Anticipated Acceptance of Head Mounted Displays: a content analysis of YouTube comments

Niek Zuidhof
Saxion University of Applied Sciences
Enschede, The Netherlands
e.n.zuidhof@saxion.nl

Somaya Ben Allouch
Amsterdam University of Applied Sciences
Amsterdam, The Netherlands
s.ben.allouch@hva.nl

Oscar Peters
Newcom Research & Consultancy
Enschede, The Netherlands
o.peters@newcom.nl

Peter-Paul Verbeek
Department of Philosophy University of Twente
Enschede, The Netherlands
p.p.c.c.verbeek@utwente.nl

Abstract— For further development of technologies but also for the implementation in real life contexts, it is important to understand users' perspectives on the anticipated use of innovative technologies in an early development phase. In addition, it is also important to get a better understanding of the explanation of this behavior towards technology use in later stages. Although Head Mounted Displays (HMDs) are not really new anymore, the uptake has been slow so far and people showed some extreme reactions. The objective of this study was to analyze the content of YouTube comments on videos of HMDs, in order to get a better understanding of relevant factors in this early phase of potential acceptance of HMDs. We analyzed 379 YouTube comments on HMDs using content analysis. Comments were divided into three groups: HMD, video, and miscellaneous. Comments about HMDs (n=124) were further analyzed. Most of the commenters showed a positive attitude to HMDs. Within the positive attitude, the most expressed themes were comments about the type of use (gaming), positive evaluations (emotions, coolness) and perceived need for an HMD. Within the negative attitudes, negative evaluations (judgments, emotions) were showed most and negative comparisons to other products were made. In neutral attitudes, the main theme was the type of use (gaming). The results specify a couple of user needs and social norms and values which people attach in this early phase to HMDs. In this early phase of acceptance, some early adoption observations were found as in when someone talks about the type of use (felt needs) and positive judgments (social norms). Early signs of rejection were found by negative judgments (social norms) and comparisons with other products (previous practice).

Keywords—technology adoption, technology acceptance, head-mounted displays, content analysis.

I. INTRODUCTION

In the past few decades, we have seen the rapid development of information and communication technologies. Recently, technology becomes body worn and can be used in several ways like media development, information technology, health monitoring and behavioral modeling [1]. A specific characteristic of wearable technology is a seamless integration of data and reality [2]. This serves Head-Mounted Displays (HMDs) neatly. The first HMD was introduced in 1968 [3] and augmented reality (AR) became a research area on its own in the 1990s [4]. Well-known examples of HMDs nowadays are Google Glass and Microsoft's Hololens. Although there is a discussion to what extent Google Glass delivers AR because of not meeting the definition of AR defined by Azuma [5], initial observations show that most people can not tell the difference. Nevertheless, both products are often labeled as HMDs and are compared with each other often on YouTube which will be shown in the method section.

Since Google Glass and the introduction of Augmented Reality, HMDs are getting more visibility by a larger public. However, the uptake has been slow and reactions so far were rather extreme in the media. Some people thought they were being recorded, others instead photographed the Google Glass users [6]. One user reported being attacked and ripped off her property in a bar [7] and Google launched rules for not being a 'Glasshole' [8]. Hence, wearable technologies literally not only come much closer than other technologies to the human body, but they also come very close to people's social norms and values and embody how interactions with others should proceed based on their expectations [9]. The reactions to HMDs demand a better knowledge of human interaction expectations with HMDs and theoretical perspectives on acceptance can help to understand whether people want to use it.

In recent years, researchers have developed numerous models to explain individuals adoption and usage behaviors of technology, explaining up to 50% of variance based on various variables [10]–[12]. These models are built on the theory of planned behavior which states that human behavior is a consciously planned process influenced by beliefs, attitudes, and intentions [13]. The beliefs and intentions are still found in the latest models but the attitude was excluded because it was found as a nonsignificant determinant [12]. Because of the extreme reactions showed to HMDs though, attitude may become more important in the acceptance of HMDs. There are few adoption models to use in an early phase of adoption [14] but the Diffusion of Innovations by Rogers offers a starting point [15]. In the early phase of decision making, prior conditions are described as previous practice, felt needs/problems, innovativeness and norms of the social system as characteristics. This study will focus on to what extent these prior conditions to the acceptance of HMDs are visible in online comments.

This study is part of a series of studies aimed to get more insight into the acceptance processes and the appropriation by humans of HMDs in real-life contexts. In this Work In Progress Session paper the first part of our study is presented aimed to explore themes and overall attitudes shown online towards HMDs. Very few studies have been conducted in this area to our knowledge. Two research questions are addressed: First, what is the overall attitude to HMDs in the early phase of acceptance? And second: which main themes can be distinguished from comments on HMDs in online videos? This study will contribute to the body of research on acceptance and potential use of wearable technologies. The results can also be informative for designers and developers of these technologies.

II. METHODS

To gather insight into the public's view of contemporary HMDs, we analysed comments to online videos via the popular online platform YouTube [16]. A content analysis [17] was chosen as a method to explore attitudes and themes in the comments on videos about HMDs.

A. Data/video selection

On YouTube, a search string was used with the words: smartglass, smartglasses, head-mounted display, augmented reality glasses, google glass and hololens. The top three most viewed videos were listed for each search string. The nature of this study was explorative and therefore we were interested in the general opinion towards HMDs. We, therefore, included a total of six out of 18 best-viewed videos of each search string in the study, see table 1. Exclusion criteria were: the video does not present an HMD with augmented reality (e.g. Xbox One), comments are unrelated to HMDs (e.g. reactions about the music in the video), a video in which comments are disabled, comments were not written in English, comments are duplicated, comments are non-independent (e.g. replies). Even though the data are publicly accessible, from an ethical point of view and after permission from the ethics committee, we posted a comment to the used videos with an explanation of the study and contact details when someone does not want his or her comment to be used in the study. Comments were downloaded, disconnected from identification and changed into respondent numbers (cases).

B. Population and sample

The population is the sum of the comments in the selected videos (see table 1) and was a total of 27.213. Sampling was done according to systematic random sampling which consists of selecting every *xth* case. By this method, every case (of 6 videos) would have an equal chance of being selected in an equal proportion. The skip interval can be established by the population size and the sample size: N/n. The desired sample size is 379 cases [18]. This resulted in the next skip interval: (58+220+290+995+21.390+4.260)/379=71,80, thus 72. The first video only had 58 comments, therefore the first comment was used and then every 72nd comment of the rest of the videos to ensure each video was used.

TABLE I. VIDEO SELECTION

Title of video	Video information		
	Views	*Comments*	*Date published*
5 Best Smart Glasses You can Buy now on Amazon	472.692	58	10-6-2017
Top 5 smartglasses you must have	777.488	220	7-1-2016
Head mounted display projects directly onto the retina: DigInfo	328.325	290	15-9-2010
HoloLens	Holo Lens Studie Demo	Windows 10	Microsoft HoloLens	2.210.567	995	21-1-2015
GOOGLE GLASS SUCKS!	23.324.038	21.390	19-4-2013
Minecraft Hololens demo at E3 2015 (amazing!)	4.501.942	4.260	15-6-2015

C. Coding

To increase validity, two raters independently resolved any difference to reach 95% consensus based on discussion of four rounds. The raters categorized the comments in three groups: HMD, video, and miscellaneous. HMD comments were further analyzed for open coding. The main messages were coded and overall positive, negative, and neutral attitudes were labeled.

III. RESULTS

The main messages related to HMDs (n=124) were included for further analysis and to answer the research question what the overall attitude is to HMDs in this early phase of acceptance and second which main themes arose from the analysis.

A. Overall attitude

First, the overall attitude regarding HMDs was coded based on the comments (n=124) given to the videos. The three categories were positive, negative and neutral. Most of the commenters showed a positive attitude to HMDs. It was coded 54 times (43.5%). Some quotes of positive attitudes in comments are: "Cool", "This is amazing!" or "Shut up and take my money!". A negative attitude was coded 35 times (28.2%). Examples of negative attitudes are: "I hate when things exist, they just inconvenience me so much", "u suck glasses" or "SORCERY! WITCHCRAFT!". The amount of neutral attitudes is similar to the negative attitudes (35 times, 28.2%). Quotes, for example, are: "I don't know about this, I just don't think this is the exact thing the person with hololens will really see. I would really like to try it myself one day and then buy it maybe.", "Is it really like this" or "first person ohhhhhhh".

B. Themes within positive attitudes

Some cases contained more than one main message, thus multiple codes were used. For example, table II shows 54 cases and 75 codes. Comments and thoughts about *the type of use* manifested the most with 30 times coded (39% of 75 codes within 54 cases). Within the type of use, gaming was the biggest topic, after which some smaller subjects appeared such as sex-related applications, medical, engineering, educational and design. The next theme is *positive evaluations* (#18/24%) which existed of excited emotions and saying how cool the HMDs are. The third theme within positive attitudes was *perceived need* (#10/13%). The rest of the themes are smaller ones, mostly practicalities such as questions about availability, places to buy etc. In some comments comparisons were made with the future, a few with predictions from the past, another one with divinity. In some comments, the intention to buy was shown clearly, where others were concerned with costs questioning the price or hoping that it will be affordable. At last, someone wanted to make clear that the Hololens really exists (see table II).

C. Themes within negative attitudes

Within the more negative attitudes (n=35, #48 codes were labeled), two themes stood out: negative evaluations and comparisons.

TABLE II.   THEMES WITHIN POSITIVE ATTITUDES

Themes (#/%)	Subtheme (#)	Example of comment
Type of use (29/39%)	Gaming (19)	- League of Legends in Hololens! :D
	Sex-related (4)	- Just imagine porn with this
	Medical (2)	- Think outside the box. imagine using this for medical (…)
	Engineering (2)	- (and yeah, yeah, those engineering and medical (…)
	Educational (1)	-(…) engineering, design or even for school?
	Design (1)	
Positive evaluation (18/24%)	Excited emotions (8)	- really awwwwwwwsom
	Coolness (6)	- It's cool!
	Google Glass (3)	-Google glass rocks!
	Not bad (1)	- Its not a bad idea
Perceived need (10/13%)		- I want that - My kids need this
Availability (5/7%)	If (3)	- I hope Google makes this
	Where (2)	- Where can I get google glasses?
Comparisons (5/7%)	Time: future (3)	- The future right there in my opinion
	Time past (1)	- (…) science diction in 2000s is becoming reality
	Divine (1)	- So this is what being god feels like
Intention to buy (4/5%)	(4)	- (…) I'm still gonna buy them lol
Costs (2/3%)	Questioning price (2)	- How much does HoloLens cost?
Confirmative information (1/1%)	Existence of Hololens (1)	- Months ago I saw hololens first time somewhere, its real

Themes within positive attitudes, n=54 # codes= 75

TABLE III.   THEMES WITHIN NEGATIVE ATTITUDES

Themes (#/%)	Subtheme (#)	Example of comment
Negative evaluations (20/42%)	Judgments (8)	- u suck glasses
	Emotions (4)	- this gave me chills
	Companies (2)	- (…) are evil
	Use (2)	- (…) with more annoying notifications
	Video (2)	- too much pre rendering
	Expectations (2)	- this will fail too
Comparisons (17/36%)	Related products (8)	- what you could have done with mouse clicks
	Time: future (4)	- im not ready for the future
	Time: past (2)	- I miss the good ol' days
	Time: current (1)	- Technology these days
	Human concepts (2)	- Sorcery! Witchcraft!
Costs (4/8%)	Too expensive (4)	- cost $1500, not worth it
Type of use (3/6%)	Gaming (2)	- make these for gaming
	Air pilots (1)	- for instance a jet pilot
Confirmative information (2/4%)	Mentions feature of smartglass (2)	- don't need it, make these for gaming
Perceived need (1/2%)	No need (1)	- don't need this useless
Distrust (1/2%)	In realization (1)	-end product will be nothing like demos

Themes within negative attitudes, n=35 #codes= 48

Most of the evaluations were *negative judgments* about HMDs, some show emotions like fear or sadness about developments like HMDs. The next theme in negative attitudes, are *comparisons* made about related products like Virtual Reality and Augmented Reality products, earlier announced products from the same companies or failed products. Comparisons in time were made as well, similar to positive attitudes about the future but now in a negative way: commenters said they were not ready and few looked back at the past ("good ol' days"). Other comparisons were made to art, one respondent reported that he or she can sculpt better by hand regarding a scene in the video. Next, a small number of themes were related to *costs*. Commenters found it too expensive or not worth the price. Comments about *the type of use* are in the minority with themes as gaming and use of HMDs for air pilots. Someone mentioned features of HMDs and another commenter clearly stated there is no *need* for the product. At last, one commenter showed *distrust* in the realization of the product (see table III).

D. Themes within neutral attitudes

With an equal proportion as negative attitudes, neutral attitudes (n=35, #25 codes were labeled) were related to one major theme and this one is at the top, just as with positive attitudes: the *type of use*.

And again similar, gaming is the most discussed topic. The rest of the comments are single comments related to sex, educational and military subthemes. A third theme is *confirmative information*. With 5 commenters, features of smartglasses were mentioned and the existence of hololens was confirmed by one commenter. Two commenters made *comparisons*, one with the current time and the other with a related product. At last, *unavailability* was mentioned and the very last comment here is about *distrust* in realization with a neutral attitude (see table IV).

IV. DISCUSSION

A. Principal findings

Regarding the first research question, the majority of the comments clearly showed a positive attitude to HMDs. Negative attitudes and neutral attitudes were smaller. Although the attitude as a construct is no longer part of some adoption models [12], it manifests in an early phase. The second research question of this study focused on which main themes can be distinguished from comments on HMDs in an online video. The themes in positive attitudes and neutral attitudes consist of discussing the type of use of HMDs with gaming on top. Maybe because most of the viewers are aged between 25-34 years [19]. Within negative attitudes, it was noticed that negative judgments are most made followed by negative emotions and a lot of comparisons to other products.

TABLE IV.   THEMES WITHIN NEUTRAL ATTITUDES

Themes (#/%)	Subtheme (#)	Example of comment
Type of use (14/56%)	Gaming (10)	- reminds me on cards (…)
	Educational (1)	- sure it does, it has some pretty amazing medical, military, educational etc applications
	Medical (1)	
	Military (1)	
	Sex-related (1)	- not wear this when fapfap
Confirmative information (5/20%)	Mentions spec. (4)	- first person ohhhh
	Existence of Glass (1)	- Google glasses are real I have one
Neutral evaluation (2/8%)	Expectations (1)	- HMD will replace smartphone
	Ambiguous emotions (1)	- Do they suck that bad, I was looking forward
Comparisons (2/8%)	Time: current (1)	- Welcome to 2013
	Related products (1)	- What about rudy project noyz pro
Availability (1/4%)	If: not (1)	- They don't sell them
Distrust (1/4%)	In realization (1)	- don't think this is what you will see

Themes within neutral attitudes, n=35 #codes= 48

To make a comparison to a suitable framework for this early phase of adoption of HMDs, the staged model in the Diffusion of Innovations seems relevant. Rogers [15] mentions prior conditions in the process of decision making. Findings of this study can possibly specify these prior conditions. Within positive attitudes, we saw that talking about the type of use can be compared to these prior conditions, such as felt needs or problems. Positive judgments are influenced by norms in the social system of the commenters. In negative attitudes, the negative judgments are also influenced by norms in the social system and comparisons with other products are based on previous practice. For neutral attitudes, it was surprising that the order of themes was partially similar to positive attitudes. We found little evidence for the prior condition innovativeness [15]. This study provided an entry to further specify the prior conditions in the acceptance of HMDs. Also, attitudes in an early phase of acceptance might be an early indicator of acceptance or rejection of HMDs.

B. Future work

This study is part of a PhD project focusing on the appropriation of HMDs. By further developing adoption models and by including more and other factors such as interaction, social and ethical factors we aim to get a better understanding of people's preferences and expectations towards HMDs. The current study will be expanded to obtain more reliability in the dataset and repeated in a later stage. The following step is a field study and focus groups. Then the use of HMDs will be evaluated through the real use of HMDs by people with a qualitative approach and supported by a survey which will have a more quantitative approach.

C. Limitations

This study was limited in using online comments that are not necessarily representative regarding the acceptance. Furthermore, we know little about the characteristics of the commenters on YouTube. Thus the results are unfortunately not generalizable to a larger population. However, we tried to gain insight in the general opinion on HMDs and a first effort was made to contribute to the body of research and provide insight into the early phase of potential uptake of HMDs.

REFERENCES

[1]   D. Farina, E. Cianca, N. Marchetti, and S. Frattasi, "Special issue: wearable computing and communication for e-Health," *Med. Biol. Eng. Comput.*, vol. 50, pp. 1117–1118, 2012.

[2]   E. de Valk, "Wat ging er mis met Google Glass," *nrc.next*, 2015.

[3]   I. Sutherland, "Head-Mounted Three Dimensional Display," *Proc. Fall Jt. Comput. Conf.*, pp. 757–764, 1968.

[4]   D. Wagner, "Handheld Augmented Reality," Graz University of Technology, 2007.

[5]   R. T. Azuma, "1997 - A Survey of Augmented Reality.pdf," *Presence Teleoperators Virtual Environ. 6*, vol. 4, August, pp. 355–385, 1997.

[6]   M. Honan, "I, glasshole: my year with google glass." Wired, 2013.

[7]   N. Ladhani, "The social implications of wearable tech," *Social Policy*. 2014.

[8]   Google, "Explorers," 2014. [Online]. Available: https://sites.google.com/site/glasscomms/glass-explorers.

[9]   O. Kudina and P. Verbeek, "Ethics from Within : Google Glass, the Collingridge Dilemma, and the Mediated Value of Privacy," *Sci. Technol. Human Values*, pp. 1–24, 2018.

[10]   F. D. Davis, "Information Technology Introduction," vol. 13, no. 3, pp. 319–340, 2014.

[11]   F. D. Davis, R. P. Bagozzi, and P. R. Warshaw, "User Acceptance of Computer Technology: A Comparison of Two Theoretical Models," *Manage. Sci.*, vol. 35, pp. 982–1003, 1989.

[12]   V. Venkatesh, M. G. Morris, G. B. Davis, and F. D. Davis, "User Acceptance of Information Technology: Toward a Unified View," vol. 27, no. 3, pp. 425–478, 2003.

[13]   I. Ajzen, "The theory of planned behaviour: Reactions and reflections," *Psychol. Health*, vol. 26, no. 9, pp. 1113–1127, 2011.

[14]   S. Ben Allouch, J. A. G. M. van Dijk, and O. Peters, "The Acceptance of Domestic Ambient Intelligence Appliances by Prospective Users," in *Tokuda H., Beigl M., Friday A., Brush A.J.B., Tobe Y. (eds) Pervasive Computing. Pervasive 2009. Lecture Notes in Computer Science, vol 5538.*, 2009.

[15]   E. M. Rogers, *Diffusion of Innovations*. New York: Free Press, 2003.

[16]   EBizMBA, "Top 15 most popular video websites," 2017.

[17]   K. A. Neuendorf, "The Content Analysis Guidebook," 2nd ed., London: Sage Publications, 2017.

[18]   L. Cohen, L. Manion, and K. Morrison, *Research methods in education*. London, Routledge, 2011.

[19]   E. Blatterberg, "The demographics of YouTube, in 5 charts," 2015. [Online]. Available: https://digiday.com/media/demographics-youtube-5-charts/.