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User Experience Design with Augmented Reality (AR)

Stefan Stumpp, Tobias Knopf and Daniel Michelis

Anhalt University of Applied Sciences, Bernburg, Germany

stefan.stumpp@hs-anhalt.de

tobias.knopf@hs-anhalt.de

daniel.Michelis@hs-anhalt.de

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Abstract: The paper examines the influence of augmented reality (AR) technology on the user experience, comparing the IKEA Place AR App with the IKEA website. The International Organization for Standardization (2010) defines user experience as a “person's perceptions and responses resulting from the use and/or anticipated use of a product, system or service” and thus describes a person’s quantification of satisfaction with a company’s digital touchpoint. AR is a technology that overlays information or interactive elements on top of the user’s physical environment. The technology is increasingly being used in an economic context and changes the user’s brand experience, as we demonstrate in our IKEA research case. User experiences at digital touchpoints are a decisive success criterion for brands like IKEA, due to their influence on the image of the company and its products. IKEA, therefore, focuses on touchpoint innovations such as the IKEA Place AR App. Taking this development into account, the research question of our study was: “How does the user experience differ when using an AR App as a substitute for the use of a web application?” To answer this question, we conducted experimental A/B testing with two groups of 28 persons each: one group used an AR touchpoint (IKEA Place App) to make product decisions and the other group used a conventional touchpoint (IKEA website) for the same task. After testing, the participants' user experience with the respective touchpoint was recorded using the User Experience Questionnaire (UEQ) (Laugwitz, Held and Schrepp, 2008; Schrepp, Hinderks and Thomaschewski, 2017). Results showed that the innovative IKEA Place App touchpoint could deliver a better user experience than the IKEA website. The App scored stronger in the user experience dimensions “Stimulation” and “Novelty”. The results illustrate the importance of innovative digital touchpoints and reflect practical recommendations for their design and thus to improve the brand experience of companies.

Keywords: Augmented Reality, User Experience, Brand Touchpoints, IKEA

1. Introduction and Motivation

The digitization of society provides new opportunities and challenges for brand management (Mauroner and Best, 2016). The design of user experiences at innovative brand touchpoints thus plays a central role in the brand strategy of companies (Rauschnabel, Felix and Hinsch, 2019). New technologies that use virtual reality or augmented reality (AR) create new ways for brands to allow contact with consumers. Whether AR games such as Nintendo's Pokémon GO (Butcher and Raynes-Goldie, 2018; Zsila et al, 2018; Rauschnabel, Rossmann and Tom Dieck, 2017), drive assistance by Jaguar or a magic mirror by Uniqlo that combines AR and gesture interfaces (Cacho-Elizondo et al, 2018, p. 100) – brand leaders have recognized the potential and are trying to integrate the new technologies into their brand strategy.

A pioneer in the integration of innovative brand touchpoints is the multinational furnishing company IKEA. The brand is experimenting with virtual reality kitchen (IKEA Communications AB 2016) and a virtual reality showroom in the IKEA furniture store Berlin-Lichtenberg (Demodern, 2016). In the field of AR, the brand is offering the IKEA Place App. With this application, furniture from the IKEA catalogue can be freely placed at home on the customers’ smartphone or tablet (Inter IKEA Systems B.V., 2017).

Efforts by corporate brands like IKEA, which offer consumers new and innovative brand touchpoints, are relevant, if there is an impact on the brand and the company's success. However, the question arises whether innovative brand touchpoints can create a better user experience, which will then have an influence on the perception of the brand by potential consumers. Even with proof of this influence, companies face the challenge of innovating and adapting touchpoints in line with the brand. This research is building on existing scientific literature to evaluate user experiences at brand touchpoints. Primarily, work exists here under the term “user experience” (cf. among others Hassenzahl and Tractinsky, 2006). The combination of both topics is becoming increasingly important (Scholz and Duffy, 2018; Gonzalez et al, 2016, p. 112). It has been observed in the study of Modak and Sinha (2019) that with the use of AR marketers are able to better demonstrate the product and consumers are able to evaluate the product better.



Figure 1: Instructions for the IKEA Place App (Screenshot from Inter IKEA Systems B.V., 2017)

It is the aim of this paper to evaluate whether innovative brand touchpoints can improve user experience using the innovative AR IKEA Place App. Furthermore, the purpose of this work is to establish a research design that can be a basis for a more extensive investigation of the research object, and to gain insights that justify a more intensive analysis of the topic.

In the first part of this paper, the theoretical framework is presented. Relevant theoretical constructs and the presentation of connections to the topics AR, brand touchpoints and user experiences are presented. The empirical part provides information about the derivation of the case study approach. First, hypotheses are derived from the theoretical considerations and the objectives of the work. These are used to model the empirical investigation. Next, the User Experience Questionnaire (UEQ) is used to answer the derived hypotheses. The results obtained are then presented, evaluated and interpreted. Finally, the results achieved are summarised, implications for research and practice are derived and proposals for ongoing research are given.

2. Theoretical Background and Hypothesis development

2.1 Augmented Reality

In their Reality-Virtuality (RV) Continuum Milgram and Kishino (1994) define Mixed Reality as a mixture of the real and virtual world represented on a display. In the context of Mixed Reality, they refer to AR “any case in which an otherwise real environment is augmented by means of virtual (computer graphic) objects”. Azuma (1997) takes up these remarks and defines them more comprehensively: “Augmented Reality (AR) is a

variation of Virtual Environments (VE), or Virtual Reality as it is more commonly called. VE technologies completely immerse a user inside a synthetic environment. While immersed, the user cannot see the real world around him. In contrast, AR allows the user to see the real world, with virtual objects superimposed upon or composited with the real world" (Azuma 1997, p. 2). Four years later, Azuma (2001, p. 34) stated that AR "combines real and virtual objects in a real environment; runs interactively, and in real time; and registers (aligns) real and virtual objects with each other". This is a widely accepted definition which is also used in current papers (Javornik, 2016, p. 5). Billinghamurst, Clark and Lee (2015, p. 84) recommend considering taxonomies such as Milgram's Mixed Reality continuum to fully understand the potential of AR in the broader context.

2.2 Evaluation of brand touchpoints based on user experience

Brand touchpoints are potential points of contact between a brand and its potential customers (Meyer and Schwager, 2007; Baxendale, Macdonald and Wilson, 2015). Interactions between customers and brands take place here. The coordination of touchpoints is essential to create a consistent brand experience ("Seamless experience" Shankar et al, 2011, p. 33). The brand experience is therefore here reduced to the individual touchpoints at which the user experience of the touchpoint should be congruent with the brand experience (Gonzalez et al, 2016, Spies, 2015, p. 66; van de Sand, 2017, p. 15). User experience is a "person's perceptions and responses resulting from the use and/or anticipated use of a product, system or service" (International Organization for Standardization, 2010). User experience thus describes the perceptions and reactions of a person before, during and after the use of a (digital) touchpoint. In this context, the evaluation of user experience with a brand touchpoint takes place during use through usability evaluation. Usability is defined by ISO 9241-11 as the "extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (International Organization for Standardization, 2018). In order to be able to evaluate individual touchpoints, a usability evaluation is necessary. When analysing the experience with a touchpoint in a larger context, a measurement of the user experience is necessary (Hassenzahl and Tractinsky, 2006; Bevan, 2008). By measuring usability or user experience, it can be deduced whether touchpoints correspond to the usage needs of potential customers. This also makes it possible to compare touchpoints (Laugwitz, Held and Schrepp, 2008).

3. Research Methodology

This study is based on a research design that combines both qualitative and quantitative research methods. The combination of qualitative and quantitative approaches of data collection is also known as mixed methods or multi-method approach (Schreier and Odag, 2010).

The UEQ by Laugwitz, Held and Schrepp (2008) enables the analysis of the entire user experience beyond mere usability. The questionnaire takes into account the feelings, impressions and attitudes of the respondents and creates a format that supports the direct expression of these elements. The scales collect usability aspects (Efficiency, Perspicuity and Dependability) and user experience aspects (Stimulation, Novelty) and thus offer a comprehensive impression of the user experience of brand touchpoints (Schrepp, Hinderks and Thomaschewski, 2017). The UEQ consists of 6 scales. Attractiveness reflects the overall impression of the product and shows whether users like the product. Efficiency shows whether users can solve their tasks without unnecessary effort. Perspicuity indicates whether it is easy to become familiar with the product, i.e. whether it is easy to learn how to use it. Dependability shows whether users can feel control over the interaction. Stimulation shows whether it is exciting and motivating to use the product. Novelty indicates whether the product is innovative and creative and whether the product catches the user's interest.

Attractiveness is a pure liability dimension. Efficiency, Perspicuity and Dependability are aspects of pragmatic quality, while Stimulation and Novelty are aspects of hedonic quality (Laugwitz, Held and Schrepp 2008).

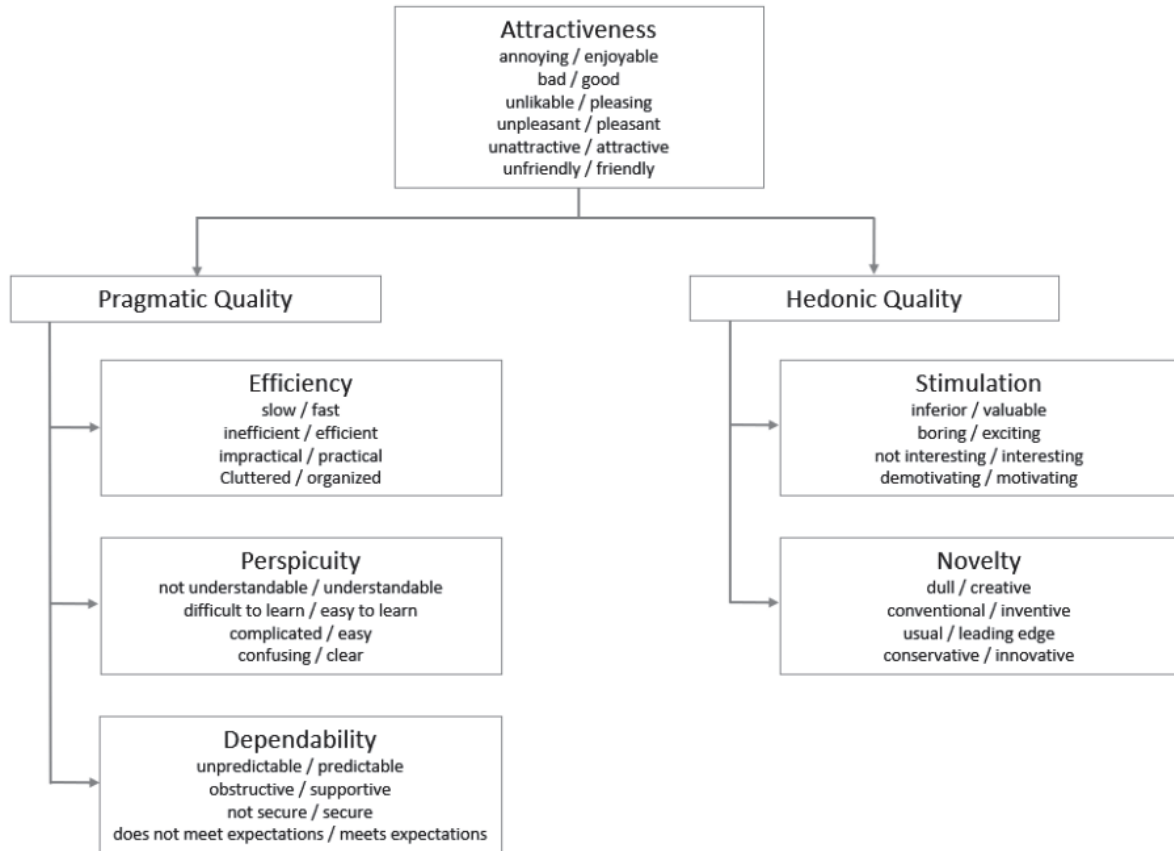


Figure 2: Assumed scale structure of the UEQ (Schrepp, Hinderks and Thomaschewski, 2017)

As figure 2 shows, Laugwitz, Held and Schrepp (2008) evaluate user experience with the dimensions “Attractiveness” (DV1), “Efficiency” (DV2), “Perspicuity” (DV3), “Dependability” (DV4), “Stimulation” (DV5) and “Novelty” (DV6), which are represented by a total of 26 characteristics. The dimensions correspond to the dependent variables which are influenced by the available touchpoint (IV1). In this case, these touchpoints are the IKEA Place App and the IKEA website. The indicators for the dependent variables, i.e. the corresponding dimensions or their characteristics, are given by the evaluation of the user in a semantic differential from -3 to +3. The independent variable, the available touchpoint, is provided to the test persons and can assume the nominal scaled values “IKEA Place App” and “IKEA Website”. Table 1 provides an overview of these considerations.

This research assumes that the user experience will be improved by using the IKEA Place App. The following hypothesis is therefore applied:

Measured mean value of user experience scores higher with the IKEA Place App than with the IKEA Website. This hypothesis must be specified regarding the user experience dimensions in order to determine the influence of the individual dimensions. The resulting hypotheses for the respective dimensions are shown in table 2.

Table 1: Indicator, Manipulator and measurement level (User Experience)

	Dependent variable	Indicator	Measurement level
DV1	Attractiveness	Evaluation of the touchpoint regarding the corresponding dimension	Ordinal scale, symmetric differential from -3 to +3
DV2	Efficiency		

DV3	Perspicuity		
DV4	Dependability		
DV5	Stimulation		
DV6	Novelty		
	Independent variable	Manipulator	Measurement level
IV1	Touchpoint	Choice of touchpoint	Nominal scale, values: "IKEA Place App" and "IKEA Website".

Table 2: User Experience Hypotheses

	Hypotheses
H1	Measured mean value for <i>Attractiveness</i> scores higher with the IKEA Place App than with the IKEA website.
H2	Measured mean value for <i>Efficiency</i> scores higher with the IKEA Place App than with the IKEA website.
H3	Measured mean value for <i>Perspicuity</i> scores higher with the IKEA Place App than with the IKEA website.
H4	Measured mean value for <i>Dependability</i> scores higher with the IKEA Place App than with the IKEA website.
H5	Measured mean value for <i>Stimulation</i> scores higher with the IKEA Place App than with the IKEA website.
H6	Measured mean value for <i>Novelty</i> scores higher with the IKEA Place App than with the IKEA website.

For the experiment an A/B-Testing approach was used. The sample consists of 56 randomly selected students. In groups of four participants each, the test persons were asked to plan the furnishing of a room with four items from IKEA's product portfolio. The corresponding products were to be selected and placed imaginarily in the room. Group A had access to the IKEA Place AR App, which represents the innovative brand touchpoint.

Group B accomplished the same task with the IKEA website. The sample of the IKEA Place App (Group A) consists of 42.9 percent female and 57.1 percent male participants, the sample of the IKEA Website (Group B) consists of 32.1 percent female and 67.9 percent male participants. The average age is 20.6 years for users of Group A and 21.1 years for users of Group B. Both groups were asked to visualize their product decisions on a flipchart. The four objects to be placed were always a couch, an armchair, a table and a floor lamp. There were no monetary limits. The decision-making process for the selection of objects and their placement could be discussed together in the group. The decision for a product and its location was ultimately taken by only one participant at a time, whereby each one could take one product. This ensured that each participant came into direct contact with the touchpoint and their user experience could be determined. There was no time limit for the experiment and no external help for using the touchpoints.

An online survey questionnaire was conducted after the experiment to collect the information needed to proof the hypotheses. The user experiences with the digital brand touchpoints IKEA Place App and the IKEA website were determined by the UEQ. In addition, the respondents had the opportunity to comment on three open-ended questions in their own words about what they liked most and least about the applications and which features they thought were missing. These questions are intended to create a deeper understanding of the test persons' user experience, which may not be reflected by the UEQ.

4. Results and findings

The participants were asked to rate their familiarity with the IKEA brand on a 7-point Likert scale from 1 (not at all familiar) to 7 (very familiar). None of the subjects gave a rating lower than 3, with an average of 5,57. Therefore, it can be assumed that the subjects are familiar with the brand. The respondents were also asked about their purchase intensity of IKEA products. No respondent stated that they had never purchased from

IKEA. 57 percent of the respondents are regular IKEA customers who buy IKEA products at least once every six months. Test persons were randomly selected and therefore could not volunteer for the survey due to their possible IKEA affinity. 11% of the PLACE App group participants had already used the PLACE AR app before the experiment. 71% of the participants of the Web App group had already used the website before the experiment. As there is a notable difference in application knowledge (as seen in figure 3), it should be mentioned, that this could have an impact on measured user experience.

IKEA brand touchpoints used before the experiment

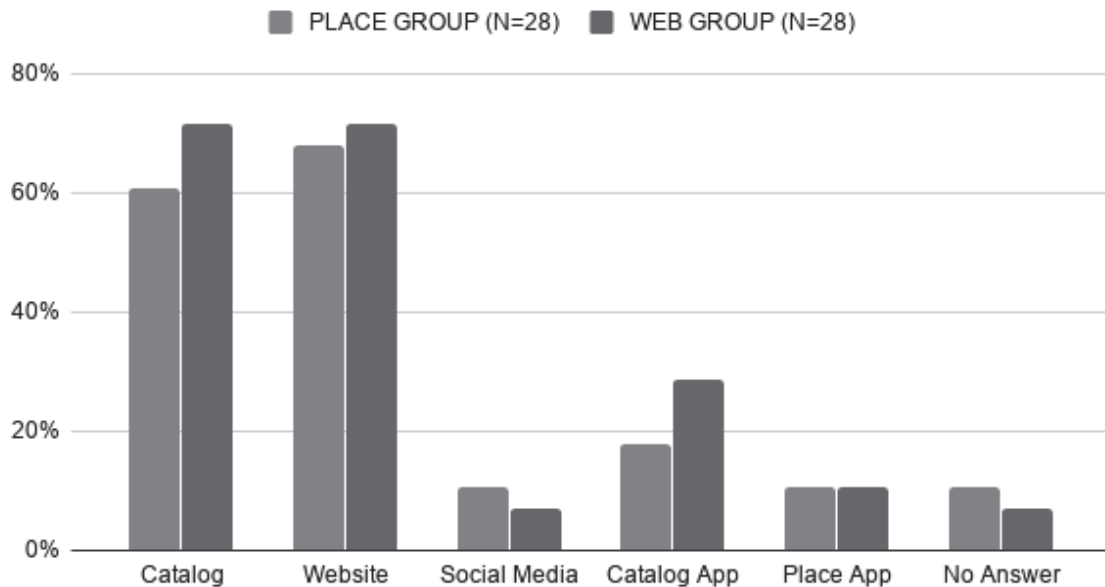


Figure 3: IKEA brand touchpoints used before the experiment

The user experience evaluation results of both touchpoints are shown in table 3. The table shows the mean values of the user experience dimensions recorded by the interviewees about the use of the IKEA Place App and the IKEA website. The IKEA Place App scores higher in every dimension but for Perspicuity and Dependability due to higher mean values.

Table 3: Comparison of Scale Means, standard deviations and confidence intervals

Scale	IKEA Place App						IKEA Website					
	Mean	STD	N	Confidence	Confidence Interval		Mean	STD	N	Confidence	Confidence Interval	
Attractiveness	1.88	0.75	28	0.28	1.60	2.16	1.79	0.70	28	0.26	1.53	2.04
Perspicuity	1.85	0.79	28	0.29	1.55	2.14	1.93	0.89	28	0.33	1.60	2.26
Efficiency	1.40	0.90	28	0.33	1.07	1.73	1.34	0.72	28	0.27	1.07	1.61
Dependability	1.36	0.67	28	0.25	1.11	1.61	1.65	0.61	28	0.23	1.42	1.88
Stimulation	1.89	0.79	28	0.29	1.60	2.19	1.07	0.99	28	0.37	0.70	1.44
Novelty	1.92	0.87	28	0.32	1.60	2.24	0.69	1.30	28	0.48	0.20	1.17

To verify the significance of these results, a Two Sample T-Test assuming unequal variances was carried out. Since a normal distribution cannot be assumed with 100 percent certainty, a Mann-Whitney-U-Test was also carried out (see table 4). This is a nonparametric test that compares two groups even without the assumption of normally distributed data (VassarStats.net, n.d.). The IKEA Place App performs significantly (with both tests)

better in the dimensions of Stimulation and Novelty. This significance is also given by taking into account the Bonferroni correction, a mathematical statistical method that helps to neutralize alpha error cumulation in multiple comparisons.

Table 4: Two sample T-test and Mann-Whitney-U-Test

Scale	Two sample T-Test assuming unequal variances	Mann-Whitney-U-Test				Significant Difference
	Alpha level 0,05	U _A	z	P ₍₁₎	P ₍₂₎	
Attractiveness	0.6236	356	0,58	0,2810	0,5619	No
Perspicuity	0.7228	431	-0,63	0,2643	0,5287	No
Efficiency	0.7748	360	0,52	0,3015	0,6031	No
Dependability	0.0923	484	-1,50	0,0668	0,1336	No
Stimulation	0.0012	203	3,09	0,0010	0,0020	Yes
Novelty	0.0001	165	3,70	0,0001	0,0002	Yes

With reference to the hypotheses formulated in table 2, it can be stated that hypotheses 5 (Stimulation) and 6 (Novelty) are verified while hypotheses 1 to 4 are not. The dimension Stimulation describes whether a user perceives an application as exciting, motivating and interesting. Novelty, on the other hand, describes the degree of innovation and creativity of the application. It can therefore be assumed that the users surveyed in this study rate the IKEA Place App as more exciting, interesting and motivating than the website. In addition, the new application is perceived as more innovative and creative. Furthermore, we can assume that these perceptions also have a direct effect on the perception of the brand. Rauschnabel, Felix and Hinsch (2019, p. 49) also come to similar conclusions that hedonic benefits lead to a change in the brand attitude when using AR.

In open-ended questions, the respondents were given the opportunity to comment on what they liked most and least about the application and what they thought was missing. The IKEA Place App testers particularly praised the novelty of this approach. Some test persons were surprised how realistic the virtual objects in the room looked. The test persons were thrilled “how fast and easy it is to learn the application and plan the room before buying”. Some respondents also critically mentioned that the control system was a little difficult to operate at first, but after those first difficulties the app was very well received. Some test persons also criticized the placement as being too sensitive or for furniture being placed too close together at the beginning. A few test persons also had problems quickly finding the desired object in the furniture categories.

From the points of criticism, the test persons accordingly noticed what they lacked in the application. Some test persons would have liked instructions, easier handling and a catalogue overview. During the placement process, a few respondents would have liked to receive a (coloured) indication if objects did fit.

The IKEA website has been praised for its good structure and clarity, which provides quick access to a lot of product information. The inspiring ideas and the wide range of products were also praised. However, the clarity of the website seems to be questioned by other test persons. For example, some respondent said that they found the clarity poor, that it was not so easy to find some things and that the site was “somewhat overloaded”. Test persons also perceived some products in the wrong category. In the end, some respondents found the page to be “a bit too monotonous”, some respondents wished for clearer pages, better filtered categories and more colour variety. It is noteworthy that some test persons stated that they would like 3D models showing how individual or several pieces of furniture would look in the room. Exactly these wishes are served with the IKEA Place App, which was available to the other group. Some of those test persons did not report any experience with the IKEA Place App.

In the following the observations, which became apparent during the experiment, are described. The test persons gave the impression of having fun with their task. The IKEA Place App test persons showed a high dynamic right from the start of the experiment. They took the tablet and went directly to the room area to be decorated, gathered around the tablet and experimented with the app. However, some users were afraid at first when they were asked to place an object. At first, the respondents to the website were less dynamic. At the beginning of the experiment, they sat on their chairs in a circle and thought about how to proceed. On the

other hand, the individual test persons were less afraid of the tablet when selecting their objects on the website. The existing knowledge about the website minimized the learning effort for most people to complete the task. The test persons of the IKEA Place App left a very satisfied impression after the successful placement of their object. In the groups, opinion leaders crystallized, but their influence was limited by the group instruction that everyone should choose and place one item. The test persons who had the website at their disposal to complete the task were also showed the IKEA Place App after they took the survey. Although they described their experience with the website as positive, their enthusiasm for the IKEA Place App was noticeable. They may have been able to better appreciate the benefits of the IKEA Place App based on their experience with the website.

5. Limitations and Future work

The results of this study reflect the findings of a literature search, an A/B experiment and a quantitative online survey. The methodological diversity made it possible to obtain different qualitative and quantitative findings, but it is a specific challenge to link these results stringently.

A limitation of the present study arises from the fact that only a small number of test persons were used for the experiment and that they were composed exclusively of students, which resulted in a sample selection of users between the ages of 18-30. For further studies it is therefore conceivable to increase the number of participants and their diversity. Also, the study considers the respondents' brand knowledge, but not their technological knowledge. It would therefore be of interest to take this into account and compare it with the available results. Furthermore, we have conducted a case study on IKEA and our empirical findings are related to one specific company context. Therefore, a transfer of the study to other industries and fields of application would be of interest.

The research area dealing with AR technology and its impact on brand user experience is still young and offers room for further research. The predicted growth of the AR industry (IDC, 2018) requires a better understanding of the impact this technology will have. Our recommendations for future research include additional studies addressing customer receptiveness towards AR.

6. Summary and conclusion

The results presented are of both practical and theoretical relevance. The study provides empirical support for measuring the impact of AR applications on user brand experience. Furthermore, the mixed methods approach contributes to a deeper understanding about AR technology. There are indications that the use of innovative touchpoints has a positive influence on the dimensions of Stimulation and Novelty of the user experience.

AR technology has the potential to fundamentally change the retail industry (Spreer and Kallweit, 2014). It offers the opportunity to improve our perception and enrich our environment (Van Krevelen and Poelman, 2007). However, the finding that not all dimensions were rated equally well in comparison to website use is an indication that there is still potential for optimisation in the application. In sum, IKEA Place App today do not seem to influence the customers in the best possible way. In order to further improve AR experience with the IKEA Place App, it is suggested that IKEA should find a balance between different dimensions of the user experience by also improving the dimensions Attractiveness, Perspicuity, Efficiency and Dependability of the application. While the results for this study are particularly connected to IKEA Place and the IKEA website, the findings could also be of interest to companies that are also planning to implement AR technologies to improve brand user experience.

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