated in the country of domicile or abroad or the user can select congresses according to date or location.

Appendix B Storyboard related to the redesign of some universal accessibility features.

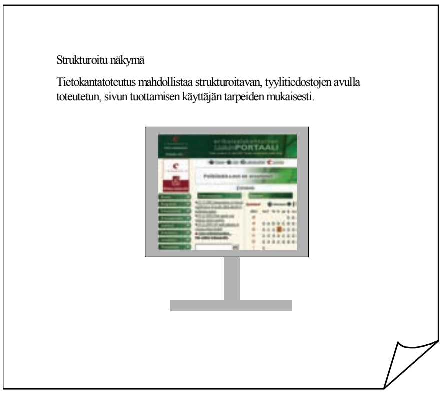


Starting point of the development of the existing IS. Storyboarding was used during the development phase to generate understanding, discussion and criticisms among the researcher, designers and managers.

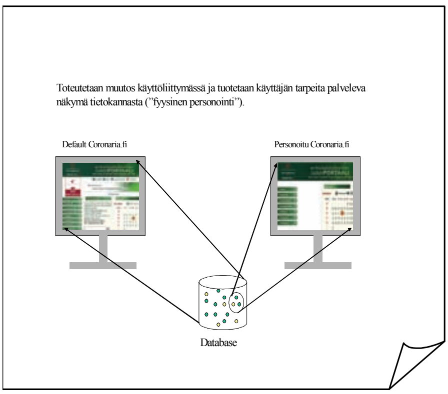
Considering low vision users (visually impaired) who can only read print that is very large or magnified. The problem is that usually when magnifying the font size users have to scroll the screen continuously.
This may cause cognitive overloading and the user is unable to find relevant information quickly.



Description related to the technical solution which could be easy to implement into different environments.



Structured view considering the previous solution.



Solution which can provide a personalized view considering users with visual disabilities effective use of the database.

Appendix C Web questionnaire

Usage of medical portal

Dear Medical Professional,

This survey is related to a dissertation which is being written in the Department of Information Processing Science in Oulu University. The objective of the research is to examine factors related to the usage of personalized services. The research is based on liaisons between Coronaria Ltd and the Department of Information Processing Science of Oulu University, in order to develop the medical portal. All those respond to this survey will be entered into a prize draw, with the chance of winning one of two Polar M62 heart-rate monitors. We hope that you will take some time to answer the questions, which should take about 15 minutes. Answering is voluntary, and does not commit you to anything. Individual responses and respondent information is not going to be analyzed separately. Respondents will remain anonymous. This study's researcher is Seppo Pahnila M.Sc. (e-mail seppo.pahnila@oulu.fi) and its supervisor is Professor Harri Oinas-Kukkonen (e-mail harri.oinas-kukkonen@oulu.fi). Both work in the Department of Information Processing Science in Oulu University.

01. Gender

a) Male
b) Female

02. Age

a) under 22
b) 22–31
c) 32–41
d) 42–51
e) 52 or over

03. Occupation

a) Specialist
b) Doctor
c) Medical student
d) Other

04. My computer expertise is:

a) Very weak
b) Fairly weak
c) Average
d) Fairly good
e) Very good

05. To what extent do you use the following medical portal services? (Please answer on a scale of 1–5)

1=Never
2=Rarely
3=Seldom
4=Often
5=Very often

a) Special field news
b) Special field articles
c) Forms
d) Congresses
e) Search services
f) Ordering medical products
g) Special field links
h) Drugs
i) Leisure-time services (weather, news, etc)

06. Would you like the medical portal to adapt automatically according to services you have used, in other words, would you like the system to personalize the service? (For example, the system would place services you have used regularly at the top of the page)

a) No
b) Do not know
c) Yes

07. Would you like the most regularly-used services concerning your special field to be displayed in the medical portal? (e.g., most used services- list of your special field)

a) No
b) Do not know
c) Yes

08. Would you like the most regularly-used services of all special fields to be displayed in the medical portal? (e.g., most used services- list of other users)

a) No
b) Do not know
c) Yes

09. In my opinion, it is important that I can make the site more personal by editing the appearance (layout) of the service, such as the color of the page".

a) Fully disagree
b) Disagree
c) Disagree to some extent
d) Do not know
e) Agree to some extent
f) Agree
g) Fully agree

10. In my opinion, it is important that I can make the site more personal by adapting the content of the service, such as by selecting and deleting content according to my own preferences.

a) Fully disagree
b) Disagree
c) Disagree to some extent
d) Do not know
e) Agree to some extent
f) Agree
g) Fully agree

11. In my opinion, it is important for the site to become more personalized automatically according to my usage, by adapting the appearance (layout) of the service, such as the color of the page.

a) Fully disagree
b) Disagree
c) Disagree to some extent
d) Do not know
e) Agree to some extent
f) Agree
g) Fully agree

12. In my opinion, it is important for the site to become more personalized automatically according to my usage, by adapting the content of the service, such as by selecting and deleting content according to my own preferences.

a) Fully disagree
b) Disagree
c) Disagree to some extent
d) Do not know

e) Agree to some extent
f) Agree
g) Fully agree

13. How many times do you use the medical portal a week?

a) Not at all
b) Less than once a week
c) About once a week
d) 2 or 3 times a week
e) Several times a week
f) About once a day
g) Several times a day

14. How many hours do you use the medical portal for every week?

a) < 30 min
b) < 1 h
c) 1–5 h
d) 5–10 h
e) 10–15 h
f) 15–20 h
g) 20–25 h
h) > 25 h

15. How frequently do you use the medical portal?

a) Extremely infrequently
b) Quite infrequently
c) Slightly infrequently
d) Neither
e) Slightly frequently
f) Quite frequently
g) Extremely frequently

16. Perceived usefulness (on a scale of 1–7)

1=Strongly disagree
2=Disagree
3=Disagree to some extent
4=Uncertain
5=Agree to some extent
6=Agree
7=Strongly agree

a) Using the medical portal in my job enables me to accomplish tasks more quickly.
b) Using the medical portal improves my job performance.
c) Using the medical portal increases my productivity at work.
d) Using the medical portal enhances my effectiveness at work.
e) Using the medical portal makes it easier to do my job.
f) On the whole, I find the medical portal useful in my job.

17. Perceived ease of use (on a scale of 1–7)

1=Strongly disagree
2=Disagree
3=Disagree to some extent
4=Uncertain
5=Agree to some extent
6=Agree
7=Strongly agree

a) Learning to operate the medical portal is easy for me.
b) It is easy to get the medical portal to do what I want it to do.
c) My interaction with the medical portal is clear and understandable.
d) I find the medical portal flexible to interact with.
e) It is easy for me to become skilful at using the medical portal.
f) On the whole, I find it easy to use the medical portal.

18. Compatibility (on a scale of 1–7)

1=Strongly disagree
2=Disagree
3=Disagree to some extent
4=Uncertain
5=Agree to some extent
6=Agree
7=Strongly agree

a) Using the medical portal would be compatible with all aspects of my work.
b) I think that using the medical portal would fit well with the way I like to work.
c) Using the medical portal would fit into my work style.

19. Anxiety (on a scale of 1–7)

1=Strongly disagree
2=Disagree
3=Disagree to some extent
4=Uncertain
5=Agree to some extent
6=Agree
7=Strongly agree

a) I feel apprehensive about using the medical portal.
b) When given the opportunity to use the medical portal, I am afraid that I may damage it in some way.
c) I have avoided the medical portal because it is unfamiliar to me.
d) I hesitate to use the medical portal for fear of making mistakes that I cannot correct.
e) The medical portal terminology sounds like confusing jargon to me.

20. Information quality (on a scale of 1–7)

1=Strongly disagree
2=Disagree
3=Disagree to some extent
4=Uncertain
5=Agree to some extent
6=Agree
7=Strongly agree

a) I use this site to get relevant information for my job.
b) I use this site to get accurate information for my job.
c) I use this site to get timely information for my job.
d) I use this site to get thorough information for my job.

21. Enjoyment (on a scale of 1–7)

1=Strongly disagree
2=Disagree
3=Disagree to some extent
4=Uncertain
5=Agree to some extent
6=Agree
7=Strongly agree

a) Using the medical portal is extremely fun
b) Using the medical portal is extremely pleasant
c) Using the medical portal is extremely pleasurable
d) Using the medical portal is extremely exciting
e) Using the medical portal is extremely wise

22. Attitude towards using the medical portal (on a scale of 1–7)

1=Strongly disagree
2=Disagree
3=Disagree to some extent
4=Uncertain
5=Agree to some extent
6=Agree
7=Strongly agree

a) Using the medical portal is a very good idea
b) Using the medical portal is a very wise idea
c) Using the medical portal is a very pleasant idea
d) Using the medical portal is a very positive idea

23. Behavioral intention to use medical portal (on a scale of 1–7)

1=Strongly disagree
2=Disagree
3=Disagree to some extent
4=Uncertain
5=Agree to some extent
6=Agree
7=Strongly agree

a) I will use the medical portal on a regular basis in the future.
b) I will frequently use the medical portal in the future.
c) I will strongly recommend others to use the medical portal.

24. Perceived behavioral control (on a scale of 1–7)

1=Strongly disagree
2=Disagree
3=Disagree to some extent
4=Uncertain
5=Agree to some extent
6=Agree
7=Strongly agree

a) I am able to use the medical portal.
b) Using the medical portal is entirely within my control.
c) I have the resources, the knowledge and the ability to make use of the medical portal.

25. Normative beliefs (on a scale of 1–7)

1=Strongly disagree
2=Disagree
3=Disagree to some extent
4=Uncertain
5=Agree to some extent
6=Agree
7=Strongly agree

a) Top management thinks I should adopt the medical portal.
b) My immediate supervisor thinks I should adopt the medical portal
c) My peers think I should adopt the medical portal
d) People in my department/job think I should adopt the medical portal

e) Computer technical specialists in the organization think I should adopt the medical portal.
f) My close friends think I should adopt the medical portal

26. Need for control 1 (on a scale of 1–7)

1=Strongly disagree
2=Disagree
3=Disagree to some extent
4=Uncertain
5=Agree to some extent
6=Agree
7=Strongly agree

a) I'm not concerned about the security of the medical portal (in other words privacy, confidentiality, and/or proof of identity).
b) Security features do not affect my choice of whether or not to use the medical portal at all.

27. Stickiness (on a scale of 1–7)

1=Strongly disagree
2=Disagree
3=Disagree to some extent
4=Uncertain
5=Agree to some extent
6=Agree
7=Strongly agree

a) So far, the medical portal has satisfied my expectations.
b) I feel that I get from the medical portal all the information I need.
c) The medical portal has a good reputation among its users.
d) Using the medical portal is popular because it has a good reputation.
e) Using the medical portal has a personal significance for me.
f) I feel the medical portal familiar to me.
g) I intend to continue using the medical portal.
h) I gladly recommend the medical portal to other people that I know.

28. Often in our jobs, we are told about software packages that are available to make our work easier. For the following questions, imagine that you have been given a new software package for some aspect of your work. It doesn't matter exactly what this software package does, only that it is intended to make your job easier and that you have never used it before. The following questions ask you to indicate whether you could use this unfamiliar software package under a variety of conditions. For each of the conditions, please indicate whether you think you would be able to complete the job using the software package. Then, for each condition that you answered "yes" please rate your confidence about your first judgment, by selecting a number from 1 to 10, where the number indicates how confident you are about your ability to complete the job. If you are definitely not at all confident, you do not need to state any rating.

Ability to complete the job using the software package…

1=I am not at all confident that I could complete the job
2=I am very unconfident that I could complete the job
3=I could complete the job poorly
4=I could complete the job to some extent
5=I am moderately confident that I could complete the job
6=I am tolerably confident that I could complete the job
7=I am fairly confident that I could complete the job
8=I am confident that I could complete the job
9=I am very confident that I could complete the job
10=I am totally confident that I could complete the job

a) Yes, if there was no one around to tell me what to do as I go.
b) Yes, if I had never used a package like it before.
c) Yes, if I had only the software manuals for reference.

d) Yes, if I could watch someone else using it before trying it myself.
e) Yes, if I could call someone for help if I got stuck.
f) Yes, if someone else helped me get started.
g) Yes, if I had a lot of time to complete the job.
h) Yes, if I had just the built-in help facility for assistance (e.g., help).
i) Yes, if someone showed me how to do it first.
j) Yes, if I had previously used similar packages to do the same job.

29. Need for control 2

1=Strongly disagree
2=Disagree
3=Disagree to some extent
4=Uncertain
5=Agree to some extent
6=Agree
7=Strongly agree

When using services provided on the Internet, I would give demographic information (on a scale of 1–7):

a) if a statement was provided regarding what information was being collected;
b) if a statement was provided regarding how the information was going to be used;
c) in exchange for access to the pages on the website;
d) in exchange for some value-added service (notification of events, etc.)
e) if a statement was provided regarding that my demographic information is not going to be misused.

30. When using services provided on the Internet, I'm anxious that my demographic information will be misused (on a scale of 1–7) (Dismissed)

1=Strongly disagree
2=Disagree
3=Disagree to some extent
4=Uncertain
5=Agree to some extent
6=Agree
7=Strongly agree

31. If some service on the Internet requires registration, I will refrain from filling out the registration form (on a scale of 1–7) (Dismissed)

1=Strongly disagree
2=Disagree
3=Disagree to some extent
4=Uncertain
5=Agree to some extent
6=Agree
7=Strongly agree

a) if it takes too much time
b) if it requires me to give my name
c) if it requires me to give an e-mail address
d) if it requires me to give my mailing address
e) if no information is provided on how the data is going to be used
f) accessing the site is not worth revealing the requested information
g) I do not trust the service collecting the information
h) I do not care how my information is used

32. A user ought to have complete control over which sites get what demographic information. (on a scale of 1–7) (Dismissed)

1=Strongly disagree
2=Disagree

3=Disagree to some extent
4=Uncertain
5=Agree to some extent
6=Agree
7=Strongly agree

33. In my opinion, giving demographic information on the Internet is not secure. (on a scale of 1–7) (Dismissed)

1=Strongly disagree
2=Disagree
3=Disagree to some extent
4=Uncertain
5=Agree to some extent
6=Agree
7=Strongly agree

34. Using services on the Internet do not secure my privacy (on a scale of 1–7) (Dismissed)

1=Strongly disagree
2=Disagree
3=Disagree to some extent
4=Uncertain
5=Agree to some extent
6=Agree
7=Strongly agree

35. In general, how anxious are you about Internet security (privacy, confidentiality, and/or proof of identity)? (on a scale of 1–5) (Dismissed)

1=Not at all
2=Slightly anxious
3=Uncertain
4=Fairly anxious
5=Very anxious

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