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Website Usability for Internet Banking

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Abstract

Internet users can fail at several hurdles, e.g. issues related to trouble-free and self-explanatory interaction. Not only users but also organizations are affected adversely by these difficulties. The purpose of this study is to enhance the limited repertoire of methods for quantifying web applications usability, which have remained unchanged for years. It first develops a model explaining the relationship between usability dimensions and success variables. Consecutively, the model's hypotheses are empirically validated by conducting an experiment for testing Internet Banking applications. Results show positive usability effects of increased recognizability, real world metaphors, anticipating support, dominant designs and a higher degree of freedom through the undo button. For practitioners, this research offers a quantitative method for development and quality management projects. Its scientific contribution consists of adding a novel approach for usability measurement in the field of Usability Engineering. It provides findings about the relationship between usability dimensions and usability success factors which presents a basis for further research in this field.

Keywords: website usability, Internet Banking, experiment, usability dimensions, usability success

1 Introduction

No other medium than the Internet – the fastest growing form of communication media in history (Berners-Lee, T. and Fischetti, M. 1999) – has ever confronted its (new) users with such vast and diverse difficulties of use. Even nowadays as the Internet is used as a common instrument, its utilisation often evokes problems. Whereas the use of a TV set could be conceived as convenient handling, successful activity on the Internet is unequally complex. Users – especially beginners – can fail at several hurdles, starting on with issues related to technical infrastructure and the appropriate use of a computer to issues related to finding the required offerings and target-oriented interaction. These issues can occur separately or in a usage sequence, but the implementing steps'

chronological order is predefined (first one needs a terminal, secondly a connection, lastly one has to search and find the desired supplier to use his offerings) in such a way that the "total system" reaches a high degree of complexity (Park, K. and Willinger, W. 2005).

Not only users but also organizations are affected adversely by these difficulties. Sales and saving potential can be endangered when users are not able to easily and quickly complete the essential search and order processes. Organizations having a website which does not allow trouble-free and self-explanatory handling for less experienced users will need to implement costly support and assistance (Stockburger, S. and Fernandez, T. 2002). Moreover, they risk losing turnover to the benefit of their rivals which put less or no usability obstacles at all in the way of their users. In summary, deficient usability can put successful online business transactions at risk.

The two main factors that have an effect on the usefulness of a software product or an Internet application are usability and utility (Nielsen, J. 1993). Most software products' features are not only sufficient but often very complex, due to the technological development over the last decades, and therefore tend to overstrain the average user. This makes it economically necessary for every firm to strive for minimizing potential difficulties of use and optimizing the usability. For example a study considering 66 usability tests showed that usability-based redesigns of commercial websites could increase key performance indicators (e.g. number of orders, number of newsletter subscriptions) on average by 82 percent (Nielsen, J. and Giluz, S. 2007). Research in usability is aimed at such improvements. Its purpose is to detect the usability thresholds of software products or Internet applications, to reduce them and thus generally facilitate human-computer interaction (Canny, J. 2006).

The purpose of this study is first to develop a model explaining the relationship between usability dimensions and success variables. In an attempt to enhance the limited repertoire of methods for determining web applications' usability quality, which have remained unchanged for years. Following this, the model's hypotheses are empirically validated by experiments in the context of usability-related design of Internet Banking applications. The banking industry has been chosen because of the fact that Internet Banking applications are considered one of the most successful and most established Internet applications ever (Pikkarainen et al. 2004, p. 224) and the fact that Internet Banking contains many interesting characteristics from the usability point of view (multi-stage processes, diverse and complex basis, independent transactions, etc.).

The empirical work of modelling is currently still valid in this context as usability is going to be an even more relevant topic when it comes to publishing websites on mobile devices, especially in relation to mobile commerce (m-commerce).

2 Foundations

2.1 Classification

Along with the growth of the Internet, academic research in the field of web usability has increased during the last two decades. Most of the contributions only have low scientific aspirations. In fact practical manuals and handbooks for usability improvements are dominant (e.g. (Bawa, J., Dorazio, P. and Trenner, L. 2001), (Brinck, T., Gergel, D. and Wood, S. 2002) or (Jacko, J. and Sears, A. 2003)). Key contributions to usability research originate from Jakob Nielsen ((Nielsen, J. 1993), (Nielsen, J. and Mack, R. 1994), (Nielsen, J. 2000), (Nielsen, J. and Tahir, M. 2002), (Nielsen, J. and Loranger, H. 2006)), although the focus of his work is shifting from methodical to contentual aspects.

Besides the research concerning web usability, research on human-computer interaction (HCI) also needs to be taken into account. HCI as a sub discipline of computer science evolved in the 1970s (Jacko, J., Stephanidis, C. and Harris, D. 2003). Work covering a comprehensive view includes (Dix, A., Finlay, J., Abowd, G. and Beale, R. 2004), (Jordan, P. 1998) and (Sears, A. and Jacko, J. 2007).

In the field of HCI research, one of the research directions is the development of user-friendly interfaces. During the 1990s, the thematic priority has been usability testing. In the last decade, the focus has shifted towards usability engineering. (Shneiderman, B. 1987), (Rubin, J. 1994), (Mayhew, D. 1999), (Faulkner, X. 2000) and (Lazar, J. 2001) are key contributions in this field. Over the last years, usability methods' profitability considerations were gaining attraction; one basic work is (Bias, R. and Mayhew, D. 2005).

2.2 Theoretical Background

Referring to (Nielsen, J. 1993), the relation between Personal Computers' dissemination and their success can be described as follows: The usefulness and therefore the success of software products and Internet applications is determined – besides objective technical utility – increasingly by the fact of how easy it is being made for users to capture this potential (usability). It is Usability Engineering's key task to design the handling as easily and as intuitively understandable as possible.

Whereas usability can be described in the user's context, the term has also been allocated in the field of human-computer interface (Shneiderman, B. 1987). (Nielsen, J. 1993, p. 25) classified the term within the context of system acceptability. There has been an academic discussion going on for the last few years about the field of acceptability-oriented computing, a term initially introduced by (Rinard, M. 2003). Usability is considered to be a specific and important building block for the acceptance of a whole system.

The term human-computer interaction (HCI) has been introduced by (Shneiderman, B. 1987) and superseded its predecessor "Computer-Human Interaction" (Myers, B. 1998, p. 45). However, there is no general accepted agreement on which subjects are covered by the area of HCI (Hewett, T. et al. 1996) as it is considered to be an interdisciplinary science (Sears, A. and Jacko, J. 2007, pp. 12/13). The ideal strives for user-centred design in every element of the computer system; user software's usability is one part of it amongst many (Myers, B. 1998).

There are a great number of national and international obligatory norms and non-obligatory guidelines for software and website developers. ISO norms aim at setting standards, whereas guidelines aim at advising developers on how to increase a system's usability (e.g. (Koyani, S., Bailey, R. and Nall, J. 2001, p. III)) and (Vanderdonckt, J. 1999)). Special domains cover accessibility and intercultural aspects (Mandel, T. 1997). Usability measures generally apply for every software product. Due to the Internet's particular characteristics, special recommendations have been published (e.g. (Mariage, C., Vanderdonckt, J. and Pribeanu, C. 2004)) to distinguish between characteristics and requirements of a web interface and a general graphical user interface. Although the benefit of guidelines is unquestioned, their application is criticized based on missing systematics (Burmester, M. and Machate, J. 2003, p. 43). The usability engineering process is responsible for developing user-friendly interfaces (Rosson, M. and Carroll, J. 2002). Models, for example the Usability Engineering Lifecycle by (Mayhew, D. 1999) split this process into three or four phases (requirements analysis, concept, design/testing/development, and deployment).

2.3 Usability Research

Current research effort in the field of usability studies covers the work of e.g. (Pearson, M. and Pearson, A. 2008), which proved that ease of use and navigation are two critical components in determining website usability. Another example is the work of (Cappel, J. and Huang, Z. 2007), which showed that most of the improvement potentials of company websites' usability is related to link appearance, navigation and the inclusion of more positive features such as breadcrumb trails and search boxes to improve usability. (Tarafdar, M. and Zhang, J. 2007) identified usability as a significant predictor of reach, one of the two website performance indicators.

In their paper, (Liao, Z, and Cheung, M. 2008) define six service quality attributes and examine their effects on CSIBS (customer satisfaction in Internet banking services). Regarding the derivation of these six attributes, they refer to the Technology Acceptance Model (Davis, F. 1989) and to the SERVQUAL model (Parasuraman, A., Zeithaml, V. and Berry, L. 1988). Results show that each service quality attribute has a positive effect on CSIBS, but this impact has not yet been quantified. This paper differs from (Liao, Z, and Cheung, M. 2008) in so far as we develop a model explaining the relationship between usability dimensions and success variables and consecutively validate it in the context of Internet Banking applications.

2.4 Research Gaps

Based on our literature review, four fundamental research gaps have been identified.

In the first place, methods for assessing usability of a system are much more discussed than their content – the usability issues – themselves. Quality, effectiveness and efficiency of usability methods are being discussed based on the issues found while the nature of an issue and its importance are not being analyzed. There is no content framework that systemizes usability issues in order to make them comparable, like e.g. in (Zaphiris, P. and Kurniawan, S. 2007). The field of usability research is lacking in a model that states which contentual design dimensions are relevant to the usability of a website.

Secondly, there is a shortcoming concerning clearly defined usability standards (Sears, A. and Jacko, J. 2007, p. 1107). Contentual statements about usability of websites are usually subjective and are often based on either practical knowledge of experts or detailed formation guidelines (Burmester, M. and Machate, J. 2003). The latter have been developed in practice without systematic scientific verification.

Thirdly, in many cases the cost-benefit relation of website usability is not clear, neither to companies nor within publications (Bias, R. and Mayhew, D. 1994, p. 16). This could be attributed to the fact that the terms success or benefit of website usability are not differentiated and only vaguely used. Sometimes these terms are even used in a contradictory way (Kuniavsky, M. 2003, p. 353). Success criteria are often composed of the constructs "perceived usefulness" and "perceived ease of use" (Ratner, J. 2003, p.19), deriving from Davis' "Technology Acceptance Model" (Davis, F. 1989, p. 320).

Lastly, the absence of scientifically established findings of the relationship between usability and success is another research gap. There are publications which contain allegations, plausible statements and case studies while showing positive effects of usability and more often negative effects of insufficient usability, but those correlative statements have a low generalizability level.

3 The Model

The model's main objective is to limit, to describe and to array usability aspects based on theory and partially in accordance with existing norms, e.g. ISO 9241. As a first

result, six usability dimensions emerged which could be associated as characteristics with any user interface.

The comprehension of usability success is being defined, arrayed and structured based on theory. As a second result, four clearly outlined success variables emerged. Two of them are objectively measurable; the other two are subjectively describable by a test person. The coherence between the six usability dimensions and the four success variables is being described by hypotheses. In total, they represent the empirically verified model which provides a so far nonexistent basis for explaining usability success.

3.1 Dimensions

Existing literature differentiates between dozens of factors which affect usability, from colour composition of user interfaces through to support features (Stander, A. and van der Merwe, N. 2003). Our model does not aim at quantitatively including all those factors. To a greater degree it tries to identify fundamental and success-related usability dimensions in order to explain a critical part of the performance.

3.2 Success Variables

Until now, no generally accepted, consistent and measurable criteria exist for quantifying usability of a system (Bias, R. and Mayhew, D. 2005), despite a few approaches, e.g. (Bevan, N. 1995), (Keevil, B. 1998), (Winter et al. 2007). Usually, only the completion rate is being determined (Johnson, T. 2006, p. 546). A system is useable for a user when he can complete an interaction successfully. Using completion rate as the only measurement parameter is not sufficient. Besides completion success in a strict sense, also other factors, e.g. processing speed (Schaffer, E. 2004, p. 125), are decisive for the users' experience.

In addition to the completion rate, there are more criteria necessary in order to define the term success and make it quantifiable. Through the process of literature review and preliminary investigation, three more variables have been identified. As a result, the following four sound measurement parameters have been chosen and taken together, they explain as much usability success as possible: completion rate (Nielsen, J. 2001), processing speed (Toms, E., Dufour, C. and Hesemeier, S. 2004, p. 52) and (Baca, B. and Cassidy, A. 1999, p. 777), perceived ease of use (Davis, F. 1989, p. 298) and perceived usefulness (Davis, F. 1989, p. 320). Completion rate and processing speed are the more objectively measurable qualities of success in terms of effectiveness and efficiency, perceived ease of use and perceived usefulness are the more subjectively measurable qualities of success in terms of users' satisfaction.

3.3 Preliminary Empirical Investigation

For acquiring the foundations to establish the model, several qualitative empirical investigations have been accomplished prior to testing the model. Every study has been designed as a qualitative examination of commercial websites' and web applications' usability. First, a design outline has been tested by groups of six to eight participants. Secondly, different design versions of the same application have been tested comparatively by ten to 21 participants. These tests have been composed of a standardized pre-interview, the usability test itself, and a standardized post-interview. Finally, particular functionalities of the same application have been tested in groups according to their main interests. This last study has been conducted with groups between 16 and 21 participants. Every test has been realized with a clickable interface and recorded on video. The main goal of these studies was the exploration of the central

usability dimensions and their effect on success. The main question was, which design elements influence usability to an eminently wide degree and how can this effect best be measured. This explorative questioning was used to prepare the model's development.

3.4 Hypotheses

Based on literature review and the explorative studies, six main hypotheses have been formulated. They describe the supposed correlation between the usability dimensions and usability success. In order to determine the specific usability benefit, the correlation with usability success is formulated in each case with four subordinate hypotheses.

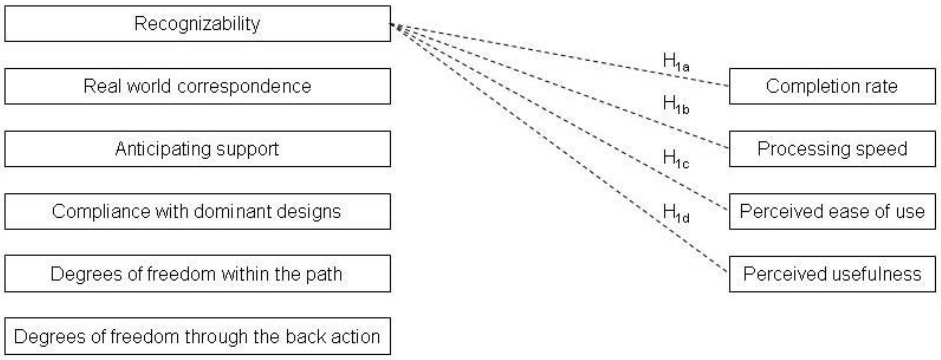

Figure 1: Recognizability (H1)

Recognizability is a system's quality which allows the user to identify quickly and without difficulty how he can accomplish a certain purpose while using the system. This through exploration ascertained finding is supported by scientific sources, e.g. (Holzinger, A. and Ebner, M. 2003, p. 782) and (Keevil, B. 1998). The subordinate hypotheses assume a positive effect of recognizability on all four success factors.

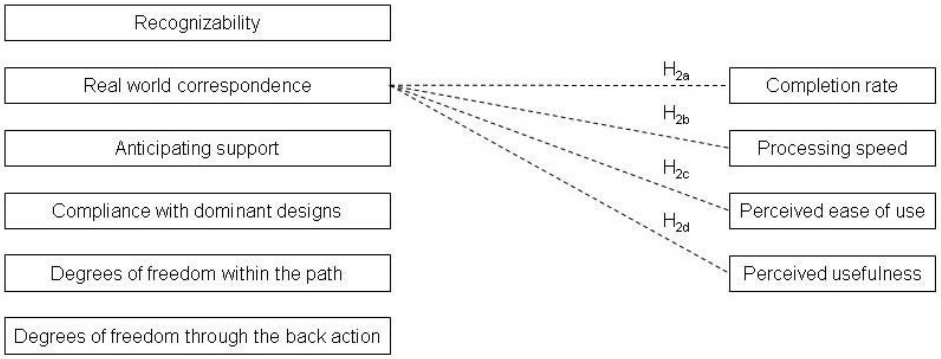

Figure 2: Real world correspondence (H2)

Real world correspondence summarizes figures, signs, icons, terms and other design items of an interface, which are oriented towards objects and common symbols in the users' material environment. Usability issues are often related to the unsatisfied need for clarification of abstract phenomena, see (Becker, S. 2004) and (Czaja, S. 2006). The subordinate hypotheses assume a positive effect of real world correspondence on all four success factors.

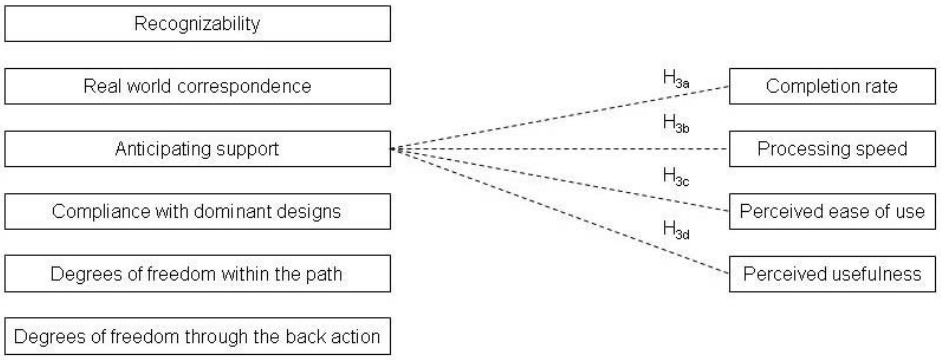

Figure 3: Anticipating support (H3)

Anticipating support is a system's ability to allow autonomous understanding and actively propose the presumable next step of a user's procedure with the objective of facilitating the fulfilment of his task. The term in a non-technical sense does not exist in scientific literature. The subordinate hypotheses assume a positive effect of anticipating support on all four success factors.

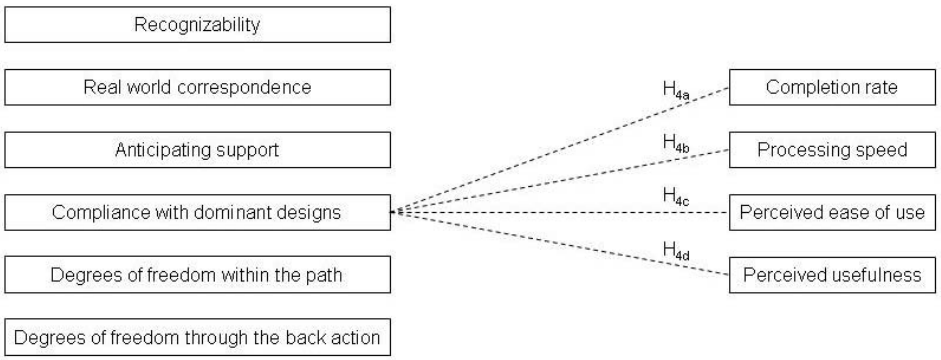

Figure 4: Compliance with dominant designs (H4)

Compliance with dominant designs describes the adoption of established design standards which are familiar to users. This through exploration ascertained finding is

supported by scientific sources, e.g. (Morville, P. and Rosenfeld, L. 2006), (Nielsen, J. 2007) and (Voss, A. 2003). The subordinate hypotheses assume a positive effect of compliance with dominant designs on all four success factors.

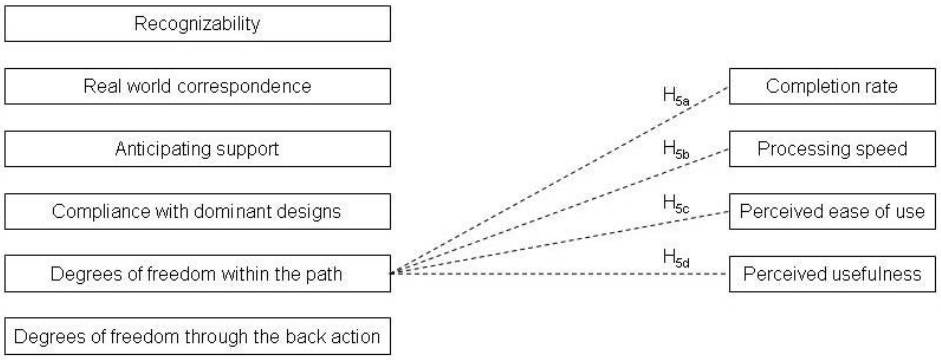

Figure 5: Degrees of freedom within the path (H5)

The degrees of freedom within the path indicate the extent to which a system allows the user to reach a specific goal on several alternative ways, if possible with the help of shortcuts. For this subject, only a few scientific sources exist, e.g. (Mayhew, D. 1999). The subordinate hypotheses assume a positive effect of the degrees of freedom within the path on all four success factors.

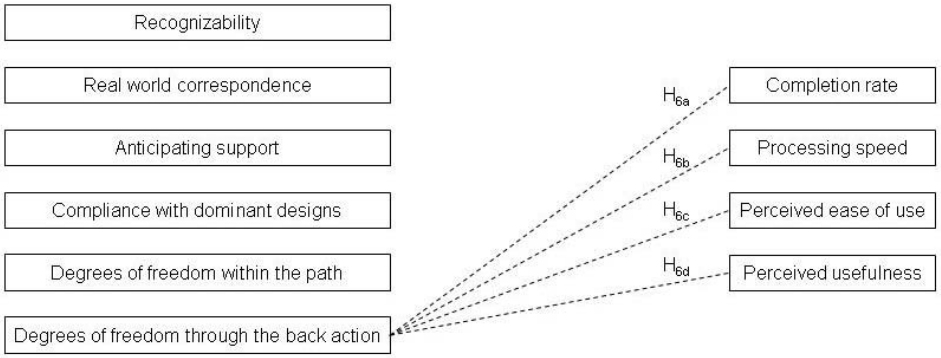

Figure 6: Degrees of freedom through the back action (H6)

The degrees of freedom through the back action indicate the extent to which a system allows the user to undo one or more erroneous or incorrect entries. Scientific sources confirm the back action's role, e.g. (Shneiderman, B. 1987, p. 239) and (Rosson, M. and Carroll, J. 2002, p. 175). The subordinate hypotheses assume a positive effect of the degrees of freedom through the back action on all four success factors.

4 Research Methodology

For empirically validating the model, two different versions of a click through prototype of a fictitious Internet Banking application were used in an experiment.

4.1 Test Design

Using experiments as research methodology offers the advantage of systematically observing specific situations under the circumstances controlled and modified by the researcher. The essential characteristic of experiments – the active manipulation of the test conditions by the researcher himself – was the main decision criterion for having the possibility to differentiate cause and effect. The three conditions for choosing experiments as research methodology according to (Hager, W. 1987, p. 73 et seq.) are complied: dependent variables are definable from independent variables, the sequence from independent to dependent variables is given, and data from two or more groups is being compared.

Here, the method of a synchronous remote usability test has been used for testing the six hypotheses regarding the correlation between the usability dimensions and the success factors. With the help of two different versions of a 77-page click through prototype, the participants were guided towards these varied characteristics. These varied characteristics are not the solution to the participants' tasks itself but should have an influence on the process of resolution. The two different prototype versions differ from each other in a high or low form of the respective usability dimension.

Pre-tests were used to ensure the prototype's randomized configuration of the varied characteristics and to eliminate technical and operational defects. Those pre-tests already showed that the dependant variable "completion rate" might be too rough for a target-aimed analysis. The participants have been divided into two groups, based on the usability dimensions' varied characteristics (later, the analysis compared the two groups). Every participant received a set of tasks, in total 51 participants completed the experiment.

4.2 Test Item

An Internet Banking application considered one of the most successful and most established Internet applications ever has been chosen. Usability issues are important in this field as a great number of Internet users accomplish their banking affairs online and as banks will expand this channel in the future (Pikkarainen et al. 2004, p. 224). From the usability point of view, Internet Banking contains further interesting characteristics: its nature is application-like (it is used in the form of multi-stage, completed processes), its basis is diverse and complex (balance queries, transactions, search, withdrawals, etc.), transactions can be processed independently from each other (in contrast to an online shopping process), it is very obvious whether a transaction has been successful or not and lastly, there are many existing examples which serve as a reference.

5 Results

5.1 Assessment

Each of the 51 participants solved six tasks. In total, 283 out of 306 partial experiments were completed successfully. This relatively small number of failures does not allow drawing reliable, statistically valid conclusions and it implies that "completion rate" can not be a suitable measurement parameter. Instead, it should be considered as a fundamental condition of usability (and as a knockout criterion in this model): if a task cannot be completed successfully, there is a usability problem.

The remaining three success factors have been analysed regarding their variance as the standard element of examining causal correlation. Because the participants have been treated differently, treatment variables were used to build groups. In this experiment, the treatment variables are the prototype's two different versions. The variance analysis' goal is to work out whether the observed differences within the critical variables are based on the varied treatment or on the random composition of the groups. The data has been assessed using a univariate analysis, which considers one dependent variable at a time. In total, the statistical assessment contains six univariate covariance analyses, carried out separately for each partial experiment.

Demographic data (gender, age, education, Internet experience, Internet Banking experience) has also been taken into account during the pre-assessment, but both age and gender did not show significant relevance to the test's outcome. Demographic data proved to be relevant are Internet experience and Internet Banking experience. Therefore the variable "Internet Banking experience" has been added to the final assessment as a covariate. The variables "positive characteristic of a usability dimension" and "negative characteristic of a usability dimension" have been added as categorical variables.

5.2 Outcome

The remaining three success factors and the corresponding 18 subordinate hypotheses have been reassessed; nine of them could be confirmed.

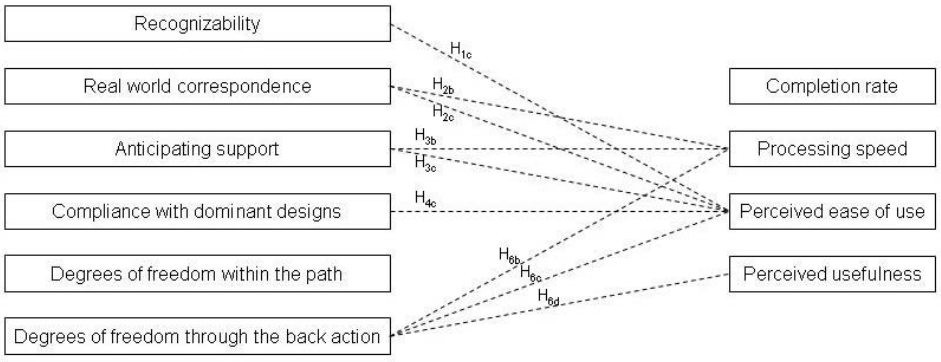

Figure 7: Confirmed hypotheses

Increased recognizability proved to lead to a higher perceived ease of use. Real world metaphors proved to lead to a higher processing speed and to a higher perceived ease of use, so does anticipating support. An interface that complies with dominant designs proved to lead to a higher perceived ease of use. A higher degree of freedom through the back action proved to lead to a higher processing speed and to a higher perceived ease of use and usefulness.

All data in this experiment have been interpreted by using a univariate analysis. The statistical methods used included variance analysis for the several indicators (processing speed, perceived ease of use, perceived usefulness) as the standard element for determining causal correlation. This step included the use of treatment variables (in this case the different versions of the prototype). A confidence interval of 95% has been

used to evaluate the results' significance and to confirm or reject the single hypotheses. Overall, the statistical evaluation contained six different univariate covariance analyses which have been separately carried out using the variable "positive / negative version" as a categorial variable and "Internet Banking Experience" as a covariate.

6 Discussion

The main goal of the model's development and the subsequent experiment consisted of verifying the fact that usability consists of single, distinguishable factors, which affect a system's user-friendliness. Although not all of the hypotheses could be confirmed through the experiment, the usability dimensions turned out to influence the process success both for objectively measurable (processing speed) and subjective parameters (perceived ease of use and perceived usefulness). Compared with the model, the experiment involves a few limitations – geographic limitation (Swiss participants), application limitation (Internet Banking) and sector limitation (financial affairs) – which confine the results' wider scope.

Considering the topic's high complexity, the identification of further dimensions or an enhanced differentiating of the existing dimensions could be conceivable. The dimensions used in this model are neither sector-specific nor website-specific, but rather a suggestion for a generic set of universally valid characteristics. They are equally relevant in different context, but context-specific, they could be implemented differently. The main theoretical contribution is the development of a differentiated model based on a deductive literature review process and a preliminary, explorative empirical investigation.

Practical implications are to be found for the fields of user-centered development, usability testing and return on investment and acceptance of usability methods. A target group's early inclusion will lead to considerable higher usability of the final product. The proposed six usability dimensions and the new, more differentiated term of success provide additional orientation for practitioners (website operators, web developers and usability service providers). They can also remove today's unstructured lists of usability defects in test results. Lastly, they can help to professionalize the handling of usability and provide a more systematic proof of success.

In summary, this study first showed a model that states which content design dimensions are relevant to the usability of a website. The model considers the cost-benefit relation of website usability using success variables and has been developed with systematic scientific verification.

7 Conclusions

Key conclusions contain the following statements: A higher recognizability of the next step results in positive effects on usability. Real world metaphors are superior to abstract solutions. It is reasonable to prominently indicate the operation step which will in all probability be used next. Sticking to dominant design supports orientation. The higher availability of a back action results in notably positive effects on usability.

The rejected hypotheses could be subject to further research. By means of additional experiments, a modified test design could be assessed in order to confirm or reject the first experiment's outcome. Every hypothesis has been tested with at least one task. This represents the usual approach for experiments. Nevertheless, measurement inaccuracies within the operationalisation of the model's variables can not be precluded. A possibility for further research could be to minimize the risks of measuring errors and increase validity through developing a larger-scale prototype and adding more tasks related to the same usability dimension. The success factors are more focused on single pages or input forms than on a whole process and are therefore geared to rather

transaction-oriented websites. Interesting for further research would be the enhancement of the model with new context-specific dimensions.

Further research could also consist of a comparative study for the new platform generation. One the one hand, the work could concentrate on the problems which intensified since the conduct of this study, e.g. usability issues concerning the dynamic features of Web 2.0 interfaces; on the other hand it could investigate patterns for web usability according to (Crumlish, C. and Malone, E. 2009) and continue this approach with a focus on usability.

As usability is going to be an even more relevant topic when it comes to publishing websites or rich applications on mobile devices, especially in relation to mobile commerce (m-commerce), this study's findings could be a basis for further research in the field of m-commerce usability.

Acknowledgement

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