Smart Ski Goggles – Development and Business Model Generation of Smart Glasses Applications

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ABSTRACT

The research project Smart Ski Goggles investigated how to enhance visitor experience while skiing on a mountain by delivering real-time information and a navigation system using state-of-the-art data ski goggles (Oakley Airwave). Information about lifts, slopes, weather, hospitality, social media and even navigation (e.g. to huts and lifts) were integrated into a single application allowing users to explore the region according to their interests. Additionally, as the software was developed for a fairly new kind of device with no established app distribution channel, business model scenarios were generated to explore possibilities how to reach marketability for the software together with the data ski goggles. A co-creation approach was used to develop a tailor-made solution right from the end users' needs and requirements.

Author Keywords

smart glasses; wearables; head-worn displays; user experience; user interaction; co-creation; business model

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

One main goal of the project was to investigate an emerging technological solution (smart glasses) with bringing in the user at an experimental stage of a possibly upcoming commercial solution. Another more general goal was to understand the practical usage potential of real-time information displayed in smart glasses and find solutions for technical challenges in a real-world setting. Additionally, for the generation of business model scenarios it was crucial to analyze the stakeholder needs in the ski resort of Schladming/Austria, which was our venue partner in this project. The project took place between October 2013 and May 2014 in the context of EXPERIMEDIA [6], a research project providing a technological framework as well as venues to perform real-world experiments in the field of Future Internet.

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We provide information focused on the three major parts of the project. First, we describe our methodological approach based on co-creation to develop a system displaying real-time information in ski goggles equipped with a micro-display, see Figure 1. We will discuss the results and explain why we think this approach was suitable for such kind of service. Second, we explain the implementation and discuss technical challenges of Smart Ski Goggles and the integration of external services. All below described features were really implemented and are no mockups. Third, we provide information about possible business model scenarios for Smart Ski Goggles.

METHODOLOGY

A four step co-creation approach was being applied to integrate as many as possible potential end users into the conception, implementation and evaluation of this project. Co-creation [3] is based on the principle that the context of the future use of an artefact (e.g. software) is crucial for its success and can best be understood, if people out of the target group are participating in the artefact development. Thus, the goal was to maximize the impact of the proposed technical solutions by continuously involving them in the development process.

Figure 1. Ski goggle with integrated micro-display

All four steps were tightly linked together to gain a maximum of valid insights. In the first step two focus groups were conducted to discuss user requirements, screen designs and interaction concepts. This was the basis for the conception of the Smart Ski Goggles software and the following second co-creation step, a representative online survey. Each of the focus groups consisted of seven participants and lasted for around 120 minutes. All participants were between 19 and 49 years old and were skiing on a regular basis.

Step 2, the online survey should basically answer the questions: 'Which features would you use and when?' and 'How much are you willing to pay to rent or buy a smart ski goggle?' This second step examined the user requirements on a representative level and served as a basis for a detailed target group specification for the following two field tests. We used computer assisted web interviews with a representative (for Austria) sample of 1005 participants. The target sample (people who use smartphones, have downloaded apps and were skiing at least once in the last two years) was 382 people.

In the third co-creation step the focus was set on usability aspects and it was conducted as a field test. These test runs were also used to evaluate whether the implemented features were considered to be as useful as the results of the focus groups and the online survey suggested. The test runs were conducted in Schladming on two days with in total 15 participants. We used the thinking aloud method [1] combined with observation and interviews. The total duration of the test for one participant was around three hours. At the beginning of the test the participants were briefed about the system setup und provided features.

Finally, the fourth co-creation step was focused on user experience (UX) aspects. To get feedback from as many participants as possible we used self-administered digital questionnaires before and after the test run. So the participants had to fill out the questionnaires, from which we could analyze quantitative data. Additionally, short interviews with all participants and one focus group (n=5) were conducted to get more qualitative data. This second field test was conducted in Schladming on five consecutive days in which 54 participants tested the software during a timeframe of two to five hours. To learn more about usage patterns we also logged all user activity.

MAIN FEATURES

The lift waiting time feature was implemented as a list, sorted in a way that the closest lift is on the top position. The lift waiting time is indicated by colored icons (green = no waiting time, yellow = short waiting time, orange = long waiting time), see Figure 2.

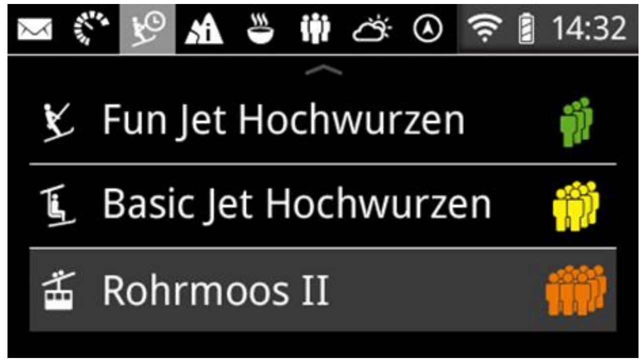

Figure 2. Screenshot of the lift waiting time feature

The navigation feature allowed the users to select a starting point as well as a target point for the navigation, e.g. from a specific lift exit to another specific lift entrance. The resulting route is presented as a list of routing points to be passed, see Figure 3. Additionally, if the user approaches an important point on the slope a photograph with a superimposed arrow will automatically appear to indicate the correct direction, see Figure 4. Actually, the picture consisting of photograph and arrow is pre-produced. In a future version, the arrow could be superimposed on a live video stream (given a future ski goggle would have a camera integrated).

Figure 3. Screenshot of the navigation route list

With the notification feature the service operator has got the possibility to push messages into the application and inform skiers in real-time about important information, e.g. announcing an event or providing a weather warning. One of the most surprising and interesting features derived from the initial focus groups was that above the users speed of 20 kph the screen shows only the speed, time and a notification icon (the latter only if a new notification has arrived). This is to not distract the user while skiing. If a navigation is active only the information for the next route segment is being displayed instead of the speed.

Figure 4. Screenshot of photograph with superimposed arrow to indicate the right direction during navigation

IMPLEMENTATION

The Smart Ski Goggles system consists of three components, see Figure 5. First, the data ski goggle (Oakley Airwave) is defined as the frontend. It is used to display real-time information, which is gathered from the integrated GPS antenna and from the attached smartphone.

The application running on the data ski goggle is referred to as the client app. The Bluetooth-connected smartphone runs the Smart Ski Goggles gateway app. The gateway app is responsible to exchange data between the client application and the third component of the system, the backend server, via a mobile network (e.g. 3G). It uses a custom developed message protocol to request information and receive the related responses as well as a network data caching system in order to counteract mobile network outages or network reception drops. The development of a custom message protocol was necessary to have more flexibility in the way data is exchanged between client and gateway app. In addition, the gateway app implements a prefetching mechanism so that often used data such as lift waiting time indication, and weather service are available in advance.

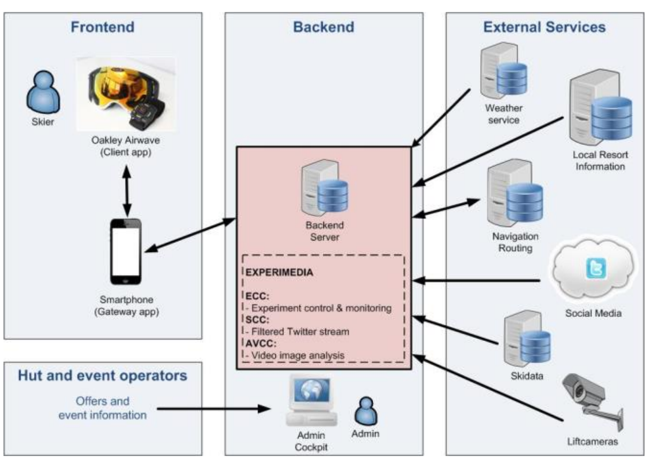

Figure 5. System overview

Using the technological framework of EXPERIMEDIA the Smart Ski Goggles backend processes information from a number of different external data sources such as weather service, resort information service and navigation information provider. In addition, it receives lift utilization statistics from a video analysis component ('AVCC' in Figure 5). These statistics are analyzed and used to provide the lift waiting time indication to the user. Furthermore, the backend also receives turnstile usage information from each lift which is also used for the same reason (not all lifts could be equipped with a video camera) and as backup in case the video analysis is not working, e.g. due to bad weather. Finally, the backend server has got a web frontend which can be used for pushing notifications to the client. The integration of the experiment control & monitoring component (ECC) was meant to provide and analyze Quality of Service (QoS) live data in connection with Quality of Experience (QoE) data from the field test as described in [5]. Due to technical problems based on the simultaneous connection of up to ten participants this approach could not be realized during the field test.

BUSINESS MODEL GENERATION

The basis of our approach is to use the Effectuation method [2] combined with the business model canvas of Osterwalder/Pigneur [4]. This is based on the fact, that there are many uncertainties with new technology like data ski goggles, as e.g. the broader technology acceptance of smart glasses at all is not very well researched so far. Here, a business model in general describes which key resources are necessary to produce a certain value proposition (i.e. the product or service). Furthermore, it describes via which channels this product or service is being offered and distributed to the customer. Finally, it opposes financial costs to expected turnover. For Smart Ski Goggles it was necessary to elaborate different alternative business model scenarios, because there is no substantial market in place so far for data ski goggles. So, it is even more of importance to evaluate different scenarios.

The scenarios we were working on (see Figure 6 for an example) provide alternative approaches from users buying the data ski goggles with the Smart Ski Goggles software pre-installed to the ski resort operators renting the data ski goggles with Smart Ski Goggles software on it to skiers. To work out these scenarios basic data was necessary. This was collected via the online survey (second co-creation step), from which we e.g. learned how much people were willing to pay as a rental fee, in average roughly eleven Euro. For the same purpose we conducted a series of interviews with typical stakeholders of a service like Smart Ski Goggles, e.g. ski resort operators. Thus, we gained insights into the needs and opinions of important partners in the value chain. For a later exploitation this understanding is crucial. We also did a global online research to find out whether services like Smart Ski Goggles are available somewhere and how the business model there would work.

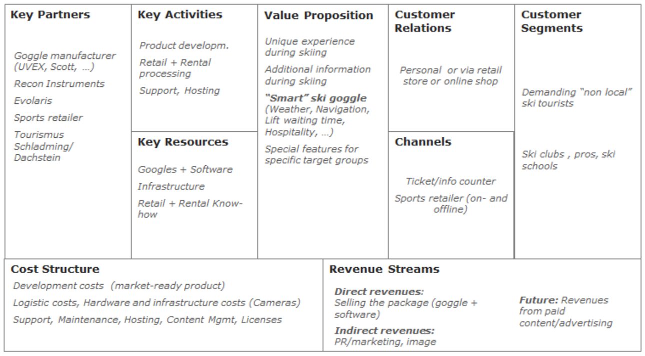

Figure 6. Example of business model scenario for Smart Ski Goggles

In general there are two distinct approaches in distributing the Smart Ski Goggles software and the necessary data ski goggles. The customers can buy the ski goggles or they can rent them. For the buying option we learned that 69.4 % of the participants in the online survey are basically willing to buy a data ski goggle. On the other hand, the average price these people were willing to pay was between 114 Euro (people who thought the goggle must not cost more than a regular ski goggle) and 161 Euro (people who thought the goggle can cost more than a regular ski goggle). In any case, these price expectations are much lower than the current price of the Oakley Airwave (roughly 650 Euro). With higher volumes and less brand-intensive goggle manufacturers the price is supposed to go down. But it is not likely that it falls below 200 Euro in the coming years. So, for the buying scenarios it has to be kept in mind that only a very small target group can be reached.

To discuss the elaborated business model scenarios with experts a business model workshop was conducted with participants from different stakeholders in Schladming. The scenarios were evaluated against feasibility and necessary pre-conditions to implement them in real-life. A crucial discussion point was that the cost to further develop and test the current prototype of Smart Ski Goggles to get it to marketability has to kept low, otherwise the ski resort wouldn't invest in a service with such a small volume of users. For all elaborated business model scenarios it has to be taken into account that probably none of these will lead to huge turnovers in the first years as the market is not that developed yet. But, apart from the turnover potential also the marketing potential has to be considered. Smart Ski Goggles is definitely a unique experience for guests and a ski resort can differentiate itself from competitors through destination-specific information and services like e.g. real turn-by-turn navigation.

RESULTS

In the online survey we asked potential users which feature would be interesting during skiing (category A) or in a break (category B), as well as, whether a feature was not interesting at all (category C), multiple answers were allowed per category. It confirmed our expectation that warnings (61.5 %), weather (56.8 %), navigation (50.5 %) and lift waiting time (47.9 %) are top requested features in categories A and B. Additionally, it clearly showed that presenting the users pulse on the screen (an idea of the early concept phase) is of comparably low interest (52.9 % qualified this feature as 'not interesting'). Showing text messages and e-mail (60.2 %) and other social media contents (61.8 %) were also rated as not interesting.

Testing the accuracy of the lift waiting time indication was difficult, as not so many people were on the slopes during the test runs. This has to be taken into consideration when analyzing the very positive value of the participants instant feedback for the lift waiting time. 214 of 238 feedbacks (90 %) confirmed a correct waiting time.

As the test participants had to fulfill two navigation tasks during the field tests we got a lot of feedback about this feature. To fulfill the navigation tasks the participants had to go to a specific start point and select the target of the navigation. After that the route was calculated and displayed on the screen as a list of route elements. The participants missed functionality like the usage of a completely free starting point (due to technical reasons not possible during the project lifetime) and the recalculation of the route in case someone moves into a wrong direction. After interviewing the participants we assume that such expectations arise from the fact, that many people are already very much used to the navigation features of cars and smartphones. The qualitative feedback of the participants showed that it was not clear to them that a slope is by far not as structured as streets and that the movement on a slope is very different to that on a street. A navigation functionality which was evaluated as very positive was the automatic display of a photograph with a superimposed arrow to indicate the direction at an important point on the slope, see Figure 4. In average each participant of the second field test started five navigations, so the participants not only tried to fulfill the navigation tasks but also used the navigation with their own start and target points. For 75 % of these navigations the route could be loaded. This means, that in one of four cases the mobile network connection was not available. The usefulness of the navigation feature was rated with a mean of 3.2 (n=54, 1 very useful, 5 not useful at all). These values underline the need for improvement if this feature should be further developed.

The sent notifications (by the ski resort operator) were considered to be useful and not too frequent. During the second field test we sent four notifications per test run. The contents of the notifications were a voucher for a drink, a hint to use the instant feedback for lift waiting time, the announcement of an event and advertisement for a hut. Especially the notifications about huts were very interesting for the participants. 75 % of all send messages were read by the participants. The usefulness of this feature was rated with a mean of 2.3 (n=54, 1 very useful, 5 not useful at all).

From a technical perspective the research project proved that the operation of a service like Smart Ski Goggles is feasible, all technologies needed are in place and more or less conventional. As with all mobile devices battery life is a crucial topic. On the other hand the battery life has turned out to be sufficient for a day on the slopes (5 to 6 hours), given that the display is switched off during longer brakes and the outside temperature is not below -5 °C. The most challenging part was the integration of different kind of data sources in the backend. Our caching approach proved to be very reliable.

Business model-wise the summary is twofold. On the short-term and if such a service is solely focusing on data ski goggles it won't finance itself as the market potential is too small at the moment. But on the other hand a ski resort could use this service for marketing reasons. Furthermore, parts of the services features could be used within smartphone apps or info terminals.

CONCLUSIONS AND FUTURE WORK

The approach to co-create software for smart glasses in a multi-step approach together with potential users basically proved to be very useful. With integrating them from the very beginning of the project the features could be implemented as close as possible to real needs, requirements and concerns. Some of the requirements and wished features could not be implemented due to technical, conceptual or resource reasons. On the other hand one could argue that integrating potential users in the conception of features for a device which is so new that it barely hit the market is not a good idea. This has to be confirmed if it comes to the fact that many people really believed the glass shield of the data ski goggle would be the display (like a HUD in a car). So, it is very important to make it clear to the participants of such a study how the display works. This can be achieved best by letting them try the goggles by themselves. In general, the selection of participants and the research design for the user tests is crucial. The results are strongly biased by the professional background and personal expectations of the participants. Furthermore, if participants are testing together (as happened in the second field test) they are influencing each other which again leads to biased test results. Another important point was the inclusion of many stakeholders throughout the project. Only with these experts from different areas like ski resort operations, retail, tourism and marketing a holistic view of the service could be reached.

A crucial point are system tests in which the complete system is being tested in real-life conditions, as we have a complex system with many components (goggle, remote, smartphone, backend server, several other data sources) with unpredictable real-time performance (mobile network availability, GPS availability and accuracy, etc.). In a future project of this kind more focus has to be set on system testing compared to feature development. Additionally, the user feedback for the lift waiting time feature was not as valuable as it would have been when testing under more crowded slope conditions. With the current software version, a navigational route can only be calculated if we have live access to the routing server. In future work for the navigation feature the necessary live access to the routing server could be widely avoided if most used or even all possible navigation routes are being pre-fetched on the gateway app. In general, the navigation feature has the most potential for improvement.

From a business perspective the difficulty is that the market for these devices has yet to be developed. As long as there are no useful apps available not many people will buy such goggles. On the other hand as long as not so many devices are used no company wants to invest in developing such apps. This chicken-egg-problem is typical for the very early stage of new products and can only be solved by entrepreneurial thinking and acting. This research project has contributed to this situation in providing deep insights into technological, organizational, economical and social aspects of such services. In a next step the results of the research project have to be discussed with interested stakeholders (hardware manufacturers, ski resorts, retailers, etc.) to further develop the business model scenarios and to explore how Smart Ski Goggles could potentially be commercialized. Since the end of the project a marketable version with a limited feature set was developed and is live since December 2014 [7]. Furthermore, the Smart Ski Goggles software will further be developed based on the concrete requirements of ski resorts [8].

In summary the project showed that in general there is a huge potential for using data ski goggles with apps like Smart Ski Goggles. People are basically open to use smart glasses if they offer an added-value to them. During the project we collected a lot of new feature ideas, like e.g. personalization or audio output for navigational hints. Though, security and privacy aspects have to be taken seriously. From a user's point of view it is crucial to have an easy and clear UI as well as an intuitive interaction concept. On top of that other user experience factors like the form factor, weight, battery life, price, etc. have to be taken into account when developing applications for smart glasses.

In general, real-time information services using smart glasses can create added-value and enable more efficient applications in a large variety of different domains. As mentioned above, these services will only be successful, if the usage scenario is understood in a holistic way. The public discussion about Goggle Glass clearly showed, how important it is to balance technological and social factors when introducing new technology.

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