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USABILITY TESTING OF INSURANCE WEBSITES VIA PROXY USERS

The subject of the article is an usability evaluation of web-based insurance calculators using physical proxy users. **The purpose of the study** is to develop and experimentally validate a combined methodology for usability testing of insurance websites using proxy users. To achieve the stated goal, the following **tasks** must be performed: to define a set of usability metrics; to develop a usability testing procedure with physical proxy users; to evaluate the usability of web-based insurance calculator using the prosed testing approach; to analyze identified usability problems; to assess the strengths and limitations of the proposed approach. **Research methods:** The study proposes usability testing methodology that combines quantitative and qualitative usability metrics. Mathematical modeling, normalization and aggregation of usability metrics, experimental evaluation based on scenarios using physical proxy users, comparative analysis, and sensitivity analysis were applied. **Results achieved.** The obtained result confirms the feasibility of applying the combined usability testing methodology, since both quantitative and qualitative usability components make an independent contribution to the integral evaluation of usability. As a result of experiment, it was found that the objective usability component of the insurance calculator interface was lower than the subjective one, which confirms the presence of underlying usability issues related to interaction efficiency, despite an overall general positive perception of the interface. The obtained value $(\Delta UI \approx 0.061)$ of integral usability index range confirms the reliability of the proposed methodology. **Conclusions.** The proposed combined usability testing methodology allows to identify hidden problems in the efficiency of interaction with the interface. The methodology can be applied even in cases where real end users are not available for testing, which makes it suitable for data-limited systems.

Keywords: usability; software testing; user experience; web design; insurance website; UX metrics; proxy users.

1. Introduction

The effectiveness of interaction between human and any software extremely depends on its convenience and ease of use. Those factors can largely affect website's demand and its success in the market. Usability is important because it helps create an intuitive interface, which forms a positive user experience (UX). Consequently, this affects customer satisfaction and website traffic, which may increase a company's revenue.

According to the International Association of Insurance Supervisors (IAIS) 2017 report, InsurTech is a branch of Fintech that transforms the insurance industry through digitalization. This involves implementing digital solutions to optimize processes of signing and servicing insurance contracts, claims settlement, and customer support during insurance payouts [1].

On the one hand, the impact of InsurTech on accident insurers is significant, as most of personal accident insurance products are relatively simple and targeted at a wide range of consumers [2]. On the other hand, insurance websites are often characterized by high cognitive load due to the need to input and work with insurance data that is becoming increasingly complex and voluminous [3], especially for long-term products or those with high premiums. Consequently, tasks associated with interacting with insurance websites are becoming more complex, which in turn requires greater cognitive effort from the end user [4]. However, it is important to consider that the structure of the interface of any website or application can influence the usability of the software and user cognitive load.

Most insurance companies in Ukraine utilize digital technologies to optimize their operations. This enhances customer convenience through a simplified insurance process that enables online policy purchases using websites or mobile applications. Such digitalization also helps to automate internal workflows, which increases operational speed and reduces error rates in claims settlement [5]. However, the low level of digital literacy among a segment of the Ukrainian population encourages the use of intermediaries (brokers) when selecting and purchasing insurance products and contracts online.

Currently, not all insurers are capable of maintaining innovation-driven operations due to the challenging environment in Ukraine, driven by economic instability, which has led to decreased solvency and a decline in demand for insurance services. Furthermore, updated regulatory requirements have significantly impacted the industry landscape: the number of insurance companies in Ukraine decreased from 210 as of December 31, 2020, to 65 as of December 31, 2024.

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The current market consists of about 55 non-life (accident) insurers and 10 life insurance companies [6].

Car insurance, health insurance, and property insurance remain the most popular categories of insurance services in Ukraine [7]. The market leaders in terms of insurance premiums are large companies such as ARX, TAS Insurance Group, VUSO, Oranta, INGO, USK, PZU Ukraine, and others, which collectively account for more than half of the market's insurance transactions. Additionally, insurance digital comparison services and platforms are widely used in Ukraine to help users identify the most accessible insurance products based on parameters such as policy cost, coverage, and company ratings [8]. Examples of such platforms include TrustLife, Finance.ua Insurance, HotlineFinance, and others.

Digital solutions continue to expand in the insurance industry through personalized approaches, self-service platforms, and behavioral pricing models, which are aimed at increasing customer satisfaction, trust, and purchase intention [9, 10]. Nevertheless, around 90% of insurance products in Germany are still sold through traditional physical sales channels [11]. They are represented by insurance agents or brokers and bancassurance channels linked to corporate sector. The share of online sales remains limited, except certain products as car insurance [12].

Since insurance products are complex and German customers are inherently risk-averse, this underscores the role of intermediaries in insurance coverage selection [11]. Furthermore, insurance websites foster to the adaptation of sales to digital expectations of customers by proving quick access to information and online interaction. Moreover, such platforms operate with sensitive customers' data, which highlights the importance of creating a convenient and secure environment for end users.

Comprehensive assessment of insurance websites can be complicated due to a problem of insufficient consistency between subjective and objective usability metrics. Additionally, there is no formalized testing approach to verify usability of such applications without direct user participation.

2. Analysis of recent studies and publications

Usability plays a key role in success of web and digital solutions because it determines the effectiveness of user interaction with such products and can directly contribute to the company's competitive advantage [13, 14]. According to Jakob Nielsen, usability consists of five main components such as learnability, efficiency, memorability, errors, and satisfaction [15]. Additionally, principles of minimizing cognitive load and using persistent and clear navigation contribute to increased usability [16]. UX can be evaluated using structured questionnaires combined with usability testing, accounting for psychological factors of decision-making [17, 18].

According to ISO 9241-11 standard, usability is defined as efficiency, effectiveness, and users' satisfaction in a given context of use [19]. Findings in insurance digital services show that easy and intuitive navigation and modern interface design are extremely important for UX and users' trust in the system's reliability and security [20, 21]. This highlights the importance of prioritizing interface simplicity and high-quality design. Many of the usability recommendations from J. Nielsen and Nielsen Norman Group, from breaking down content of software application into blocks to optimizing system response time, are aimed at minimizing user cognitive load.

Usability evaluation methods can be divided into data-driven, user-based, feedback methods [22, 23]. Data driven methods use machine learning algorithms to analyze user behavior data but need to understand user needs to promote effective user interaction and optimize user interface design. User-based methods provide detailed interaction analysis but can be limited in sample size and resources. On the one hand usability feedback methods are simple, but on the other hand results can be affected by self-reporting bias.

Insurance websites provide users an opportunity to obtain information about available insurance products and to purchase them quickly and remotely, with minimal time spent. Online insurance policies usually have the ability to submit claims online. The main functions of an insurance website or mobile application include information search by client, product purchase, policy servicing, claim settlement, and loss adjustment [24].

Moreover, insurance websites often use calculators for the automated calculation of policy costs (insurance premiums). During the conclusion of insurance contracts (both life and non-life), the process of underwriting or client risk assessment occurs automatically or semi-automatically. This process is based on data entered by user (e.g., gender, age, health status, driving experience, etc.), which serves as the basis for determining the final policy price.

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Users of financial and insurance web applications typically perform complex tasks when selecting and paying products. Disruptions in these workflows may look like confusing navigation, unclear instructions, prolonged system response time, failure to display insurance contracts, or slow system performance [25]. Such issues can lead to decreased user satisfaction and task abandonment. Factors that reduce user confidence and trust and hinder effective use of website include complex and confusing website's interface, as well as problems with visual design components, such as small font sizes and non-intuitive layouts, which are especially critical for elderly users.

Since it is important for insurance websites to maintain long-term relationships and effectively manage large customer base, strengthening customer loyalty becomes a potential source of a company's market and financial success. Thus, customer satisfaction with insurance websites is closely linked to their usability, where ease of navigation and aesthetic appeal play a crucial role in this relationship.

Although digital insurance applications provide benefits to customers and companies, the handling of sensitive data poses risks [26]. Moreover, regulatory requirements in Germany, such as Versicherungsvertragsgesetz (VVG), oblige companies to ensure transparency, security, and usability [27]. It is possible to involve proxy users, who are physical participants with characteristics or experiences similar to target audience, to participate in usability evaluation when the access to end users is limited [28, 29]. At the same time, strict data protection policies limit the use of traditional testing methods, and methodological guidelines in such cases remain limited.

3. Purpose and objectives of the study

Given the difficulties associated with engaging real end users for usability evaluation in related areas, such as digital insurance services, alternative approaches to testing are needed.

The aim of this study is to develop and experimentally validate a methodology for usability testing of insurance websites using physical proxy users.

The object of the study is a web-based insurance calculator, and the subject of the study is its usability evaluation using proxy users.

To achieve this goal, the following research questions are addressed:

1. To define a set of usability metrics.
2. To develop a usability testing procedure with physical proxy users.
3. To evaluate the usability of web-based insurance calculator using the prosed testing approach.
4. To analyze identified usability problems.
5. To assess the strengths and limitations of the proposed approach.

4. Research materials and methods

Insurance plays a substantial role in financial stability and digital platforms allow insurance contracts to be processed in real-time. However, web-based insurance interfaces are often complex due to personal data requirements and integration with internal systems, which increases the risk of user errors [15]. In order to improve interaction in such systems, informative prompts and simplified forms for user data entry can be implemented. Usability testing for web-based insurance applications was conducted using a combined testing approach, which allows for the assessment of both the effectiveness and the perception of the interface by physical proxy users.

The study employs a combined usability testing methodology for insurance websites, which integrates both objective and subjective data collection methods and includes the following stages, as shown in Figure 1:

Stage 1. Respondents selection and group competence index calculation.

Stage 2:

– interface preliminary analysis;

– identification of key functional blocks of a website.

Stage 3:

– defining a set of subjective evaluation metrics and usability hypotheses;

– subjective evaluation (questionnaire);

– finding problem areas of the interface.

Stage 4:

– selection of test scenarios for key functional blocks of the interface;

– objective evaluation (moderated real-time usability testing);

– confirmation and classification of identified usability issues.

Stage 5. Integration and analysis.

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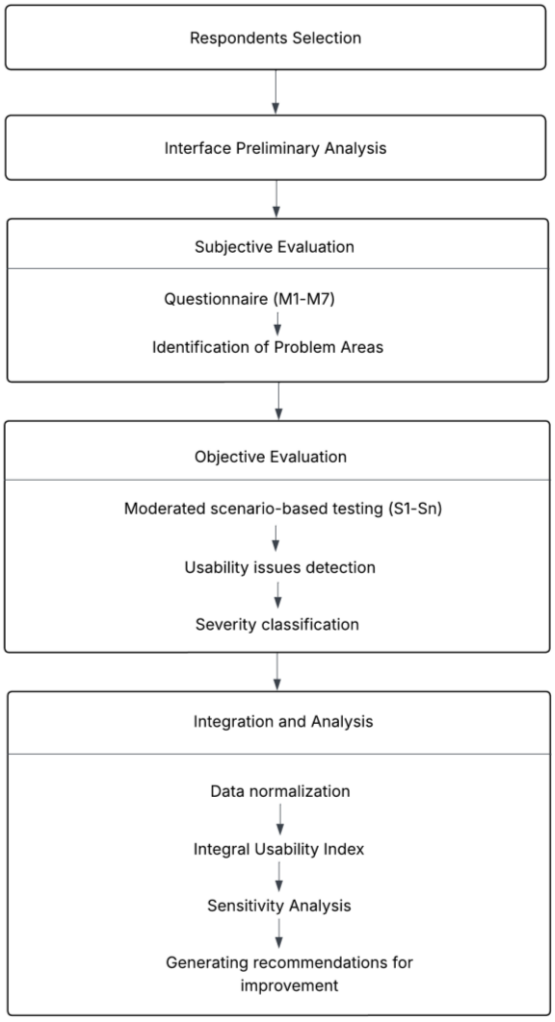

Fig. 1. Proposed combined methodology for usability evaluation of insurance website

Stage 1 involves selecting respondents for usability testing. Considering that access to real users of insurance websites and platforms may be restricted due to corporate security policies or the EU General Data Protection Regulation (GDRP), it becomes necessary to engage physical proxy users. These participants must be individuals who possess experience or specific characteristics, which are similar to the target audience of the insurance website. For instance, they should have basic digital literacy and be at least minimally interested in quick conclusion of an insurance policy. To ensure more accurate usability evaluation results, the respondent group should represent different levels of experience with online insurance contracts (low, medium, and high). Additionally, the representativeness of proxy users can be enhanced by including respondents with a direct connection to the specific insurance product. For example, involving a small proportion of car owners among proxy users for car insurance testing, or individuals aged 21–50 who prioritize health and quality medical services for health insurance evaluations.

Since both subjective and objective usability evaluation of the interface will be conducted, it is required to involve two groups of respondents. The first group will be used for subjective evaluation and it should be larger because such type of research will focus on satisfaction metrics (questionnaire) and requires a broader sample size to make a confident decision. This is especially relevant in cases when it is necessary to determine whether there is a significant difference in designs [17] of a website or mobile application. The second group consists of a smaller number of participants in order to objectively confirm usability issues identified during the subjective evaluation. In accordance with J. Nielsen's findings, a sample size of up to 8 respondents is sufficient to identify approximately 90% of usability problems.

To enhance the accuracy of result interpretation, a group competence index (GCI) was introduced, which takes into account the distribution of website interface knowledge among participants. The index was determined as a weighted average on an ordinal scale with uniform rank coding of competence levels (1 – low level, 2 – medium level, 3 – high level), according to the following formula:

$$GCI = \frac{\sum_{i=1}^{3} C_i l_i}{n}, \quad (1)$$

where C_i – competence code for a group of respondents, by proficiency level; l_i – number of respondents in a group of a certain level of competence; n – total number of respondents in all groups.

Stage 2 involves identifying key usability test tasks based on the insurance type (life or non-life), such as policy calculation, plan selection, and contract submission. The corresponding key interface components are defined for these tasks (e.g., calculator forms, personal accounts, and contract terms). A preliminary analysis allows to identify main usability issues of the interface and to formulate usability testing objectives, which can help to enhance user interaction with the product. In order to achieve this, a usability specialist (UX analyst) or a designer may be engaged to conduct an expert evaluation of the interface from a perspective of a new user in a system.

Stage 3 focuses on developing a respondent questionnaire, which includes up to seven subjective

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evaluation metrics (M1-M7). These metrics cover key aspects of user experience with the interface (provided that relevant metrics are available on the insurance website):

M1 – Overall convenience (ease of use, simplicity, and interface clarity, including ease of finding information on pages).

M2 – Interface design (including visual appeal, readability, and comprehensibility of key interface elements).

M3 – Ease of navigation (how easy it is to navigate between different sections of the site, find specific elements on the page, perform backward/forward transitions, etc.).

M4 – Functionality (interface content accessibility, system performance and available functionality).

M5 – Evaluation of error messages.

M6 – Interaction and feedback (user action outcomes, including visual changes and/or audio signals).

M7 – Cognitive load (whether design elements create unnecessary noise such as poor layout, complex paths to a goal, absent or implicit feedback from a system, which interferes with focusing on a task).

It is necessary to define corresponding usability hypotheses for each subjective metric. These hypotheses detail metrics and set the scope for specific problem areas of the website.

Each subjective metric is rated on a 5-point Likert scale, where 1 – is bad/strongly disagree and 5 – is very good/agree. Additionally, each subjective metric can consist of a different number of sub-questions i (from 2 to 6), the scores for which are aggregated into component subjective metrics, which are determined as the average values of the answers to the corresponding sub-questions of the questionnaire.

For each component subjective metric, variance and weighting coefficients are calculated to evaluate consistency and ensure the comparability of results:

$$Var\left(M_j\right)=\frac{\sum_{i=1}^{n}\left(M_{ij}-\bar{M}_j\right)^2}{n-1}, \quad (2)$$

$$w_j=Var\left(M_j\right)\Big/\sum_{j=1}^{7}Var\left(M_j\right), \quad (3)$$

where $\bar{M}_j$ – average metric M value across its sub-questions; j – metric index, $j=\overline{1,7}$; n – number of sub-questions for j metric; $Var\left(M_j\right)$ – variance of j-th subjective metric; w_j – variance-based weights.

Component subjective metrics M1-M7, which were measured using a Likert scale from 1 to 5, are linearly normalized to the range [0;1] for comparability with objective results:

$$M_{j_{norm}}=\frac{M_j-M_{\min}}{M_{\max}-M_{\min}}=\frac{M_j-1}{4}, \quad (4)$$

where M_j – metric M value M; $M_{\min}$ – minimum metric value; $M_{\max}$ – maximum metric value.

As a next step, the integral subjective component of usability is calculated as an average value of normalized metrics:

$$UI_{subj}=\frac{\sum_{j=1}^{n}M_{j_{norm}}}{n}. \quad (5)$$

Upon completion of the subjective evaluation, interface elements that negatively impact user experience are identified. These findings can subsequently be used to develop objective test scenarios.

Stage 4 involves the selection of usability test scenarios for key functional blocks of the interface (Si). The scenarios should not be too time-consuming to perform. Test developer (moderator) must prioritize which interface functions and potential problem areas require immediate verification, for example:

S1 – simple insurance product calculation;

S2 – new contract generation;

S3 – finding elements and verifying validations.

Moderator provides participants of the moderated usability testing with a general task statement, the final goal, and the necessary steps to initiate the test. Test participants are not restricted in their actions, but they must adhere to the main objective of the test scenario. Participants are allocated approximately 15–20 minutes to complete test tasks or scenarios, after which moderator immediately analyzes and records the results (e.g., in a spreadsheet).

According to the ISO 9241-11 standard, the following objective metrics are used (depending on the scenario objective and key functions): task completion time, effectiveness, number of errors in scenario and navigation errors. Objective metrics are grouped by type within scenarios, according to the presence of the metric in the test scenario, where T – time (s), E – number of errors, R – binary value of scenario success (0 – failure, 1 – success), N – binary value of navigation errors (0 – absent, 1 – present).

Objective metrics of varying scales and types are normalized to a unified range to ensure comparative

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analysis across scenarios. Normalized values are calculated for every scenario featuring these specific. T and E values are estimated using the minimization principle:

$$X_{norm} = 1 - \frac{X - X_{\min}}{X_{\max} - X_{\min}}, \quad (6)$$

where $X = (T, E)$.

Next, the aggregated metrics T, E, R, N are calculated for all scenarios using the mean value method for the set of scenarios where such metric is encountered:

$$X_{avg} = \frac{\sum_{i=1}^{k} X_{i_{norm}}}{k}, \quad (7)$$

where $X_{norm} = (T_{norm}, E_{norm}, R, N)$; k – number of scenarios where the metric is present.

The aggregated error rate E_{total} is calculated using the formula:

$$E_{total} = wE_{avg} + (1-w)N_{avg}, \quad (8)$$

where E_{avg} – aggregated value of E metric across all scenarios in which it is present; N_{avg} – aggregated value of N metric; w – weights for values E_{avg} and N_{avg}.

It was applied $w = 0.6$ because correct execution of scenario is mandatory, but navigation and usability are equally important components for the end user.

Then, the integral objective component of usability is calculated:

$$UI_{obj} = \frac{T_{avg} + E_{total} + R_{avg}}{3}. \quad (9)$$

After moderated usability testing is completed, it is needed to determine if usability issues identified during subjective evaluation have been objectively confirmed and any previously undiscovered issues are recorded. The identified problems are classified and assigned severity and priority levels, as shown in Table 1, depending on their technical impact on the task and end users and its frequency of occurrence (severity), and the specified priority by manager of addressing the identified issues (priority). Then, recommendations are formed for further validation through re-testing for the identified usability problems.

At ***Stage 5***, to overcome the inconsistency of disparate metrics, an integral usability index is introduced, which allows aggregation of individual measures into a single comparable criterion.

Table 1. *Classification of identified usability issues*

Severity	Description	Priority	Description
Critical	Critical issue that requires immediate correction because it disrupts core functionality	Now!	Problem should be fixed immediately due to the criticality of the problem
Serious	Significant impact, but does not affect the basic logic of the site	High	The fix is important but not urgent.
Important	Important but not critical issue that can be fixed in the longer term	Middle	Fix can be postponed even though the problem needs to be addressed
Light	Minimal impact on core functionality	Low	Low priority – the problem is not significant, the main functionality works correctly
–	–	Won't fix	The problem will not be fixed because its resolution depends on the customers' decision.

The index includes objective and subjective components of the assessment. To formulate the integral usability index, a simple linear model was used with the parameter λ, which regulates the contribution of objective and subjective metrics into UX. According to ISO/IEC 25010 requirements for functional correctness and reliability of applications, it was assumed that the objective component UI_{obj} is more significant, while subjective component UI_{subj} is less significant:

$$UI = \lambda UI_{obj} + (1-\lambda)UI_{subj}, \ \lambda = 0.5. \quad (10)$$

The value of parameter λ is determined for a specific insurance website, however, in the general case, $\lambda = 0.5$ it is used to balance the interface's attractiveness and efficiency. The consistency between objective and subjective evaluation of UX was analyzed based on the Δ value:

$$\Delta = \left| UI_{obj} - UI_{subj} \right|. \quad (11)$$

5. Research results

This section presents the results of an experimental study of the proposed combined usability testing methodology for web-based insurance calculator. The object of the study is the eVorsorge GmbH (eVo) insurance calculator website, which is designed to

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calculate the cost of insurance services based on entered user data and save contacts in system. These features are implemented through the functionality of the insurance calculator (Tarifrechner), which has step-by-step navigation between pages. To enhance visual aesthetics and take into account customer feedback, a new calculator interface, designed as Maklerrechner, was developed using the React library. The interface supports validation with visual display of errors (see Figure 2).

All actions in Maklerrechner are integrated into a single-page interface with side navigation and restriction of available fields in accordance with the terms of the contract, as shown in Figure 3. The target audience is represented by brokers, employees of insurance companies and private and corporate clients. The Maklerrechner version of insurance website was used as a test platform for usability testing based on typical user scenarios.

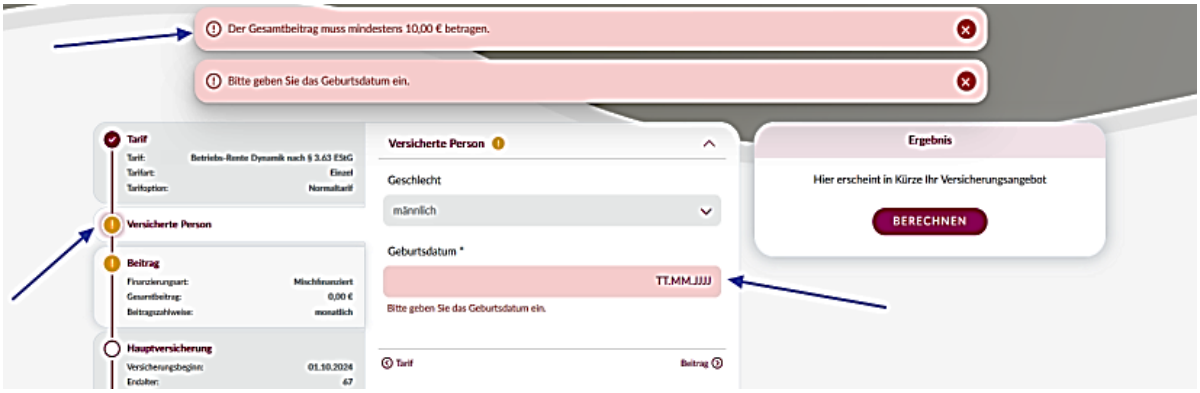

Fig. 2. Visual presentation of Maklerrechner interface error messages

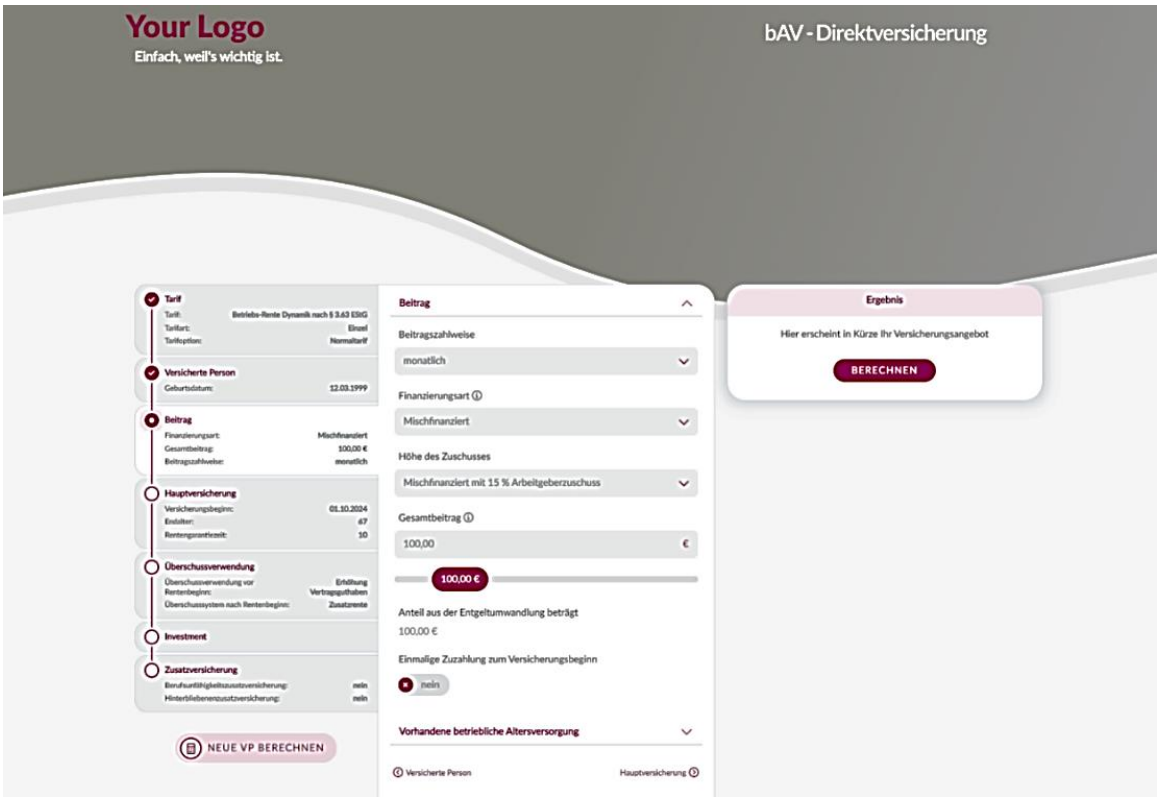

Fig. 3. Visual design of the developed Maklerrechner interface

The main actions of specialized users (e.g. insurance brokers) are given in the algorithm on Figure 4. The key steps of the algorithm are filling in user data and calculating the contract premium.

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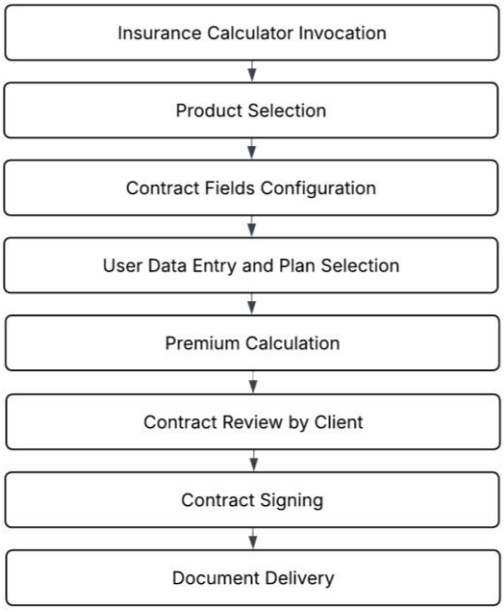

Fig. 4. Key actions of specialized users of the insurance website

There were restrictions on access to real users for usability testing due to eVorsorge company security policies and the GDRP data privacy law that led to use of physical proxy users. eVorsorge insurance company employees were divided into two groups of physical proxy users, who participated in the experimental study, in which typical scenarios of the insurance calculator usage were completed (e.g., creating a new insurance contract, simple contract premium calculation).

Test participants with different levels of experience in Maklerrechner interface were used to evaluate the interface. First group of the proxy users $(n = 36)$ was used for subjective evaluation of the current state of Maklerrechner interface and identification of its main problems using a questionnaire. The second group $(n = 8)$ was used for objective analysis of the identified UX problems through moderated real-time testing. The characteristics of the first and second groups of respondents are presented in Table 2.

Table 2. *Characteristics of physical proxy users*

Competence Level	**Competence Code** (C)	**Number of respondents** (l_i)	**Group Competence Index** (GCI)
Tarifrechner – Subjective evaluation ($n = 36$ participants)			
Low	1	0	2.833
Medium	2	6	
High	3	30	
Maklerrecher – Subjective evaluation ($n = 36$ participants)			
Low	1	14	1.944
Medium	2	10	
High	3	12	
Tarifrechner – Objective assessment ($n = 8$ participants)			
Low	1	0	3
Medium	2	0	
High	3	8	
Maklerrecher – Objective assessment ($n = 8$ participants)			
Low	1	3	2.125
Medium	2	1	
High	3	4	

As can be seen from the data in Table 2, *GCI* for the Tarifrechner interface was higher than *GCI* for Maklerrecher in both groups of participants (2.833 and 3 for first and second group correspondingly). *GCI* for new Maklerrecher interface was higher for the second group of proxy users $(n = 8)$ and scored 2.125 out of 3, which indicates a predominance of users with medium level of competence. Thus, obtained interface usability values should be interpreted in the context of moderate competence.

To evaluate subjective perception of the interface, subjective metrics M1-M7, which cover key aspects of UX with the insurance calculator website, and a Likert scale from 1 to 5 points were used.

Usability testing hypotheses for the corresponding subjective metrics were formulated as follows (see Table 3): H_1 – Maklerrechner interface is easy to use and perform tasks; H_2 – Insufficient readability of tooltips; H_3 – Simplified sidebar and location and visibility of buttons allow easy transitions between sections; H_4 – Maklerrechner interface is intuitive and provides sufficient operational speed; H_5 – The system provides direct navigation to the specific field containing

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the error and enables batch closing of errors, which simplifies the process of their correction; H_6 – Tooltip pinning upon clicking the Info Button enables easy interaction with the hint text; H_7 – Maklerrechner interface outperforms Tarifrechner in terms of usability and efficiency.

Table 3. *Aggregated and normalized subjective metric values*

Subjective Metric	Description	Avg	Variance	Weight	Normalized Value
M1	Overall convenience	4.387	0.018	**0.027**	0.847
M2	Interface design	4.473	0.032	**0.046**	0.868
M3	Ease of navigation	4.275	0.019	**0.027**	0.819
M4	Functionality	4.070	0.146	0.210	0.768
M5	Evaluation of error messages	4.130	0.168	0.242	0.783
M6	Evaluation of Info Button	4.347	0.167	0.241	0.837
M7	Comparison with Tarifrechner interface	4.127	0.145	0.208	0.782
Mean					**0.815**

Obtained experiment results in Table 3 show that subjective metrics M1 (Overall convenience), M2 (Interface design) and M3 (Ease of navigation) have the highest weight values: 0.027, 0.046 and 0.027 correspondingly. These metrics also have low variance values, which indicates their reliability and significance in evaluating the usability of Maklerrecher inteface.

The integral subjective component value of usability UI_{subj} was 0.815, which shows a positive UX rating of the interface as intuitive and easy to use, and also demonstrates consistency in positive ratings across most key aspects of interface. After survey completion, an analysis of the obtained results was conducted, as presented in Table 4. The results of the subjective usability evaluation were used to develop objective test scenarios, which allowed to focus UX evaluation on most important usability issues.

Table 4. *Usability problems found (subjective evaluation)*

No.	Competence level	UX problem	Interpretation of the Problem
1	Low	It was more difficult to find certain elements on the page	There are navigation issues for new users
2	All levels	Errors in application work	There are problems with the interface or functional component
3	High	Automatic closure of error messages results in a slower interaction speed	Users expect more control over interactions with error messages
4	Low	Maklerrechner interface and navigation structure are unintuitive and complex, making it difficult for users to comprehend	It is more difficult for new users to work with Maklerrechner
5	Middle	Not very clear error messages in the Maklerrechner compared to standart Tarifrechner	Inconvenience of error messages compared to Tarifrechner
6	All levels	In Maklerrechner it is more difficult to find the desired element on the page	The page structure needs improvement
7	All levels	Inconvenience of using the Info Button	Info Button work needs improvement

Objective usability assessment was performed by a separate group of 8 participants $(n = 8)$, which allowed to record quantitative metrics of the effectiveness and accuracy of task performance. Objective usability assessment in this study was based on moderated real-time testing using 4 types of tasks or scenarios designed to validate previously identified UX problems. Moderated testing took place online on the Zoom platform for each participant separately.

The following objective usability metrics were used: task completion time T, effectiveness or successful completion R, number of user errors in scenario E and navigation errors N. Each test scenario S1-S4 contained a different set of objective metrics, depending of the purpose of the scenario. Results of the objective assessment are presented in Table 5. After normalizing the values of objective metrics, the aggregation of objective metrics across all scenarios was performed using the Formula 7.

The results of aggregated normalized values of objective metrics across all scenarios are shown in Table 6.

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Table 5. *Grouping of mean values of objective metrics by type and scenario*

Scenario	Description	Type of Objective Metric			
		T , s	E	R , $\{0,1\}$	N , $\{0,1\}$
S1	Simple insurance product calculation	64	0.375	1	0.5
S2	Creating a new contract	64	0.125	1	–
S3	Finding elements and verifying validations	–	–	0.875	0.5
S4	Using Zurück zur Berechnung button	–	–	–	0.625

Table 6. *Normalized values of objective assessments across all scenarios*

Objective Metric	Description	Normalized Value
T	Time	0,301
E	Errors	0,723
R	Effectiveness (Resultativity)	0,958
Sum Σ		1,982

Usability testing hypotheses were tested using a subjective questionnaire and the objective assessment confirmed them. Usability testing hypothesis H_1 (convenience of the new interface) was confirmed: the average survey rating when comparing interfaces was 4.387. The hypothesis H_2 (Insufficient readability of the text in the tooltips) was rejected: the average readability of the text was rated as 4.47 out of 5. The hypothesis H_3 (simplified sidebar for navigation and buttons) was rejected: navigation and ease of finding elements on Maklerrechner page were rated at 3.76. The hypothesis H_4 (interface ensures fast and intuitive task execution) was confirmed: the average survey rating was 4.070. The hypothesis H_5 (simplified work with validation of errors) was rejected: the error message clarity value compared to the one in old Tarifrechner interface was 3.88. The hypothesis H_6 (Info Button ease of use) was confirmed: the average survey rating was 4.35. The hypothesis H_7 (effectiveness of the new interface) was confirmed: the average survey rating was 4.13, but there were certain elements of the new interface and structure that turned out to be more complex.

Objective usability analysis of the interface identified a number of UX problems that were not captured during subjective usability evaluation. In particular, the appearance of some interface elements did not meet user expectations (not all required fields are validated on contract form), some elements were misleading (red text under a tooltip) or redundant (a calendar for entering date of birth). Moderated testing also demonstrated that participants found it more convenient when click on a validation message automatically takes them to the corresponding field with error.

Overall integral usability index UI was calculated using the Formula 10 and its value was 0.738, which shows user satisfaction with Maklerrechner interface, positive perception of its design, navigation and functionality (see Table 7).

Consistency of objective and subjective usability evaluation was measured through Δ, which was 0.154 (scale [0;1]). Comparison of integral usability index UI value calculated at different λ is presented in Table 8.

Table 7. *Integral usability index*

Component	Normalized Value
Subjective component	0.815
Objective component	0.661
Integral usability index UI	**0.738**

Table 8. *Values of integral usability index across different λ values*

λ	UI
0.3	0.768
0.5	0.738
0.7	0.707

Integral usability index range was calculated using the following formula:

$$\Delta UI = \max(UI) - \min(UI), \quad (12)$$

$$\Delta UI = 0.768 - 0.707 = 0.061.$$

Obtained integral usability index range value was 0.061 and it had moderate sensitivity to choice of λ value in range [0;1].

Identified UX problems were classified by severity and priority and are presented in Table 9.

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Table 9. *Severity assessment and prioritization of identified UX issues*

UX problem	Severity	Priority	Proposed Solution
Inconvenient navigation			
Small size of main navigation buttons	Light	Low	Refine button visual appearance and enlarge their hit areas to enhance clickability and reduce interaction errors
Poor Berechnen button placement	Important	Middle	Include Berechnen button at the bottom of the final data entry page, analogous to the main navigation controls
Poor Zurück zur Berechnung button placement	Serious	High	Add the button to the left panel after Neue VP Berechnen button
Incorrect work of Info-Button			
Unable to copy text from tooltip	Important	Middle	Add message capture when clicking a button
Inconsistency of the visual appearance of elements with user expectations			
Field requirement	Light	Low	Redesign the visual appearance of the elements and add distinct labeling to highlight required inputs
Incorrect display of fields	Light	Low	
Inconvenient work of error messages			
Inconvenient display of error messages, especially with large amounts of incorrectly entered data	Important	Middle	Add the ability to automatically take user to the corresponding field with error when a validation message is clicked
Irrelevant interface elements			
Non-functional data entry slider	Light	Low	Add a Beitrag value gradation with maximum and minimum values
Redundant calendar for entering date of birth	–	–	Won't fix

6. Discussion of research results

The simple linear model of integral usability index that was presented in the previous section, is applied to Maklerrechner web-based insurance calculator for a case that an objective component of usability UI_{obj} was taken as more significant according to ISO/IEC 25010 requirements to software applications, with $\lambda = 0.5$ value in range [0;1] and moderate level of GCI for physical proxy users.

The results obtained in Tables 3 and 5 demonstrate how subjective and objective components of usability and integral usability index behave under such conditions.

The Table 7 and calculated value of $\Delta = 0.154$ show a discrepancy between objective and subjective usability evaluation, which indicates that combined usability testing methodology shows practical effectiveness by identifying hidden interaction usability problems, which are not reflected in subjective user feedback, in a much more precise manner than subjective and objective usability testing approaches used separately by other researchers.

The Table 8 and range of integral usability index $\Delta UI \approx 0.061$, which show moderate sensitivity to the λ parameter, confirms reliability of proposed combined usability testing methodology. Thus, $\lambda = 0.5$ was chosen as a balanced value.

The proposed combined usability testing approach can be applied in insurance web applications, financial platforms, and other applications with restricted access to real end users. The proposed testing methodology can be relevant for UX analysts, QA engineers, designers, developers, and software development teams, providing a balanced evaluation with both quantitative and qualitative metrics.

A limitation of the study is the analysis of a single interface version. Validation of the proposed improvements through re-testing may be considered in the future.

7. Conclusion

An analysis of usability evaluation methods for web-based insurance applications was conducted. As a result, two main types of usability evaluation were identified as subjective, which used a questionnaire that cover key aspects of UX for the interface, and objective, which used a moderated real-time testing. Key usability metrics were identified for each type of usability evaluation. That made it possible to enable the identification of interface elements that cause UX problems and subsequently design objective test scenarios to check performance metrics of user interaction with the interface. Unlike some publications, which focus only on the one type usability evaluation, this study focuses on combined usability testing approach that is less researched.

The ability to use physical proxy users for usability testing of insurance web-based application was analyzed due to the insurance company security policies and

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GDRP restrictions. It was found that test participants could be divided into two groups to provide subjective (36 participants) and objective evaluation (8 participants) of Maklerrechner interface. GCI value for both Tarifrechner and Maklerrechner interfaces was higher than 1.90 out of 3, which demonstrated that proposed usability testing methodology can be successfully applied in the context of moderate competence.

The proposed testing methodology includes sequential stages as respondent selection, preliminary analysis, subjective stage, objective stage and integration stage. This approach made it possible to compare obtained subjective and objective results of usability evaluation between each other using normalization of values.

The integral usability index allows to evaluate overall level of usability of the interface. Simple linear model of integral usability index ensures and regulate the contribution of objective and subjective metrics into UX. The proposed combined usability testing approach found a discrepancy $(\Delta = 0.154)$ between objective and subjective evaluation, which shows their inconsistency. The range of integral usability index $(\Delta UI \approx 0.061)$ indicates moderate sensitivity to the parameter λ, which confirms proposed testing methodology reliability. Objective metrics received lower values comparing to subjective ones, which shows the presence of hidden usability efficiency issues despite an overall positive perception of the interface. As a balanced solution, the $\lambda = 0.5$ value was set, which enables equal contribution from both types of metrics and reduces evaluation bias.

The use of proxy users allows the proposed usability testing methodology to be applied even in cases where real end users are unavailable, which makes it suitable for systems with limited data access (e.g., insurance applications). The proposed methodology combines quantitative and qualitative usability metrics and provides a versatile and effective tool for usability assessment.

Conflict of Interest

The authors declare that they have no conflict of interest regarding this study, including financial, personal, authorship, or other, that could influence the study and its results presented in this article.

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Data Availability

Data are available from the authors upon reasonable request.

Use of Artificial Intelligence

The authors confirms that they did not use artificial intelligence technologies in the creation of the this work.

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ТЕСТУВАННЯ ЮЗАБІЛІТІ СТРАХОВИХ ВЕБСАЙТІВ ЗА ДОПОМОГОЮ ПРОКСІ-КОРИСТУВАЧІВ

Предметом дослідження є оцінювання зручності застосування цифрових страхових вебкалькуляторів за допомогою проксі-користувачів. **Мета роботи** – розроблення й експериментальна перевірка комбінованої методики тестування юзабіліті страхових вебсайтів за допомогою проксі-користувачів. З огляду на окреслену мету необхідно виконати такі **завдання**: визначити набір метрик зручності використання; розробити процедуру тестування зручності застосування за участю проксі-користувачів; оцінити зручність використання вебсайту страхового калькулятора за допомогою запропонованого підходу; проаналізувати виявлені дефекти зручності використання; оцінити переваги й недоліки запропонованого підходу. **Методи дослідження.** У роботі запропоновано комбіновану методику юзабіліті тестування, яка поєднує кількісні та якісні показники юзабіліті. Застосовано математичне моделювання, нормалізацію та агрегацію метрик юзабіліті, експериментальне оцінювання на основі сценаріїв користувачів, порівняльний аналіз і аналіз чутливості. **Результати роботи.** Дослідження підтвердило доцільність застосування комбінованої методики тестування, оскільки кількісні та якісні показники роблять незалежний внесок в інтегральну оцінку юзабіліті. Результати тестування виявили, що об'єктивні показники інтерфейсу страхового калькулятора є нижчими за суб'єктивні, що підтверджує наявність прихованих проблем ефективності

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взаємодії за умови загального позитивного сприйняття інтерфейсу. Розмах інтегрального індексу $(\Delta UI \approx 0.061)$ підтверджує надійність методики. **Висновки.** Запропонована методика комбінованого юзабіліті тестування дає змогу виявляти приховані проблеми ефективності взаємодії з інтерфейсом. Методика може бути застосована навіть у разі, якщо реальні користувачі недоступні для тестування. Це робить її придатною для систем з обмеженим доступом до даних.

Ключові слова: юзабіліті; тестування програмного забезпечення; досвід користувачів; вебдизайн; страховий вебсайт; метрики досвіду користувачів; проксі-користувачі.

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