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Still Searching or Have You Found It Already? – Usability and Web Design of an Educational Website

Julia Lamberz, Thorsten Litfin, Özlem Teckert, Gunther Meeh-Bunse
University of Applied Sciences Osnabrueck, Faculty of Management, Culture and Technology (Lingen Campus), Lingen, Germany

Abstract

Background: Apart from a straight-forward and intuitive operability an appealing design determines the success of a website equally well. For this reason, the selection of images and navigation bars plays a determining role. The eye tracking method proved to be appropriate in order to verify the usability of websites. **Objectives:** The aim of the study was to improve the usability of the website of an educational institute for trainees as target group. **Methods/Approach:** For this purpose, the use of an eye-tracking technology was combined with a survey. The eye-tracking study was implemented task-oriented. Test persons were asked to search for particular courses within this institute. **Results:** This approach in combination with a subsequent questionnaire resulted in tangible indications of search patterns of the test group. Furthermore, their perception and their appraisal of the usability as well as the web design was analysed. Even though most tasks were accomplished effectively and efficiently with a positive user feedback, a potential for improvement was detected, in particular with regard to the images and the location of the search field. **Conclusions:** The selected choice of methods enables researchers and web designers to derive recommendations for the orientation, structure, optimisation and comprehensibility of a website.

Keywords: eye-tracking, usability evaluation, website usability, web design, images, perception
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Introduction

Ideally, the design of a website should be geared to the user requirements of its specific target group. In practise, however, website user often have to struggle with misinterpretative menus, hidden information and complicated ordering procedures (Vogt, 2002). In order to support the search process both a target group oriented

structure and images are helpful, especially, if goods and services are presented and distributed (Küster et al., 2011). Images not only attract attention but also have the potential to provide orientation during the search process (Riegelsberger et al., 2003). Moreover, images are processed with little cognitive effort and evoke direct affective reactions in form of emotions (Kroeber-Riel, 1996). In addition, images are processed faster than text during a search effort. Furthermore, together with the related text they ideally aggregate into a conceptual association. If an image shows little complexity, users recognise the theme within 20ms (Madigan, 2014). Other studies demonstrate that images with medium complexity are recognised after one to two seconds. However, images that display inconsistent content may trigger confusion and disorientation among users. This also applies to websites with too many images.

Already in the 1990s Nielsen realised the significant prominence of usability for the development of websites. He defined the criteria: effectiveness, efficiency, and user satisfaction as determining factors for usability. In doing so, he describes the effect of websites with little usability as following: "Usability rules the Web. Simply stated, if the customer can´t find a product, then he or she will not buy it." (Nielsen, 2000). Furthermore, he emphasizes the relevance of a user-friendly web presence that should be tailored to the demand of a particular target group. The success of a website depends on the requirements of their customers. In addition, web designers must consider the dependency of the usability on the task list of the users (Shackel, 2009). For this reason, a task-oriented analysis enables the identification of sales patterns and, if appropriate, of usability problems. This should be accomplished in a way that users including their requirements, expectations and desires are the focus of a usability evaluation of a website (Ehmke et al., 2007, Mich et al., 2003).

The objective of this empirical study is examining the usability of the website of an educational establishment including their main target group, "trainees". The focus was on the analysis of three different search procedures. For this reason, a task-based eye-tracking study was combined with a subsequent questionnaire. The goal of the eye-tracking study was to identify usability problems in terms of their effectiveness, efficiency and user satisfaction. For this reason the duration of each search request and the scan path of subjects on the initial website "courses offered" were analysed, followed by a computer-based questionnaire. Therefore, the results of the duration measurements were compared to the results of the questionnaire.

Our study provides a variety of contributions for further research: firstly, our research aims at analysing the usability of a website focussed on specified target groups. Although numerous usability studies examine websites applying eye-tracking approaches, the focus is in many cases on recognition and evaluation of the search process, in order to appraise its efficiency and effectiveness (Jacob et al., 2003). However, in our study we combine the eye-tracking approach with a survey in order to analyse the usability of a website in terms of its effectiveness, efficiency, contentness and web design simultaneously. Only the comparison of both approaches delivers sufficient results. Secondly, our study has the potential to serve as a companion for future web usability studies. The reason is the application of a generic methodological design including typical metrics for eye-tracking methods (Ehmke et al., 2007, Jacob et al., 2003). Moreover, a task-based analysis of a website suitable for educational institutes is envisaged. In this way valuable findings for the web design of providers from the education sector for the specific target group 'trainees' are expected.

In order to achieve this objective the article is divided into six different sections: following the introduction a literature review provides an overview of the state of the

art of usability and web usability studies. Research questions are derived based upon this review. Especially, the opportunity of eye-tracking in general and web usability research in particular are discussed in this article. In this way criteria and methods for the evaluation of websites are derived and provided. This is followed by the presentation of the research methodology where the sample description and research instruments are presented. In the fourth part of the paper, research data analyses and main findings are provided. These results are analysed and discussed both from a theoretical and an applied perspective. In the final section limitations of the study together with future research opportunities and implications are explicated and discussed.

Literature Review

Usability und Web-Usability

The literature provides numerous definitions for usability, invariably related to the usability of software systems. Usability is generally classified by means of various parameters defining the user-friendliness of software systems as a quality criterion (Speicher, 2015). Hereby, the international and widespread Norm EN ISO 9241-11 is applicable and describes the notion of "usability" in three dimensions (DIN EN ISO 9241-11, 2006):

- Effectiveness in solving problems;
- Efficiency in system handling;
- User satisfaction in relation to the software.

Effectiveness means a user achieves his or her goal entirely and accurately. Furthermore, a user is efficient if he or she reaches his or her goal with little effort. If these goals are achieved, then the user is not impaired during his or her activities and he or she is satisfied (Schweibenz et al., 2003). On the one hand the definition of DIN ISO 9241-11 assigns usability criteria to the software system (efficiency of operation) and the user (user satisfaction), respectively. On the other hand, the definition includes task fulfilment in an efficient way which is the responsibility of the user. All important aspects of the usability of websites are included in this definition. For this reason, the three criteria of the ISO norm served as the basis for this eye-tracking study.

Yet, the question arises: what are the implications for the usability of web pages (subsequently referred to as 'web usability')? Numerous studies conclude that web usability and, at the same time, user satisfaction depend on the following points:

1) Display of information and images according to the target-groups;
2) Instant allocation of information and comprehensibility of the web content (McCarthy et al., 2004, Schweibenz et al., 2003).

Eye-Tracking

The analysis of scan paths with the eye-tracking approach is motivated in particular by the eye-mind hypothesis. According to the eye-mind hypothesis humans exclusively process visible information. For this reason, the assumption is made that scan paths are closely related to human-cognitive processes (Just et al., 1976).

The eye-mind hypothesis fosters the application of the eye-tracking approach for a scan path analysis. Scan paths can be assigned to patterns. In an early study Yarbus (1967) detected that fixation patterns and fixation intensity both depend on the task assigned to the test person. In follow-up studies, scan path patterns based upon tasks such as "please, obtain an overview of this announcement" where compared to closed questionnaires, and subsequently analysed. The results confirm

the phenomenon that open-ended questionnaires result in a variety of scan path data that do not accumulate any pattern. In contrary, closed questionnaires enable the test person to control his or her attention as well as the selection processes. For this reason, results can be easier analysed and compared because of the accumulation of fixation processes of single elements such as images or navigation bars within particular areas (Bucher et al., 2006, Jacob et al., 2003). However, the degree of attention for images and other graphical elements recognized is not measurable, which characterizes the limits of the eye-tracking method (Bucher et al, 2006).

From a technical point of view, eye-tracking measures the individual scan paths of subjects. In doing so, a user looks at a stimulus. The retention time of an eye on a particular point is indicated by a visual fixation. A fixation is defined by a length of 150 to 300ms (Leven, 2013). Volckmann et al. (2006) ascertained that the fixation duration influences the attention and information uptake of a user. A longer fixation duration implies more attention and a longer time period for the information uptake of a user. The duration of a fixation within a particular location can be visualized with so-called heat maps. In this way, the elements with the longest fixation duration are indicated with red and elements with the shortest fixation duration with green. While looking at a stimulus, eyes do not focus on a single position for an extended time. Rather, they jump back and forth within a short period of time. These visual jumps among fixation locations are called 'sakkade'. These sakkades help users to orient themselves within a website. Hence, conclusions may be drawn about guidance devices in a website (Ehmke et al., 2007). Equipment for scan path recording determines the ocular alignment of a subject with the support of an infrared camera. In this way, gazing (looks) can be recorded and analysed. Contemporary technical equipment and the most recent image processing software enable scientists to video-record gazing in real time (Duchowski, 2007).

Web-Usability in Eye-Tracking Studies

The methodology of eye-tracking has been established as a support for web usability tests. Numerous studies demonstrate that various eye-tracking approaches such as time to first fixation on target, fixation duration and fixation length help to identify web usability problems (Ehmke et al., 2007).

A literature study of Jacob et al. (2003) summarises 21 usability studies that analyse usability problems employing eye-tracking systems. In these studies the metrics of eye-tracking were directly linked to usability problems. Byrne et al. (1999), Goldberg et al. (1999) und Cowen et al. (2001) conducted the first task-based studies. The authors linked the number of fixations with the task duration. In a follow-up study Goldberg et al. (2002) applied eye-tracking methods in order to identify search patterns on various websites. They discovered a general tendency towards horizontal instead of vertical search. Even conspicuous headings did not violate that rule. While analysing web designs McCarthy et al. (2004) examined the magnitude of impact of navigation bars on the search behaviour on various websites. The results demonstrate that users are capable of adapting a new website architecture instantly, while the position of navigation bars has little influence on the duration of task accomplishment (McCarthy et al., 2004). All studies illustrate that the determining factors for the recognition and the assessment of a search process are 1) efficiency (the duration until goal achievement) and 2) effectiveness (flawless and complete goal achievement).

In order to detect how users perceive, comprehend and interpret fixated pictures and information, measured values (measured by technical equipment) must be

supplemented by survey-data (Cooke, 2006). These surveys might include questions about the perception and assessment of websites in order to detect the level of satisfaction.

Methodology

The objective of the eye-tracking study was to analyse the web design and the usability of the website of the educational institute "Bildungswerk Grafschafter Wirtschaft" (www.bildungswerk-grafschaft.de), (Lamberz et al., 2017). In particular, the search procedures were inspected. At first, it was analysed how the search procedure for events offered by the association was perceived and applied. To this end, specific tasks were formulated for selected target groups. Subsequently, goal achievement (effectiveness), duration (efficiency) and user satisfaction were identified. In addition, the influence of website images on the search procedure was analysed. For this reason, the following questions were pivotal for the empirical research:

- *Effectiveness:* was the search process finalized successfully?
- *Efficiency:* was the search process finalized quickly and straight-forwardly?
- *Satisfaction:* was the search process perceived as convenient and structured?
- *Web design:* did the available images influence the search procedure?

Effectiveness and efficiency were analysed with the help of eye-tracking approaches. The analysis software of the eye-tracking system was applied to measure the duration of search requests (see table 1 and 2). Furthermore, the same system analysed the scan paths on the landing site and the site "courses offered" in order to interpret both effectiveness and efficiency of the search request (see table 3 and 4). For this reason, so-called areas of interest (AOI) were generated for the horizontal and left navigation bar as well as for the search box. These elements are believed to support search requests. The metric "time to first fixation" provides information about the scan path direction at the beginning of the search process.

In order to allocate the desired courses test persons hit the site "courses offered" (Kursangebot) after a few clicks. This site is endowed with topical images supporting the search for a suitable course. To detect whether images are recognised next to the navigation bar the duration of the metrics "total fixation duration" per AOI were compared (see table 4).

The stationary eye-tracking system, "Tobii X60 – 60 Hz", enabling the actimetry and analysis of individual gaze behaviour, was employed for the documentation of the study. A computer-based questionnaire was applied as a supplementary method to elicit the subjective perception and appraisal of the search process and of the web design. Subjects had to rate this process and the used web design on a Likert scale (see table 5). Yet, the data of gazing duration measurements are compared with responses in the satisfaction survey.

In order to assess the website of the educational institute "Bildungswerkes Grafschafter Wirtschaft", 30 subjects from the main target group, the trainees, were selected. The selection process was entirely random in collaboration with the vocational schools of the region who allowed the selection of the potential subjects during classes. None of the subjects was acquainted with the website prior to the test period of the eye-tracking study. The subjects were asked to undertake a search request for a particular course, where three courses were randomly allocated to the trainees. These courses are typical mandatory classes for trainees intending to undertake further training. They should reflect the three core offerings of the educational work. In the follow-up session, trainees were asked to complete a

computer-based questionnaire in order to identify their satisfaction with the website while undertaking typical tasks.

Table 1
Tasks of an eye-tracking exercise

Nb.	Task/search request	# of subjects	Measured value
1	Course: "Industrial clerks – preparation for final exams"	10	Duration from landing page to target site
2	Course: "English for commercial trainees"	12	Duration from landing page to target site
3	Course: "Contemporary etiquettes in the professional environment and day-to- day life for trainees, 2017"	8	Duration from landing page to target site

Note: number of subjects per search request
Source: Authors' work

Results

The applied methodology was successful in terms of reconstructing and analysing the search and browsing behaviour of the participants. All participants used the navigation boards of the landing page as a reference after a short orientation. This means the search behaviour may be referred to as targeted.

Figure 1
Comparison of the landing page and heat map for the search request "etiquettes"

Note: Absolute duration is calculated by the duration of fixations, whereas the warmest colour represents the highest value.
Source: Authors' work

In order to verify the *effectiveness* of search behaviour the scientists examined how many subjects were able to fulfil their tasks successfully. As a result, 27 out of 30 subjects were able to successfully finalize the search process (see table 2). This complies with a 90% success rate. Three subjects did not find the course "etiquettes". A reason for this might be the fact that this course was not explicitly listed in the submenu of the top navigation bar as in the case of the other courses offered. In this way, an indication for locating that course was missing. In addition, the search box was not prominently located in the upper left corner of the site and less colourful with the consequence that none of the eight subjects who registered for the course "etiquettes" recognized the search box (see table 3). In the beginning of the search process, courses were searched for using two distinct paths on the landing page. The analysis of the gaze plots revealed that after a short orientation phase the first view landed either on the horizontal or the left navigation bar. The heat map (figure 1)

displays the intensity with which subjects looked at particular elements of the website. The analysis of this gazing behaviour supported the results of the gaze plot. Both display a clear concentration of views on both of the navigation bars.

Table 2
Duration of the search request and number of search interruptions

Duration in seconds	**Task 1: Industrial clerks**	**Task 2: English**	**Task 3: Manners**	**All**
Minimum	25.09	12.55	37.64	12.55
Maximum	112.21	82.94	47.16	112.21
Mean	64.02	40.22	43.54	49.65
SD	29.28	19.53	3.82	24.25
Cancellation	0	0	3	3

Source: Authors' work

The *efficiency* analysis requires the duration of task fulfilment (table 2). The average duration of each of the accomplished tasks was 49.7 seconds. Whereas three subjects were not able to find the course, the other subjects accomplished task 3 ("manners") surprisingly quickly in 43.5 seconds. Task 1 ("industrial clerk") was accomplished in the relatively slow time of 64.0 sec. This may be attributed to the individual queries during the exercise.

Table 3
Time to first fixation: navigation bars (left/horizontal), search field and image per task

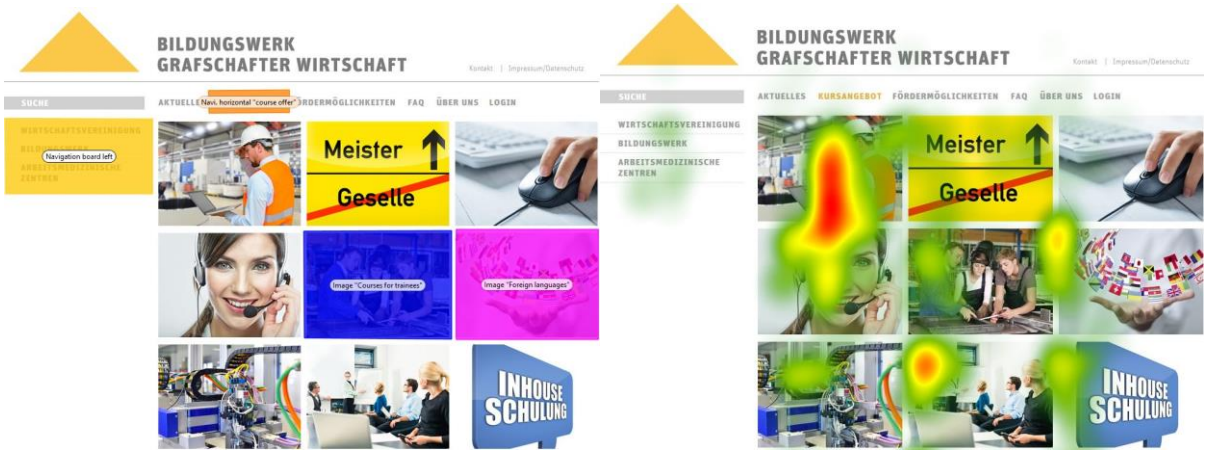
Time to first fixation (in sec.)	**Task 1: Industrial clerks**		**Task 2: English**		**Task 3: Manners**		**All**	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Navigation board left "general information"	1.99	2.79	2.17	2.36	3.72	3.41	2.27	2.62
Navigation board horizontal "Courses offered"	6.29	15.20	0.96	0.73	0.52	0.06	2.75	9.02
Search field top left	41.51	37.05	21.63	29.28	n.a.	n.a.	28.26	29.90
Central Image "Courses offered"	3.57	4.30	11.18	16.10	21.58	25.53	9.89	15.12

Note: Duration in seconds "time to first fixation to AOI" of the landing page
Source: Authors' work

The detailed analysis of scan paths in relationship to the previously defined AOIs on the landing page demonstrates that the time to first fixation of 2.3 sec is the lowest (table 3). However, the navigation box only contains general information about the school. No information about the task of finding a particular course offer can be found. The link "course offerings" is located in the horizontal navigation bar. However, this bar is recognized on average 0.5 seconds later than the left navigation box. It is remarkable that the time to first fixation in task 2 "English" and task 3 "etiquettes" is lowest (< 1sec) on the horizontal bar and other AOIs. Here, relevant information for the solution of the task was quickly identified. However, the search field was only recognized by six subjects after an average time of 28.3 seconds. In

addition, the Image "Kursangebot" (courses offered) in the centre of the site was recognized after 9.9 sec in average, which is relatively slow. An explanation might be the fast orientation of trainees with the navigation bar on this site.

Figure 2
Areas of Interest (AOIs) (left) und heat map (right) of the site "Kursangebot" (courses offered)



Note: left: representation of the three AOIs, right: absolute duration is calculated by the duration of fixations, whereas the warmest colour represents the highest value.
Source: Authors' work

Table 4
Total fixation duration: image "foreign languages", image "courses for trainees", navigation bar horizontal "courses offered" per task

Total fixation duration (in sec.)	**Image** "foreign languages"		**Image** "Seminars for trainees"		**Navigation horizontal** "Course offer"		**Navigation board left** "general information"	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Task 1: Industrial clerks	0.58	0.64	0.76	0.50	-	-	0.64	1.28
Task 2: English	0.76	0.50	1.04	0.52	0.16	0.04	0.48	1.45
Task 3: Manners	0.87	0.43	2.25	1.88	0.63	-	0.67	0.67
All	0.85	0.60	1.40	1.22	0.32	0.28	0.47	3.40

Note: Duration in seconds "Total fixation duration to AOI" of the site "courses offered"
Source: Authors' work

On the site „Kursangebot" (courses offered) the scan path analysis within the AOIs demonstrates that images are fixated with more attention than the navigation bars (see also table 4). The trainees oriented quickly on this site as well. The metric "total fixation duration" displays that looks did not remain on particular images nor on navigation bars for a long period of time (see also table 2). The image "Seminare für Auszubildende" (courses for trainees) were observed with an average duration of 1.40sec, and that was the longest time. Whereas, the horizontal navigation bar was observed by only six trainees with an average duration of 0.3sec. The heat map

(figure 2) confirms the results and demonstrates that looks prevailingly focus on images. Both of the navigation bars were fixated briefly or they were omitted.

The results of the duration to first fixation were compared to the results of the questionnaire in order to assess the *satisfaction* with the search process. The subjects evaluated the search requests as fast, straightforward and supportive for the navigation process. On the whole, the subjects were satisfied since they were able to accomplish the task effectively and efficiently. Only the search field was slightly difficult to find from the point of view of the subjects. The assessments of the subjects was consistent with the results of the eye-tracking exercise.

In comparison to the navigation bars the images on the site "Kursangebot" (courses offered) were fixated with a longer duration. The interpretation of the perception of images resulted in the observation that trainees disliked some of the images. For this reason, the *web design* must be revised in order to improve the topical relevance in relationship to the content linked. Furthermore, the target group had no desire to increase the number of images and videos. In total, the trainees were satisfied with the websites, and the layout was rated as clearly structured. These results confirm the short duration of task fulfilment as analysed by the eye-tracking approach.

Table 5
Evaluation of the perception of search requests and the web design

Questions	**All**	
	Mean	SD
Search requests		
The path was clearly recognizable	2.07	0.83
I was able to orient myself quickly	1.67	0.96
The menu is clearly structured	1.62	0.78
The design is well arranged	1.87	0.73
I perceive the navigation as structured	1.87	0.78
I was able to find the search field instantly	2.70	1.59
Information browsing is time-consuming	4.00	1.02
Information browsing is complicated	4.00	1.02
Web design		
I enjoyed the visual appearance of the website	2.06	0.63
The layout of the site is clearly structured	1.09	0.84
I like the images on the website	2.53	1.30
I want more images and videos on the website	3.50	1.13

Note: Likert scale where 1 = totally agree, 5 = totally disagree
Source: Authors' work

Discussion

The combined eye-tracking/survey study provides insights into the usability of the website of the educational institute "Bildungswerk Grafschafter Wirtschaft". The study revealed that measured durations of search requests cannot be viewed in isolation. Only after combining the analysis of scan paths on the landing page and the site "courses offered" with a subsequent questionnaire an indication for an instant orientation of the trainees on the website was found. The difficulties in orientation are due to the search field arrangement. Notwithstanding this the target group is content with the search process and the web design. The search field on the landing page should be highlighted in a better way, and not placed in the upper left corner. As in the case of many other websites the placement of the search field should be above the horizontal navigation bar.

Images on the site "Kursangebot" (courses offered) were fixated longer in comparison to the navigation bar. Moreover, these images yielded a high degree of attention. The images support the message of the content linked, which enables the user to assign topics instantly, and this way enhance the search procedure.

In addition, the search behaviour of trainees shows specific patterns confirming the importance of navigation bars, images and the designation of menu items. For this reason, important objects must be conform to a logical structure and include intuitive key terms. The combined eye-tracking/questionnaire approach confirmed the results: the specific search requests were accomplished in an effective and efficient way for the most part, whereby subjects were satisfied. The implementation of suggestions for improvement may help to optimise the usability and the web design for the related target group.

Conclusion

This study of a combined eye-tracking and survey approach demonstrates the validity of this methodology for the analysis of the usability of an educational establishment including their main target group, 'trainees'.

A unilateral focus of the usability analysis in terms of effectiveness and efficiency – as demonstrated in other studies – is thus not suitable. In addition, a holistic analysis of usability including the factors contentness and web design delivers meaningful results.

The results of this eye-tracking study may serve as a basis for further studies of this kind. For example, eye-tracking metrics can be applied in order to improve the analysis of the search process, and develop recommendations for an appropriate web design aimed at specific target groups (Ehmke et al., 2007, Jacob et al., 2003). The search behaviour can be supported by a logical structure of navigation bars and menu items as well as a positioning of the search box at an accustomed place, above the horizontal navigation bar. A number of key concepts support an instant orientation. Moreover, illustrations suited to the content have a positive influence on the search process and in this way on the contentness of the users.

However, a number of limitations should be taken into consideration when applying this approach: in particular, the number of assignments, types and numbers of subjects as well as the integration of the "back buttons" into the analysis must be factored in. This study merely developed one specific task and verified it. Future studies must request more assignments in order to depict the variety of requirements for the websites better. In addition, the entirety of relevant target groups of the related websites must participate in future studies to capture multiple necessities and requests of users. This approach has the potential to provide further results of relevance for web usability problems (Goldberg et al., 2002). Moreover, the application of "back buttons" and the analyses of sources of errors hampering the search procedure must be taken into consideration (Lee et al., 2010).

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About the authors

Julia Lamberz is currently a Research Assistant at Osnabrueck University of Applied Sciences with a focus on marketing research. She received her Master's degree in Science Marketing from the Technische Universität Berlin. She can be contacted at **j.lamberz@hs-osnabrueck.de**

Thorsten Litfin is a Professor of Marketing, Service and Innovation Management at the University of Applied Sciences at Osnabrueck. He received his PhD from the Institute of Innovation Management at Christian-Albrechts-University of Kiel. His research interests include product and pricing strategies for innovative products and services. He can be contacted at: **t.litfin@hs-osnabrueck.de**

Özlem Teckert is currently a Research Assistant at Osnabrueck University of Applied Sciences with a focus on marketing research. She received her Master's degree in Economics and Laws from the University of Oldenburg and is currently a PhD candidate in the Department of Business Administration, Economics, and Law. She can be contacted at: **o.teckert@hs-osnabrueck.de**

Gunter Meeh-Bunse is a Professor of Finance and Accounting at the University of Applied Sciences at Osnabrueck. He studied business administration at the University of Saarland and received his PhD from the University of German Armed Forces in Munich. His research interests include managerial accounting and corporate social responsibility. He can be contacted at: **g.meeh-bunse@hs-osnabrueck.de**