Mobile Augmented Reality

An interface to data for extending business opportunities and value chain innovation

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Preface

When I bought my first smart phone a couple of years ago, it felt like something had changed for the better. My G1 enabled me to do things none of my friends had ever seen before and nothing worked better than showing them an application called Layar. Presenting data and linking that to GPS coordinates on video see-through seemed something that came flying out of Star Wars movie. About the same time I finished my Bachelor in Business Engineering and started a Masters in Business Studies. Still being fascinated by Layar I decided to write a case study on their founders for International Entrepreneurship and that was probably my tipping point, from there on I knew that this my ideal industry; energetic, fast-moving and unpredictable. Quotes as "we're reinventing the world" and "Augmented Reality right now, is what the Internet was back in '97" only made things worse and I determined to write my thesis on the subject on the subject how to make money with augmented reality.

Before you lies the end product of that search. Through the interviews I had I was able to have a glimpse in the future and I must admit that had my enthusiasm hasn't been tempered; to be honest it's only gotten worse. It seems that what is measurable is in some form augmentable, that is, as long as it provides value. With this thesis I hope to take away some confusion around what is and what isn't to be considered an augmented reality application, also hopefully developers find the perspective in this thesis useful for development of new applications. I believe there is quite some way to go. For the help in guiding me to the process of writing a masters thesis my special thanks goes out to my supervisor Tsvi Vinig

Also my thanks goes out to the following people for without this thesis would not have been possible:

Jeroen Mol	CEO BuzzAr / CTO Beyond Reality BV
Remco Vroom	CEO Tab World Media, Founding Partner AR Experience
Ken Blakeslee	Partner WebMobility Ventures
Noora Guldemond	Head Sales Europe Metaio Inc.
Lester Madden	Founder and director Augmented Planet
Chetan Damani	Co-Founder AcrossAIR
Alexander Ribbink	Partner at Primeventures Invest.

Executive Summery

Research problem: Because mobile augmented reality in essence seems to be an interface to data it is unclear to what extent it is different from other data visualizing techniques as for example a web browser. Trough this uncertain situation it is unsure if mobile augmented reality, just as web browsers can be used for value chain innovation in such a way that it might lead to novel business models. The aim of this thesis is to explore by means of a qualitative research *"if implementing mobile augmented reality leads to innovative business models"?*

Theory*:* On one hand this research has its theoretical foundation in the business model literature and taxonomies by Rappa (2010) and properties of business models as described by Osterwalder et all (2009) and the emergence of business models in a digital content as described by Magretta (2001). On the other hand theoretical foundations of augmented reality as provided by Azuma (1997) on what stimuli augmented reality should be able to augment, further Benderson and Druin (1995) on when to use augmented reality, also Mackay's (1996) view on how these services should be developed is included and lastly both Bimber and Raskar's (2005) and Portales' (2010) view of what building blocks an augmented reality application should consist.

Method: The research strategy was deductive en qualitative in nature. From the literature several propositions were developed for which evidence was gathered through 7 semi-structured interviews with people from within the mobile augmented reality business notably experts, developers, investors and platforms. An initial open interview was used to find out if the right questions were asked in order to construct the semi-structured interviews. Based on emerging topics data was coded and combined. Here it was concluded that an augmented reality browser user-perspective was important as well. To ensure a quick response and good response rate, the survey length was kept to a minimum and participant were contacted through Twitter when their Tweets contained any of these words 'Augmented reality', '#augmentedreality', '#ar' were used as well as 'Layar', 'Junaio' and 'Wikitude'. 182 people clicked on the link over a period of four days. Furthermore these click-troughs came from a total of 24 countries with notably the countries portrayed below. At the point of writing of the 182 people according to Google 83 people filled out the survey, which makes the response rate 45,6%.

Conclusions:. 1) Augmented reality browsers can be considered a specific case of a web browser. It does enable the user to perform similar functions as with web browsers (e.g. finding information and connecting to each other), however it enables that for a wider range of content, which though mobile use is also based on context through visual and location data. 2) Mobile augmented reality is considered to be a data visualizing tool for interacting with physical world objects (or physical context) to solve our problems more effectively. 3) Extending business opportunities should not be done from the technical perspective of mobile augmented reality, rather from a consumer perspective. 4) Mobile augmented reality applications can be used to innovate separate parts of the value chain by transferring different parts of the value chain in one application. This by visualizing multiple streams of data and enhancing them within augmented reality in such a way that business processes run more efficiently. 5) Although most properties for the emergence of new business models are in place it is too early to conclude that mobile augmented reality already leads to new business models.

Discussion: Based on the conclusions a new definition is proposed for augmented reality: *"Augmented Reality should detect and interact with contextual data in order to visualize content in a way that not only enables a user to solve a problem, but does that to such an extent that it is more efficient and effective than would be possible using alternatives."* Furthermore based on this discussion from different angles, nuances regarding the results as well as suggestions for practitioners and for future research for scholars are made

Practitioners: 1) Projecting data on a GPS coordinate is not augmented reality, since it doesn't interact with reality. To prevent further confusion between the two, it might be beneficial to call it 'projecting data on GPS in video see-through. 2) When developing an augmented reality application, practitioners should not reason from the technical functionalities a smart mobile device has, but rather from a consumer perspective. The question the should ask themselves: "How can I enable a user to save time or money with a mobile augmented reality application in such a way that it provides a unique and relevant content, but is still easy and practical?" 4) Since mobile augmented reality is considered an instance of a web browse and a way to innovate value chains with, developers might want to look at innovating/extending already existing web-services with augmented reality, switching to augmented reality view when presenting data that way provides more value/ is more relevant for the user.

Scholars: 1) The augmented reality description provides academics with a framework, which they can use to find potential augmented reality subjects. This framework now focuses on augmenting content in a visual way; however from the literature and the interviews it is predicted that others forms (physical and sound) might also emerge. Scholars should be on the lookout for these and where necessary extend the framework. 2) Although this research didn't find any specific mobile augmented reality business models almost all the properties – increase communication possibilities, interface to data, lowering transaction costs, innovate value chain -, just as happened with a web browser are in place. Scholars might want to focus on augmented reality as an interface to data as starting point for future research on business models. 3) The absence of a way to monetize mobile augmented reality services might be one of the reasons why no new business models have emerged yet. Future research on mobile augmented reality should carefully assess if a way of making mobile payments exist which might facilitate the emergence of new business models. 4) Since augmented reality is not a goal, but a means of presenting data more relevant, scholars researching emerging new augmented reality business models, might want to focus on those services already presenting data as a starting point.

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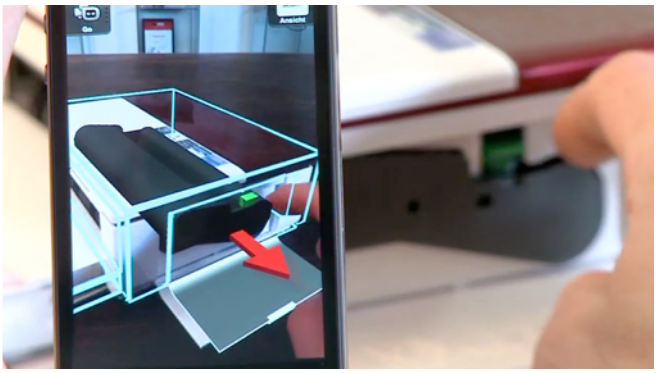
THE FOLLOWING DOCUMENTS CAN BE REQUESTED AT THE RESEARCHER:

- TRANSSCRIPT AND VOICE RECORDING JEROEN MOL
- TRANSSCRIPT AND VOICE RECORDING REMCO VROOM
- TRANSSCRIPT KEN BLAKESLEE
- TRANSSCRIPT AND VOICE RECORDING NOORA GULDEMON
- TRANSSCRIPT LESTER MADDEN
- TRANSSCRIPT CHETAN DAMANI
- TRANSSCRIPT AND VOiCE RECORDING ALEXANDER RIBBINK
- OVERVIEW OF DATA COLLECTED FROM INTERVIEWS SORTED BY RELEVANT THEMES
- ALL DATA GATHERED IN AN NVIVO FILE
- DATA GATHERED FROM ADDITIONAL WEB SURVEY

1. Introduction

Augmented Reality might sound as if it came flying straight out of a Star Wars movie, but actually it is something that has been around for quite some time and little by little we see it emerging in consumer markets and being used in business processes. Although several forms of augmented reality exist this thesis will focus one very specific, maybe even the most potential form of augmented reality: mobile augmented reality. This form of augmented reality used a combination of sensors available within mobile devices to 'measure' data from the context surrounding a mobile device user in order to visualize relevant information based on that data on your screen. The data that is measured could in theory be anything, however is limited to what sensors connected to a mobile device can meusure.

Augmented Reality company Metaio for example provides such a service in the form of a mobile phone application, which shows you how to change a printer cartridge (Byrne, 2011). By using the mobile device's camera it scans the structure of the printer to recognize the correct model. The software that places augmented reality objects over the camera view of the printer in real time and using the right scale in order to show the user how to change the cartridge (see picture 1.1).



Picture 1.1 Mobile Augmented Reality printer application by Metaio from Venturebeat.com

Because mobile augmented reality in essence visualizes data it remains unclear to what extent it is different from other data visualizing techniques as for example a web browser. Trough this vagueness it is unsure if mobile augmented reality can be used for value chain innovation in such a way that it might lead to novel business models.

The aim of this thesis is therefore to explore by means of a qualitative research approach "if implementing mobile augmented reality leads to innovative business models"?

1.1 Format thesis

To answer the main research question as proposed above a case study approach has been chosen around the subject of mobile augmented reality. The next chapter will consist of various backgrounds, firstly exploring the literature on augmented reality: what is it exactly, how did we get where we are today and why should it be considered potent in combination with mobile devices? A chapter containing a short review of the mobile augmented reality industry follows this. Also the literature on business models will be explored: which business models exist en how can mobile devices as smart-phones be used to extent these models?

Based on their common denominator, mobile devices, these two steams of literature are brought together in the next chapter containing a theoretical framework. By following the main research question, the goal of this framework in to merge the literature based on its similarities into research questions to be explored in the research process to answer the main question. In the next chapter the methods of this research will be described and explained, and how the data was gathered through 7 semi-structured interviews and how additional research through Twitter with 83 participants was undertaken in order to include user perspectives in to this thesis. From the theoretical and following the research methods, in chapter 4 the results are to be found from the interviews centered on topics emerging from the literature but also from the interviews itself, notably mobile augmented reality- meaning, browsers, sensors, stimuli, monetizing, content, value chain and business models. Furthermore it will contain the results of the survey notably focusing on user experience with mobile augmented reality applications. Following these results in the conclusion section, answers will be provided to the research question, which in turn will lead to answering of the main research question. Subsequently the discussion section explains how the conclusions are to be interpreted in accordance to the existing literature and how practitioners and academics might benefit from it. The last section will analyze the limitations of this thesis.

2. Backgrounds

2.1 What is mobile augmented reality?

Recently the technological properties of mobile devices have been harnessed in a combined way to employ a technique that has not been seen before on mobile devices: augmented reality. It however remains unclear why augmented reality applications and mobile devices are such a good match and in what context it might be useful. To answer these questions first a more complete description of what mobile augmented reality exactly is, where it has originated and what the technique precisely encompassed will be given. Furthermore of when mobile augmented reality is an option and what the limitations are.

Although augmented reality can be seen as a relatively new development in consumer markets, its roots are to be found in the late 60's of the last millennium. According to Benderson and Druin (1995) this is when researchers first started to re-describe *how* and *where* people physically interacted with technology (p.39). As further described by Azuma (1997, p.356), augmented reality is a technology that mixes virtual stimuli with real ones. These stimuli can be multifaceted (visual, sound or trough physical sensations) and are interactive in real time and registered in three dimensions.

On of the first applications of mixing stimuli in such as a way is described in Furness (1969) who found that the aerospace industry was using a head-up display on which computer generated graphics were added to windshield of a fighter yet to enrich the view of a pilot. The term 'augmented reality' however was not introduced until the early 90's when airplane manufacturer Boeing

AR Property	Description
Seamless interaction between real and virtual environments	Interaction between should be produced in a natural way as users can still work with conventional tools and are able to see each other at the same time as the virtual data.
The ability to enhance reality	With the help of augmented reality systems, different computer generated information can de added to the real world. It is also possible to change or even remove parts of the real world.
The presence of spatial cues for face-to-face and remote collaboration	Digital objects can be spatially distributed in real time according to the physical environment.
Support of tangible interface metaphor for object manipulation	In augmented reality a close link between virtual and physical objets exist. Because object in a physical context can be recognized by computer software, they can be augmented to computer generated and therefore a dynamic overlay is made possible.
The ability to transit smoothly between reality and virtuality	A classification can be made between interfaces that are dependent on the amount of virtual data in comparison to the physical environment (see figure x.x.).

Table 2.5 Augmented Reality Properties as described by Billinghurst and Kato (2002)

started using augmented reality goggles to assist engineers in the wire harness assembly process (Caudell and Mizell, 1992). In recent years, we have seen augmented reality being introduced in a variety of sectors, primarily for the visualization of both virtual data and real environments all together (Portales et al., 2010). Amongst others Portales et al. (2010) found emerging augmented areas as education, entertainment, surgery and robotics. Augmented reality, when classified (as done by Milgram and Kishgino (1994)) can be placed in between a real environment and a virtual one (see figure 2.1). Augmented reality, where virtual objects are placed in the real environment is more to the left as augmented virtually, where real objects and people are placed in a virtual environment. Then there's the virtual environment, where both the user and the environment are augmented.

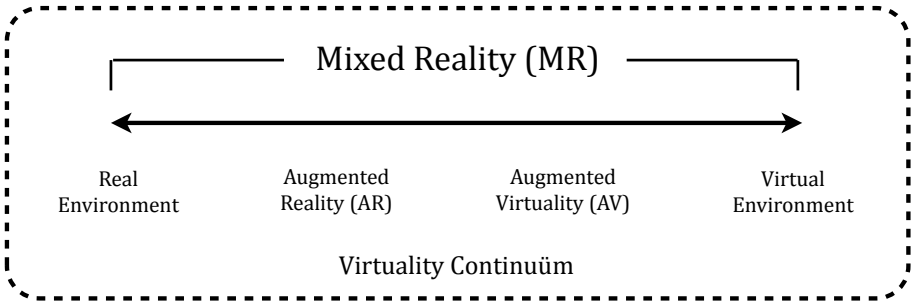


Figure 2.1 Simplified schema of a virtuality continuum. After Milgram and Kishgino (1994)

When to use augmented reality?

Augmented reality applications should automate, facilitate and collaborate in our daily activities (Benderson and Druin, 1995,). It should be a tool, which allows us to solve our problems more effectively, this by integrating many diverse and emerging technologies (Bimber and Raskar, 2005). For augmented reality to be able to do just that, Mackay (1996), in line with Benderson and Druin (1995) argue that the key into designing augmented reality applications lies in clearly specifying how people interact with physical objects in the real world and indentifying the problems that additional computational support would address. (Benderson and Druin, p.3, 1995). In other words it has to be clear in what context the user would interact with objects and people in the real world and thereby stumble across an opportunity to initiate an augmented reality application. Sometimes the augmented reality application and the real world object will overlap, and sometimes they will be completely separate. Mackay (1996) argues that augmented reality is a possibility when the case is that the user ends up missing important characteristics by just using the non-computerized technique or the computerized technique. It has to add value, given the context in which the user is.

Augmented Reality Building Blocks

According to Bimber and Raskar (2005, p6), augmented reality applications are constructed on three major buildings blocks: tracking and registration, display technology and real-time rendering. However these three blocks also stand for the challenges one has to face when constructing an augmented reality application.

First as mentioned before, augmented reality is a technology that should happen interactive in real time and be registered in three dimensions. When trying to achieve a believable augmented image, accurate *tracking* and *registration* is important (Bimber and Raskar, 2005), this because when aiming to get a believable image across to the user, the real camera should be mapped to the virtual one in such a way that that the perspectives of both environments match (Portales, 2010). Especially for a moving user, the system would have to constantly determine the position within the environment of the user surrounding the virtual object, this because the computer generated object should appear to be fixed (Bimber and Raskar, 2005).

If such a form of complete tracking with a global coordinate system is required, one can distinguish between outside-in and inside-out tracking (Bimber and Raskar, 2005; Portales, 2010). The first refers to systems where sensors are placed in the environment that track emitters on mobile objects: for example using global positioning (GPS) sensors to track where a mobile device is situated, or triangulating the position of

a mobile device between phone masts. The second type makes use of internal sensors fixed to mobile objects; a camera for vision based tracking, digital compass to track which way the phone is facing, an accelerometer to track acceleration. However these systems both have their drawback, as GPS for example isn't as accurate inside buildings as outside and vision-based tracking depends heavily on lighting conditions and visibility (Portales, 2010).

Bimber and Rasker (2005) further see both *display technology* and *real-time rendering* as basic building blocks and challenges in the future. The first being connected to limited optical (e.g. limited field of view), technical (e.g. resolution) and human-factor (e.g., size and weight) limitations. The second, real time rendering, is connected to the ability of augmented reality devices to place a layer of graphical elements on top of the real environment in a fast and realistic way. An ultimate goal according to Bimber and Raskar (2005) would be for the integrate computer generated object in such a way that the user is unable to distinguish between real and virtual.

Why build augmented reality applications on mobile devices ?

Although there are other ways of achieving an augmented reality experience (as head-mounted or spatial displays) one has to point out that mobile technology (as on smart-phones) is achieving important results in outdoor augmented reality applications (Portales et al., 2010). Mobile devices with increasing (graphical) processing power seem to have a converging effect on different types of modern technology as they combine high speed wireless data exchange (Wifi, 3G, 4G), integrate high-end camera sensors, low-cost GPS receivers, accelerometers and gyro sensors. It thus already houses many diverse and emerging technologies. Because of this combination of both inside-out and outside-in tracking devices, it has made *tracking* and *registration* of the speed and the location of the user, as well as the direction that the device is pointing a possibility. With the ever-increasing (graphical) processing power of smart-phones both *display technology* and *real-time rendering* of objects would seem to be of substantial power to get a believable image across. Furthermore by enabling the camera it's also possible to see what or who is surrounding the user, adding to that it can be used to capture live streams of the environments, which in turn can be overlaid by graphical augmentations before displaying them (Bimber and Raskar (2005) call this video see-through). The combinations of the above elements are the same as previously described by Bimber and Raskar (2005) describe to be the augmented reality building blocks. For that reasons alone one could argue smart-phones to be a potent medium for augmented reality applications.

However, mobile computing devices (as smart-phones) have another clear advantage over stationary devices (as desktop PCs); namely the ability to move with its user. If an augmented reality application has to be developed for the user to interact with its physical environment in *any* given context, it would be the logical thing to do so through a device that can be (and is most cases is) moved around with the user at *any* given moment (Díez-Díaz et al. 2007). Consequently mobile devices have the potential to add value through augmented reality in *any* given moment in which the user would find it relevant.

2.2 Mobile augmented reality market

Today we see that using your phone to find rich digital information connected to a physical object by using augmented reality has already been made possible through several smart-phone applications. Analysts predict that these possibilities will continue to grow and set the market value on $3bn by 2016 (ABI Research, 2011). Some even go as far as pointing out that a paradigm shift is occurring in the way we consume information (BBC News, 2011). According to ABI Research (2011) mobile augmented reality as an interface has the potential to become the 'zero-click interface' of the "Internet of Things'. Meaning that one doesn't have to click anymore in order to receive information connect to an object, for example through visual recognition. Having said that it sometimes remains unclear what mobile augmented reality exactly means to companies, one company calls it superimposing digital content based on a GPS coordinates, others claim that visual recognition has to be part of it because without it could not augment anything. Also there still seems to be "much uncertainty as to how augmented reality content and services should be monetized, what business models operators, vendors and content providers should employ" (Networkworld, 2010). In other words, can anyone make money from it?

Applications that superimpose digital content based on a GPS coordinate

One main player in this first 'type' of augmented reality is Amsterdam based Layar. According to Techcrunch (2011), Layar offers a mobile augmented browser that provides information on top of the camera display view in various categories, including eating and drinking, entertainment and leisure, games, government, health care, local search and directory services, real estate, retail, schools and universities, social networks and communities, tourism, transportation, and weather. Layar is the world's largest mobile augmented reality platform with thousands of developers and over 2,000 layers (PR Newswire, 2011). Layar can also direct publishers to several 3rd party content management tools and hosting companies to help publishers create their own content and publish channels (called Layars), as well as creating one of the most compelling user interfaces (see picture 2.2). Furthermore Layar supposedly servers over a million active users and is available on Android, iPhone, Symbian and Bada devices, comes globally pre-installed on millions of phones and is promoted by leading handset manufacturers and mobile providers like Samsung, Verizon and Sprint. Looking at the capital invested in the company Techcrunch (2011) mentions that in total 13.4 million has been raised in from Sunstone Technology, Prime ventures, and Intel. What

seems to be missing however is a clear strategy on how to monetize the form of augmented reality that Layar is offering. According to the founders of Layar, making money with Layar while the market is still in its current state would only work contra productive, and would cause the platform to collapse (Bmice, 2010).

Figure 2.2 Example of augmented reality application that superimposes content based on a GPS coordinate (Layar, 2011). From left to right, point of interests, 3d floaticons, "nearby POI List"

Although Layar may be the player with the largest user base, the Wikitide World Browser was the first Augmented Reality Browser for smart phone-users. It was published almost simultaneously to the first Android device end of 2008 (the G1) (Crunchbase, 2011). This browser has very similar functionalities, also scanning the users surrounding for (e.g.) geo-referenced content using the camera and the device's sensors. The obects' information is displayed in the cam right where the real object is located. Recently Wikitude launched an Augmented Reality navigations system for smart phones. Last year Wikitude received an unknown amount of VC funding by GCP fund Gamma III and tecnet funds Wikitude (2011). Not much is known on the actual use numbers of Wikitude.

Figure 2.3 Example of augmented reality application that superimposes content based on a GPS coordinate (Wikitude, 2011). From left to right, point of interests, point of interest information text box.

Applications that superimpose digital content based on visual input

Next to applications that superimpose content based on a GPS coordinate, there are also applications that do the same based on visual input. One of the main players in this subsection of mobile augmented reality is Juanio, which is developed by Munich based Metaio Gmbh that is privately funded. This is the only browser style augmented reality that has built-in optical tracking capability, which is a major advantage given the limitations of location based tracking (i.e. poor GPS accuracy in some locations and no indoor tracking capability). The Juanio browser platform makes use of so-called LLA markers (latitude, longitude, altitude markers) by which it can overcome the limitations that GPS navigation has by providing a locations. This is especially useful inside of buildings, where GPS is generally inaccurate (Juanio, 2011). Also the company has created a "targetless" Augmented Reality approach, requiring no 2D barcode-like marks for tracking and mapping their augmented content and overlays (Crunchgear, 2011). What this means that based on a pre-specified visual input the augmented reality browser can visualize an interactive content. They have more recently begun extending this concept to print ads by making interactive content visible over the ad when it is viewed through the Junaio browser (see figure 2.3).

Figure 2.3 Example of augmented reality application that superimposes content based on a visual input (Junaio, 2011). From left to right: home page, point of interest icons and 3D image from marker less 2d pattern.

User perspective

Continuing with what current smart device users think on augmented reality there is very little research to be found, a poll (see picture 2.4, translated to English from Dutch) that was placed on Tweakers.net (2011) (n= 12,389) was used asking if Tweakers.net visitors ever used mobile augmented reality applications. Although the question specifically directed at Layar and Wikitude (both location based, non-image recognition browsers) the biggest conclusion (27,7%) was "I have looked at it, but use augmented reality applications rarely", another interesting conclusion (19%) is that it is viewed a not useful gimmick. Only a total of 1.8% of the respondents said they couldn't do without augmented reality and 1,7% said they would use it regularly.

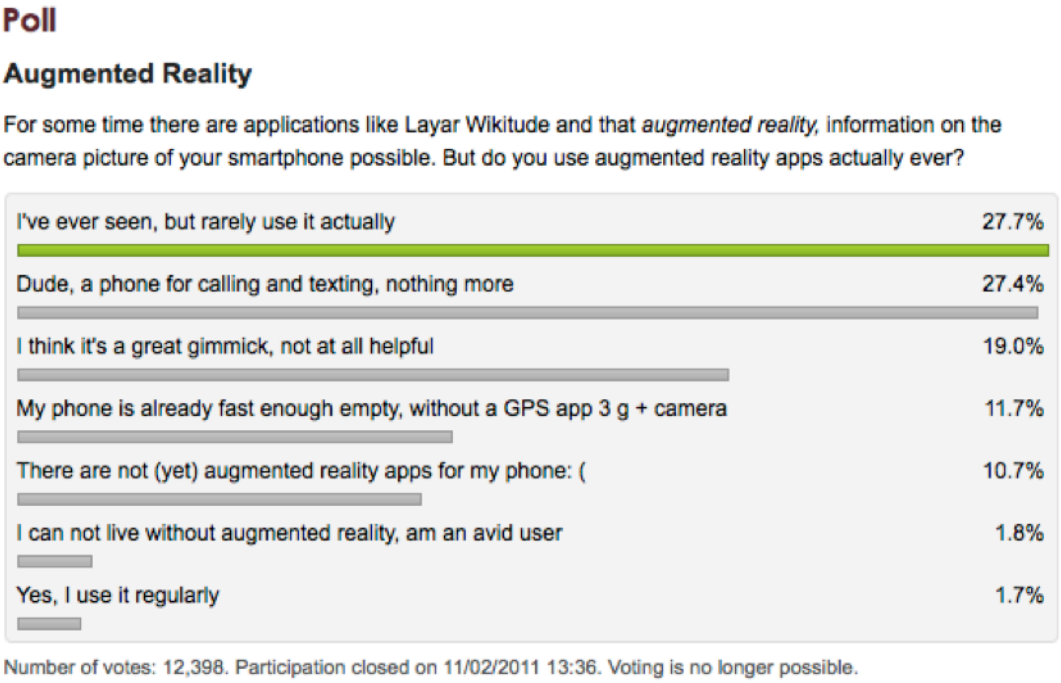


Figure 2.4 Poll placed on tweakers.net (2011) asking if visitors ever used augmented reality applications.

2.3 What are Business Models?

As already mentioned above, there still is much uncertainty as how augmented reality services are to be monetized, and what business models should be applied within this new emerging industry. A general accepted definition of the term 'business model' is still lacking today and as of such it is hard to define and determine what is to be found in a good business model. The term is often stretched out to mean anything by which it ends up meaning nothing. As one can imagine but also pointed out by Morris et al. (2005) this leads to confusion in the terminology. Which is a shame because as Magretta (2002) mentions: "a good business model remains essential to every successful organization, whether it's a new venture or an established player" (p.3-4).

Origins

The term business models first appeared in an academic article in 1957, however as a concept it only rose in popularity at the end of the last century (Osterwalder et al., 2005). A reason why a general explanation as mentioned above still is lacking might be because that over time, scholars have used terms as business model, strategy, business concept, revenue model and economic model interchangeably. Furthermore the business model has been described as architecture, design, patterns, plan, method, assumption, and statement (Morris et al., 2005, p. 726).

So what is a business model then? At heart- as Magretta (2002) explains it – business models are nothing more than stories that explain how enterprises work. In other terms, the business model spells out how a company makes money by specifying where it is positioned in the value chain (Rappa, 2010), by answering questions as: Who is the customer? What does this customer value? How are we going to generate a profit in this business? What is the underlying logic that explains how we can deliver value to customers at an appropriate cost? The answers to these questions serve as building blocks, which when fitted together make up the business model. Smith et al. (2010) describe a business model as "the design by which an organization converts a given set of strategic choices - about markets, customers, value propositions- into value, and uses a particular organizational architecture of people, competencies, processes, culture and measurement systems - in order to create and capture this value".

Thinking of business models then as combining building blocks in different ways, one can imagine that the number of potential business models is limitless (Morris et al., 2005). Rappa (2010) gives the example of a rather simple business model on one

side, a company that produces a good or service and sells it to customers: if everything goes according to plan, the revenues from sales exceed the cost of operation and the company realizes a profit. On the other side Rappa (2010) gives a more interwoven example, that of broadcasting. Radio and television has been broadcasted over the airwaves free to anyone with a receiver for much of the past century. The broadcaster is part of a complicated web of distributors, content creators, advertisers, and listeners and viewers. Who makes how much profit is not always clear and depends on many competing factors (Rappa, 2010).

Business models at heart are then anything but new and applicable industry wide; as Magretta (2002, p.4) argues "all new business models are variations on the generic value chain underlying all business". Because all new business models are variations on older ones, the purposes of them can either be being written to support an unmet need in the form of a design for a new product or service *or* concentrate on a process innovation in the value chain (Magretta, 2002), i.e., a superior way of making or selling or distributing an already proven product or service.

Business model building blocks

So what are these building blocks then? Osterwalder et. al (2005; 2009) argue that there are nine building blocks (see table 2.1 and table 2.2, which are divided between four main areas within companies: customers, offerings, infrastructure and financial viability. Taken together they should act as a blueprint for strategy to be build on, which in turn should be implemented by organizational structures, processes and systems.

Business Model Building Block	Description
Customer Segment (s)	Customers are the heart of every organization. An organization can serve one or more clients. Clients can be people but they can also be organizations
Value Proposition	Want to solve problems of customers and serve theirs needs with value propositions. The value proposition describes a bundle of products and services, which creates value for a specific customer segments.
Distribution Channel	Value propositions get delivered at customer segments through communication, distribution and sales channels. This building bloch describes how a company communicates with and reaches its customers to deliver the value proposition.
Customer Relationships	Customer relationships are build an managed for every customer segment. This building block describes the type of relationship a company engages in with its specific customer channels.

Table 2.1 Business Model Building Blocks from Osterwalder et. al (2005; 2009)

A competitive advantage

One of the great strengths of a business model as a planning tool is, as mentioned before, that is focuses attention on how all pieces of the puzzle should fall together. When this is done is such a way that it changes the economics of an industry *and* it is difficult to replace, than by itself it can be a competitive advantage (Margretta, 2005). Companies want to protect these competitive advantages and have recently – with business models within e-commerce seen as a form of intellectual property – done so with a patent (Rappa, 2010). On of the more famous ones that has been granted a patent is the one-click purchase developed by Amazon; this business model focused on a communications website. However since in essence business models are variations on the generic value chains it not always clear what is new and novel to these e-commerce business models.

Business Model Building Block	Description
Revenue Stream	Revenue streams are the result of value propositions that get successfully offered to the customers. The revenue stream describes cash that the company generates from every customer segment.
Key Resources	Ket resources are the assets that are necessary to offer and deliver all the blocks in the business model. It are the assets which are necessary tu make sure the business model work
Core Competencies	Describes the core competencies, i.e., the most important thing a company should do to make sure the business model works.
Key Partners	Some activities will be outsourced and some resources will be bought from outside the company. The building block key partners describes the network of suppliers and partners which will make sure the business model works.
Cost Structure	The elements of a business model will result in a cost structure that describes all the costs to make the business model work

Table 2.2 Business Model Building Blocks (continued) from Osterwalder et. al (2005; 2009)

Business models and the Internet

Although the concept was around longer, the term 'business models' was most frequently, however not only used in relationship with the Internet form '90s onwards (Osterwalder, Pigneur and Tucci, 2005). It is argued by Amitt & Zott (2001) that the explanation of this is to be found in the increase of cheap information technology, communication possibilities and bandwidth. Through this it became much easier for companies to work in so-called value webs, because both the coordination and the transactions costs fell substantially (Osterwalder, Pigneur and Tucci, 2005). Looking at this in terms of Margetta (2005), the rise of the Internet gave companies with proven products, ways of innovating separate processes in their value chain, in such a way that superior results could be achieved. Being able to partake in these value webs thus meant

an increase in possible business design choices that consider making, selling or distributing a product or service, which in turn led to the emergence of new kinds of business models. Within these new kinds of business models, there are two distinct groups. The first are "tried-and-true models that are reinvented by the web" Rappa (2010). As an example he gives online auctions (as E-bay), which the web has popularized and trough which it has broadened its suitability to a wide range of goods and services. These models moved a bit more to the digital environment and took a bit a bit away from the old approach, but thereby making the business model as a whole more efficient, Bambury (2006) calls these "transplanted real-world business models". Next to those Bambury (2006) also recognizes another group of business models in the online world, which he calls the "native internet business models". Unlike their tried-and-true/transplanted real world counterparts these, as the name suggests, are centered on business activities that have evolved in the online environment and are native to it. An example of this is the web-browsers Firefox, which is freely available on the web and has been developed in a so-called open source environment. The primary difference between these two different types of models is that that the most important property or commodity of the online world – information - is abundant and largely free. That in contrast to the real-world economy, which is based on scarcity (Bambury, 2006)

Types of e-business models

As it became clear that the number of potential models was endless, scholars began focusing on classifying the e-business models in to separate groups according to their characteristics (i.e. Linder & Cantrell, 2000; Rappa, 2004). One attempt is presented in table 2.3 and 2.4 by Rappa (2010), who tried to provide a complete and fitting overview of different types of business models observable on the web. This taxonomy is not meant to be exhaustive or definitive. What's more, a company could combine various different models as part of its online business strategy, for example advertising with subscription. These models are so-called hybrid models. For a more complete overview and examples of the business models that fall within these taxonomies below see Rappa (2004; 2010).

Business Model	Description
Brokerage	Brokers are described as the so-called 'market makers': they bring buyers and sellers togethers and offer services to facilitate transactions between these parties. These brokers generate revenue by charging a fee or commission for each transaction it enables and are often active in te business-to-business, the business-to-consumer and the consumer-to-consumer market.
Advertising	Advertising on the web is essentially an extension of the more traditional media broadcast model. The broadcaster in this case i a website that provides some form of (free) content and/or service (like e-mail or chat) and mixes these these with advertising messages, which in some cases can be the major form of revenue. The broadcaster may be a content creator of a distributor of content created somewhere else. This model is most efficient when the traffic on the type of broadcasting is large or highly specialized.
Information-intermediary	Information about consumer and their habits are useful and worthy, particularly when that information can be analyzed and segmented in such a way that it can applied for targeted marketing campaigns. The other way around: information collected *for* consumers about producers and their products can be useful as well. "Infomediaries": or information-intermediaties, act as channels between these two parties, assisting them to understand a given markt.
Merchant Model	Merchants are the wholesalers and retailers of services and goods. The value of these sales may be based on list prices or through actions.

Table 2.3 Business Model Taxonomies by Rappa (2004; 2010)

Business models for mobile devices

Over the last decade another device emerged that could connect to the Internet and therefore be used to connect to services online: the mobile phone. In contrast to desktop computers that were used before, these devices could be carried around. Scholars who have studies the business models on mobile phones identified that some of the business that could be used to successfully sell their products /services on mobile devices, where the same as the ones that were used online with stationary devices. (O'reilly, 1996; Palmer and Eriksen, 2000). However next to these similarities scholars also found mobile commerce and Internet commerce to be different in many respects as well. These differences were to be found in the limitations that both the mobile devices and the mobile service provides had at that time (Macinnes et al., 2002). Bødker et al. (2009) give as an example the lack of high-speed mobile Internet services or the limited screen space of mobile devices in contrast to desktop-monitors. Furthermore a save and reliable system was yet to be developed for purchasing content on mobile devices, as payments where still performed by for example sending an amount of text messages at a fixed prices per message (Pousttchi et al., 2008).

Business Model	Description
Manufacturer (direct)	The maker of a product of service may sell (by purchase, lease or license) directly to the consumer. This model in centered on the power of the web to allow manufacturers to reach buyers directly and thereby make the distribution channel more compact. This model may be chosen for its efficiency, improved customer service, or due a better understanding of customer preferences.
Affiliate	This model provides purchasing opportunities wherever people may be surfing on the web. These are given in accordance with the information that is collected of the user. In return for this financial incentives are offered to affiliated partner sites. The affiliates offer purchase-point click-through from their websites to the merchant's website. This model is a pay-for-performance, i.e., the merchant doesn't need to pay if an affiliate does not generate sales
Community	This model is founded on loyal users investing both their time and emotions in a business. Revenue can be generated based on the sale of secondary products and services or voluntary contributions. An example of this is "open source" computing.
Subscription	Charging a periodic daily, monthly or annual fee to subscribe to a service to generate revenue. Sometime these sites combine both a free content with "premium" (i.e., subscriber only or member only) content. These fees have to paid regardless of actual usage rates. The subscription model is frequently combined with advertising models.
Utility	This model is centered on measuring usage from a specific user and has a "pay as you go" approach. In contrast to a subscription service, these metered services are based on actual usage rates, for example charging customers for connection minutes

Table 2.4 Business Model Taxonomies (continued) by Rappa (2004; 2010)

Emergence of the smart-phone

In the last few years a new type of mobile device made its entrance from the business community in to consumer markets: the smart-phone. With the release of Google's G1 phone and Android devices, but primarily driven by Apple's iPhone, these mobile computing devices offer the promise of new technological revolution (Bødker et al., 2009). Among other innovations the technological advancement encompassed within these smart phones helped to bridge the differences that existed between Internet e-business models and mobile business models. Furthermore due to the advances in the wireless technology sector a rapid increase in mobile Internet speed was achieved (e.g. 3G & 4G) (Mohr, 2007), which led to the innovation of new services and products, as mobile payment (van Bossuyt et al., (2007). These advances meant that e-business models could –more than before with a 'normal' mobile phone- be utilized in combination with smart-phones in similar ways as stationary Internet devices to innovate separate processes in the value chain.

The advances also meant that – in contrast to stationary Internet devices or 'traditional' mobile phones – companies could extend their business models in ways that were not possible before. Bødker et al. (2009) give two reasons for the existence of these possibilities to extend business models in new ways through smart-phones. The first reason being that smart-phones –in contrast to stationary devices - can be carried around and used in different locations. This means that the *context* in which a service is enabled has to be taken into account, i.e., why and where is a service enabled, what is the role of this service and how does is change as the smart-phone passes through both space and time. The second way in which Bødker et al. (2009, p.25) reason that smart-phones offer different possibilities to extend business models that were not possible before is that smart-phones – in contrast to 'traditional' mobile devices – are no longer used solely as communication devices. What this means is that through the new functions that smart-phones have (as global positioning, a compass, a high quality camera), companies are enabled to piece together or extend business models in such a way to extent existing services or create new business opportunities. Through these new possibilities to extent business models and the changes that the wireless and technology sector have gone through, existing companies and new entrants face new opportunities and challenges that must be managed by the rethinking of strategies and business models (Ballon, 2007).

3. Theoretical Framework

A theoretical framework has been developed that describes how the above subjects of augmented reality and business models fit together, also taking into consideration what is going on in the mobile augmented reality market. Based on this several propositions have been developed, by which the main research question, *"does implementing mobile augmented reality leads to innovative business models?"* will tried to be answered.

3.1 What is augmented reality?

Starting with what Benderson and Druin (1995) and Mackay (1996) argue on augmented reality, namely that it should be used as a tool for interacting with physical world objects (i.e. physical context). According to them augmented reality could serve as this link between context and mobile device. Augmented reality browsers hereby become a way for mobile device users to interact with their direct surrounding. However as also pointed out above several 'types' of mobile augmented reality browsers exist seem to today, one type projects content based on a GPS coordinate, the other based on a visual input.

> P1: Augmented reality is a tool that can be used for digital interaction with objects in a physical context, which should help to solve our problems more effectively.

3.2 Augmented reality a specific case of a web browser

As described above augmented reality platforms specifically call themselves *browsers*. Furthermore one of those augmented reality platforms compares registering channels to that platform with a domain name registration. It seems that augmented reality browsers in some way are comparable to web browsers, maybe even a type of web browser. The difference between a web browser and an augmented reality browser then is expected to be in the type of content that the user is enabled to see, which for an augmented reality browser is expected to be based on stimuli. This is in line with what Azuma (1997) argues on augmented reality: that it is a way of mixing multifaceted stimuli (visual, sound or through physical sensation) in an interactive way with real ones in real time and three dimensions. This all is relevant because as described in the literature the emergence of the web browser and web pages enabled companies to innovate their value chains, which eventually led to business models (Rappa, 2004; Margeta, 2005).

P2: Augmented reality browsers can be considered as a specific case of a web browser.

3.3 Augmented Reality as a business opportunity

From a technical perspective Bødker et al. (2009) argue that the business opportunities for smart-phones in contrast to 'traditional' mobile devices are to be found in the context of the user. As has been proposed above mobile augmented reality can provide that link between context and content. Furthermore Bødker et al. (2009) argue that because smart-phones are no longer used solely for communication purposes, other smart-phone functionalities should also be incorporated in order to extent existing or when creating new business opportunities (p.25). Looking at which internal sensors current mobile devices have and can be used to measure we see a GPS sensor to measure a location, a camera for vision based tracking and registration, a digital compass to track which way the phone is facing, an accelerometer to track acceleration, a microphone to register sounds and Bluetooth to register other (mobile) devices nearby. Combining this with what Bødker et al. (2009) argue might suggest the following.

P3: Mobile augmented reality can be used to create or extend business opportunities because of the technical functionalities a smart phone has.

3.4 Augmented reality for value chain innovation

Continuing the comparison of a web browser and an augmented reality browser from a business model perspective also leads to some interesting propositions. First if augmented reality mobile augmented reality browsers are comparable to web browsers it might also have similar effects on the communication possibilities and on the coordination and transactions costs as mentioned by Osterwalder, Pigneur and Tucci (2005). Furthermore one could ask if augmented reality can enable companies to innovate separate processes in their value chain, just like web browsers did as mentioned by Margetta (2005).

P4: Just like regular web-browsers, augmented reality browsers can be used to increase communication possibilities and lower coordination and transaction costs and thus be used to innovate separate processes in the value chain.

3.5 Infrequent use augmented reality browsers

If indeed it is found that as proposed augmented reality browsers can be used to innovate processes in the value chain that wouldn't explain why the poll as presented above on "if smart phone users actually ever use augmented reality apps", suggests that today augmented reality applications in general are rarely used by end-users, even to such an extent that it is called a gimmick. When trying to find out if implementing mobile augmented reality actually leads to new business models, Magretta (2002) comments that all new business models have the purposes of either supporting an unmet need or concentrate on a process innovation in the value chain. In other words a new business model has to create value over other options available. Combining these two observations leads to the following proposition:

> P5: Current mobile augmented reality applications are infrequently used because they insufficiently provide the end-user with a way to support an unmet need or to innovate a process in the value chain.

3.6 Innovative Business Model

Proposed above is that mobile augmented reality can be used to create or extend business opportunities, by increasing communication possibilities and lower coordination and transaction costs and thus be used to innovate separate processes in the value chain. If this holds than, in a similar way as the web browser Margetta (2005), one would expect that companies can achieve superior results, which eventually led to new types of business models as portrayed by Rappa (2004; 2010).

> P6: Companies utilizing mobile augmented reality can achieve superior results leading to new business models.

4. Methodology

4.1 Justification of methods used

The aim of this thesis is to explore by means of a qualitative research approach if use of mobile augmented reality leads to innovative business models. Based on the literature it is expected to do so since it enables interaction with objects in a physical content in order to solve problems more effectively. From the proposed comparison with a web browser it is suggested that mobile augmented reality can be used for both value chain innovation and fulfillment of unmet needs. This in turn might lead to innovative types of business models

In line with what Robson (2002, p.59) argues this thesis tries to find out 'what is happening with' and 'if there are new insights on' mobile augmented reality. This study therefore classifies itself as an exploratory one. In accordance with Yin (2009), studying the organizational nature of phenomena requires adopting a qualitative rather than a quantitative approach.

The empirical method that was chosen to gain a broader understanding of mobile augmented reality in this exploratory study is a case study. This because following Yin (2009), a case study allows to "retain the meaningful and holistic characteristics of real life events". Furthermore choosing this approach other methods has an advantage when how or why question are being asked about a contemporary sets of events, over which the investigator has little control (Yin, 2009, p.13). Also bringing together, verifying information from various sources and building a relative complete profile is classified as a case studies unique strength (p.11)

This research then, instead of formulating hypotheses, is based on a central research question: does use of mobile augmented reality lead to innovative business models? This question is explored by the propositions that are derived from the literature and the theoretical framework as described before. Such reasoning makes sense according to Mason (2002) since qualitative research is more concerned with "formulating questions to be explored and developed in the research process…" (p. 19).

A good case study according to Yin (2009, p.18) should rely on multiple sources of evidence, with data needing to converge in a triangulating fashion. To achieve such a triangulation, next to describing both business model and augmented reality literature as complete as possible, secondary sources were used and seven semi-structured interviews were held. According to Saunders et. al (2007) having interviews with

experts in an exploratory study, is considered to be one of the principal ways of doing exploratory research (p. 133).

4.2. Data collection

To investigate if the right questions were asked, a preliminary interview was conducted with an industry expert. Here it was found that specifically asking the questions as presented in appendix 1 most of the time had the unwanted effect of getting into a discussion of meaning. Because of this it was subsequent interviews followed a more open approach, e.g. sending the questions up front, but letting the interviewees talk more freely on the subject of augmented reality and steering the conversation there where necessary in the direction of the question topics.

To have a diverse pool of interviewees as possible, the six additional interviews where conducted with people with diverse backgrounds within the industry of mobile augmented reality. Included was one VC that invested in a mobile augmented reality startup, three developers, two experts and one head marketing from a mobile augmented reality platform. This approach (expert, developer, platform, investor) was chosen in order to make sure that the views within this thesis represented mobile augmented reality from every working angle. For a more complete overview of the interviewees see appendix 2

As mentioned before the interviews were semi-structured and consisted of open-ended questions. Hereby it was tried to find out how interviewees would relate to the various topics connected to mobile augmented reality and in what way mobile augmented reality is used. Due to the busy schedules of the interviewees, several interview approaches were chosen: three face-to-face interviews, one Skype chat interview, two Skype phone interviews and one regular phone interview. The data was recorded with permission of the interviewees and transcribed for further analysis. Interview data were systematically coded around specific themes connected to mobile augmented reality as was expected from the literature. Data were coded into themes connected to the propositions above: AR meaning, AR browsers, AR stimuli, AR monetize, AR content, AR sensors, AR value chain and AR business models. Also emerging themes from the data were coded, mostly connected to business opportunities from an augmented reality users perspective.

4.3 Integrating an end-user perspective

As became clear from the background and as proposed in proposition five, one important aspect of business models and the development of mobile augmented reality applications is the end-user. From the backgrounds it became clear that current mobile augmented reality applications aren't used regularly which could indicate that they insufficiently support the end-user with a way to support an unmet need or to innovate a process in the value chain. To find out if this proposition would hold a small additional research (four questions) was performed where participants were searched using Twitter and Linkedin.

Based on the secondary data acquired from the survey from Tweakers.net above the first question was to find out if the participant ever used mobile augmented reality applications, followed by a question which type (location based augmented reality, visual based augmented reality, a combination). Then based on the answer given at the first question, the third question would ask what the main reasons would be of the first answer. Table 4.1 gives an overview of answer possibilities when the participant indicated he/she often used augmented reality applications, table 4.2 gives answer possibilities when the participant indicated he/she rarely used augmented reality application. These possibilities for the participants to pick from were based on two things. First the comments under the poll as described above (n=55) were scanned for relevant reasons why the people voted what they did (n=8). Secondly also the expert interviews were used to extract reasons fur using augmented reality.

Table 4.1 Possible reasons for using augmented reality applications
It provides me with a way of obtaining content quicker in contrast to a non-AR application
It provides me with a way of obtaining a different type of content than would be possible in a non-AR applications
The content that can be acquired is more accurate than in a non-AR application
The content that can be acquired is more relevant than in a non-AR application
The way of obtaining the information -e.g. holding your phone up in front of you- is more practical
The interface of the augmented reality application enabled me to find the content I was looking for more easily than in a non-AR application

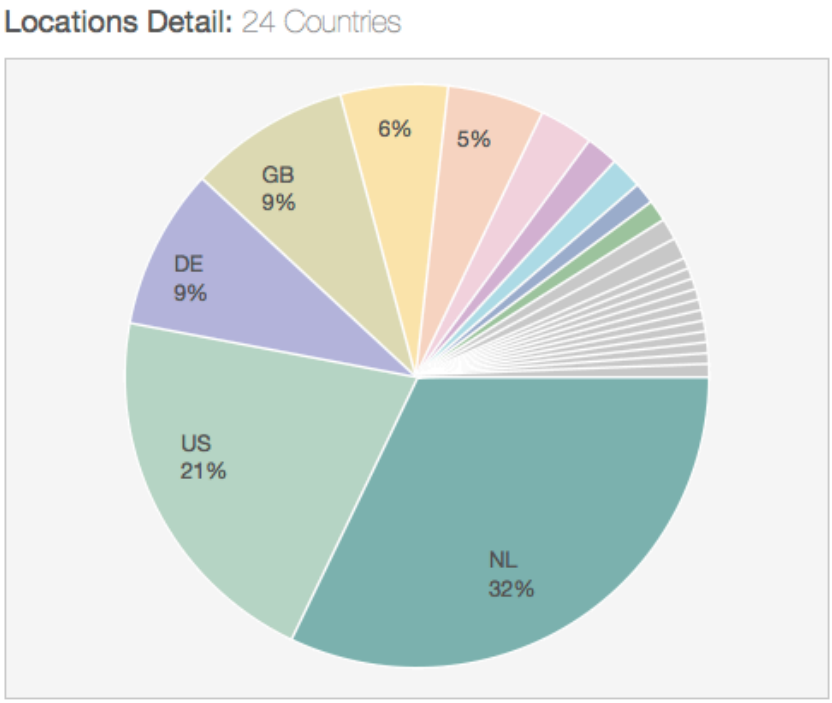
Table 4.2 Possible reasons for not using augmented reality applications
I had other non-AR applications on my device that could obtain the same content quicker
It didn't provide me with a way of obtaining different types of content than would be possible with other non-AR application
The content that could be obtained wasn't accurate in constrast to what non-AR application could provide
The content that could be obtained wasn't relevant in contrast to what non-AR application could provide
The way of obtaining the content in contrast to non-AR applications -e.g. holding your phone up in front of you- was not practical
The interface of the augmented reality application was hard to understand, therefore I couldn't find the content I was looking for

Lastly to ensure that participants could also include their own opinion they were asked to include what they would like to see added to an augmented reality application to make it even more useful / or to make it useful. This data was analyzed in a similar way as the data from the interview

As mentioned above relevant participants for the survey were found through Twitter and LinkedIn. On LinkedIn the link to the questionnaire was placed in a group called 'Augmented reality experts'. On Twitter, participants were found by filtering Tweets containing words connected to augmented reality. 'Augmented reality', '#augmentedreality', '#ar' were used as well as 'Layar', 'Junaio' and 'Wikitude' The people tweeting with one of more of these words were contacted with the following question (see picture 4.1).

Figure 4.1 Example of a tweet that was send in order to get participant for the survey.

Using Bit.ly[1] for statistics it was possible to see that 182 people clicked on the link over a period of four days. Furthermore these click-troughs came from a total of 24 countries (see picture 4.2) with notably the countries portrayed below. At the point of writing of the 182 people according to Google 83 people filled out the survey, which makes the response rate 45,6%[2].



Country	Click(s)
Netherlands (NL)	54
United States (US)	35
Germany (DE)	15
United Kingdom (GB)	15
Spain (ES)	10
Italy (IT)	9

Figure 4.2 Overview of participants in survey

[1] Bit.ly is a link-shortening tool that is used to decrease the number of characters. By placing a + behind the link (http://bit.ly/jkG4d4+) it is possible to see the statistics of people clicking on the link.

[2] Questionnaire is still online and results of the survey are publicly available through Google at http://bit.ly/mD3lnM

5. Results

5.1 What is augmented reality?

The answers of the interviewees gave seemed to be in line with what is argued is the literature, mentioning things as “augmented reality facilitates the linkages of something in your context with something digital” and “augmented reality is a contextual tool”. Furthermore it was mentioned that augmented reality should “add value given the context” and “fix consumer pains” and “solve consumer problems”

Furthermore what the interviewees emphasize is that augmented reality is not to be considered a goal, but as “a means of visualizing data”. In other words augmented reality is to be considered a tool, in a way that it can be used to fix consumer problems by visualizing data based on objects in the physical context.

5.2 Do augmented reality- and web browsers differ?

Talking with the interviewees on the comparison between ‘regular’ and augmented reality browsers led to some interesting insights. Starting with the similarities interviewees mentioned “augmented reality, just like a browser is a way of viewing data”. Just like ‘traditional’ browsers an augmented reality browser “enables people to look for content, information and connect to each other”.

A difference between traditional and augmented reality browsers is standardization. “Where for traditional browsers there is a clear separation between browsers and content, with augmented reality browsers they still are very much interlinked. Augmented reality browsers can “only do functions that they have been programmed to do and this makes it very hard to run more complex functions such as games, commerce etc”. A developer mentioned: “I don’t feel that augmented reality channels will become interchangeable between browsers any time soon”, another interviewee commented: “I think it’s to early to standardize as we are in a state of rapid innovation”.

Looking at the comparison of these browsers from a investor perspective however it was mentioned that “browsers as we know them today are something people now and recognize. That what I look for when I invest something, it has to be consumer oriented, but still be pushing creativity”.

5.3 What content do augmented reality browsers support?

Although both 'types' of browsers enable the users to see some kind of content, for augmented browser "it is a different kind of content". "With augmented reality it's a lot more about experience based content and although different forms exist, right now that is mostly location based (like a map), especially in current augmented reality browsers. Content in contrast to a 'regular' browser according to the interviewees is depended on where you are at a certain time; it has a "location element to it". Through augmented reality it is possible to look at a location, or an object through your phone's augmented reality browsers and see the digital content that is connected to it. Based on the location, "this content can be very rich or very poor". The following example mentioned by a developer illustrates how adding content to a location adds relevance.

"Some forms of augmented reality are comparable to an online blog where people write down their opinion and it becomes visible in search engines. However placing your opinion on a location is a lot clearer than placing it on a blog. I believe this will be very important for companies to recognize; their locations will have identities and these will have to be managed".

Although the location element seems to be important, according to the interviewees linking digital content to a location element seems 'just' one possibility. Interviewees also mention a form that links digital content to a visual input through image recognition, a form that links digital content by means of an external sensor and combinations between these. What they all seem to have in common though is that some kind of sensory input (internal or external) is used, in order to visualize some sort of data (which is measurable by those sensors)

Talking with the interviewees on where these differences originated, most answers point in the direction that the 'map' type of augmented reality, where content gets linked to a GPS coordinate is something that happens mostly today. Because this form of augmented reality "only enriches reality with digital content, like a snapshot" it makes augmented reality "still a rather passive medium", which is portrayed in the following example:

"Right now most augmented reality isn't based on, but rather displayed on the physical world, based on points of interest (i.e. GPS coordinates). This is because the device isn't able to visually interpret the users surroundings. It can only see a crude determination of what

should be in front of them. If the user for example would sit in front of a door, or would place a finger over the camera, the application would blissfully unaware keep displaying points op interest."

What you would want according to one of the interviewees is that "you can't make a difference between reality and digital content". To do so, "instead of projecting digital objects on to reality it should interact with reality". Now most of the time there still has to be clicked something within your augmented reality browser to make it interactive, to make it interact "imagine recognition needs to be added to augmented reality browsers".

5.4 How is augmented reality interaction different from a technical perspective?

As mentioned by the interviewees most of the time within augmented reality, content still needs to be clicked to make it interactive. One interviewee compared such clicks with clicking on a hyperlink on a website, and when "taking the literate approach", the recognition of visual input (as tags) could also be considered so, however in his words that should be considered "a leap of faith".

Providing augmented reality value through interaction with the context surrounding the users happens through "a combination of sensors, sniffers and reapers" linked to the mobile device. These sensors as mentioned by one of the interviewees "facilitate the link between something in the physical space around you, to something digital". "Every object or if something transmits a signal, which is receivable by sensors in a mobile device can be visualized within augmented reality, these sensors can, but don't necessarily have to be housed in the device". Also including that can be recognized one interviewee added that although everything that transmits a signal can be visualized, the question remained if that is desirable". Two innovative augmented reality examples that illustrate the difference between embedded and external sensors connected to a mobile device:

1.

"An iPhone for example has such a bright flash that an application for doctors has been developed which can be used as a 'visual' stethoscope. By pointing the bright flash at a patient's finger, the camera can register and visualize heartbeats."

2.

"Pinhead sensors attached to a piece of clothing can sniff out certain particles in the air and send this information to a users mobile device. You could for example measure and visualize toxic particles clouds after an accident.

5.5 What business-to-consumer opportunities does mobile augmented reality facilitate

As portrayed above looking at augmented reality from a technical perspective the possibilities for developing all kinds of innovative applications seem endless. However interviewees mention that making an augmented reality application from a technical perspective "doesn't mean that someone is going to use it". As mentioned above already an augmented reality application has to be valuable and desirable from a user perspective to be successful.

In order for augmented reality to become valuable and desirable, "implementations of it should fix consumer pains, i.e., it has to really solve a problem for people" and according to what is mentioned by the interviewees this can happen in two ways. First augmented reality can be used in order to save money, for example:

"Trough augmented reality it is possible to make difficult consumer ecommerce easy. By combining mobile devices, text recognition and augmented reality we could for example make switching from gas provider a lot easier".

Secondly according to the interviewees augmented reality applications should help save time for consumers:

"Mechanical car manuals are usually very complicated for the average user, because they do not understanding the inner workings of a car. You could deliver the same content in augmented reality by recognizing the engine and highlighting the car and explaining where the user needs to fill up the water or oil. The same could be done for explaining what all the buttons are for on a car's dashboard, or overlaying an image whist repairing a washing machine, all saving time for the user".

Because of these two things (saving time and money) some interviewees argue that it is unwise to develop augmented reality application as "a different way of displaying data that can be easier consumed in non-augmented reality interfaces. Think about buying tickets, finding a place to eat or images of objects". "We should think about ways were we can use augmented reality as the only relevant interface."

5.6 Reasons of smart mobile device users to use augmented reality applications.

In line with what the interviews suggest, enabling end-users to save time and money through augmented reality could make an augmented reality application successful. The results of the above poll as presented in the backgrounds however suggest that today augmented reality applications in general are rarely used by end-users. These observations in turn could either mean two things, first the experts that were interviewed were wrong or secondly that some of the current augmented reality applications (the above poll solely asked on location based, non-image recognition browsers) insufficiently enable user to solve their problems more effectively and/or efficiently than other non-augmented reality applications.

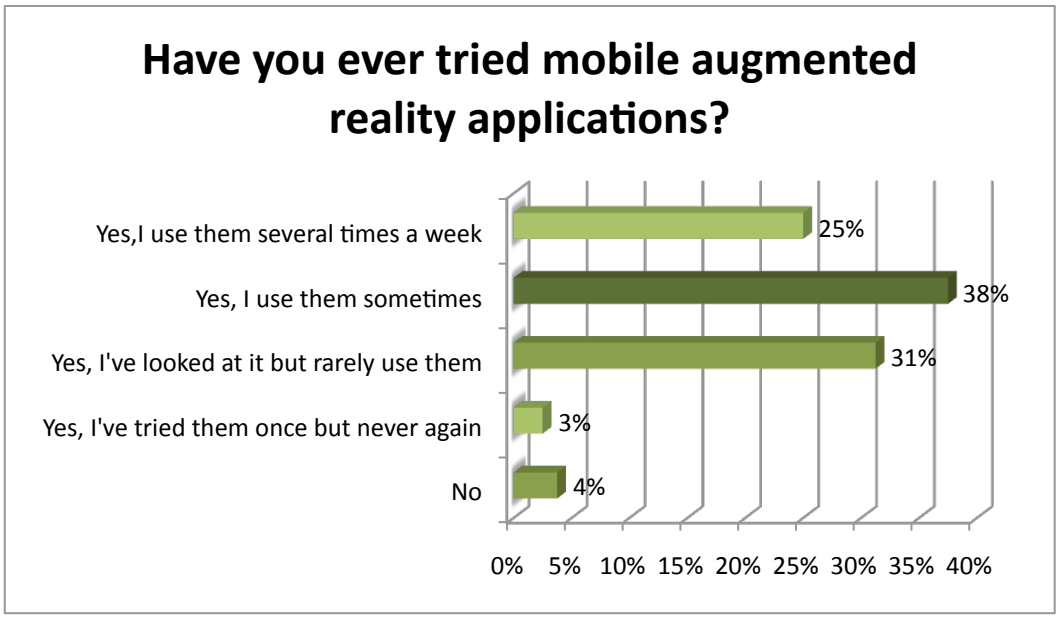


Chart 5.1 Overview of answers given when asked if participants ever used mobile augmented reality applications.

To find out what exactly was going on an additional survey was performed as described in the methods section. Based on the question as also described before in the methods section the survey (n=83) as also described before above revealed some interesting results. First the respondents were asked if they have ever tried mobile augmented reality applications (see chart 5.1), in contrast to the poll of the tweakers.net forum the greater part has used mobile augmented reality application (logically since the aim was to find participants that have used augmented reality). At this point it was chosen to split up the more frequent users (several times a week and sometimes) from the more infrequent users (rarely and never again), this to find out the type of augmented reality application they used and the reasons for the frequency they used it compared to non-augmented reality applications.

Non-frequent use of mobile augmented reality applications

Starting with the proportion of the respondents that indicated that they infrequently use mobile augmented reality application (n=33) as is visible below (chart 5.2) the majority of this group indicated (48%) to use AR applications that both use visual and map style augmented reality, secondly map style augmented reality (35%), and third solely visual based augmented reality applications (16%).

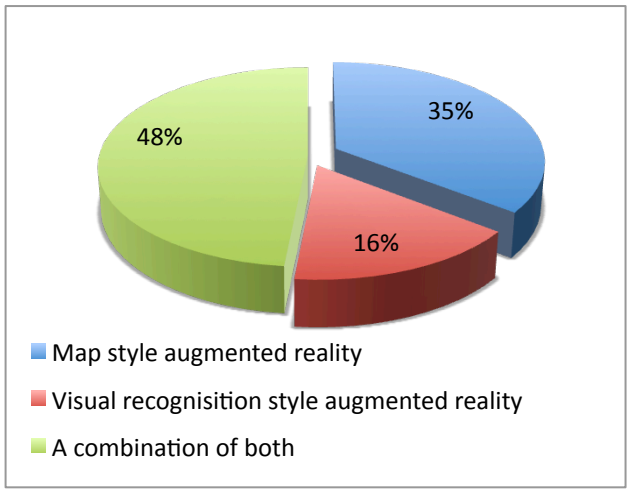


Chart 5.2 Overview of users of mobile augmented reality applications non-frequent use.

When asking the respondent in this group for reasons of infrequent use as portrayed below (see chart 5.3), the majority of respondent (58%) found that other non-AR application could obtain similar content quicker, secondly (42%) non-AR application seemed more practical for the content they were looking for, thirdly (29%) found that content within AR applications wasn't different from what could be found in non-AR application. Relevant (19%) and accurate (13%) content and also the understanding of the AR interface (13%) were less important reasons. Reasons mentioned under other

(6%) mostly focused on the lack of content all together within AR browsers.

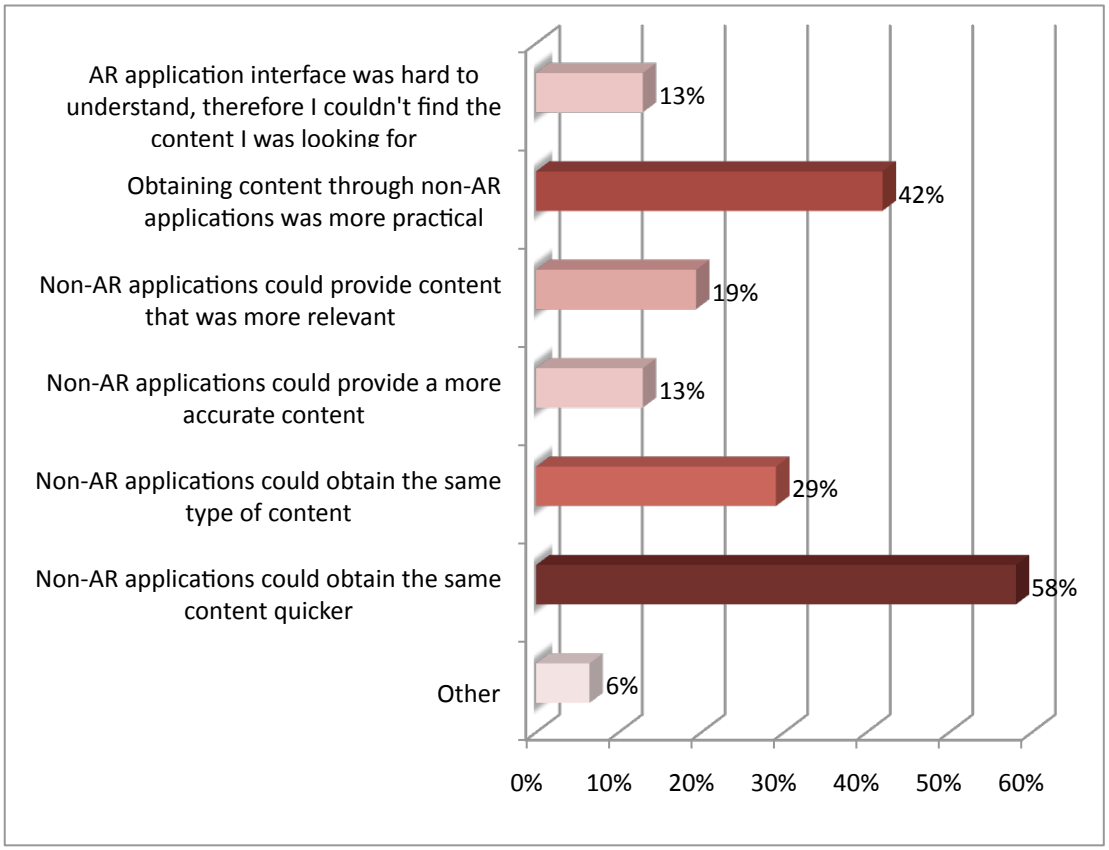


Chart 5.3 Overview of answers given when asked if participants reasons for infrequent use of mobile AR application.

Lastly being asked the question: "what would have to change in order for you to start using mobile augmented reality applications more often?" Answers within this group broadly focus around four topics, firstly the usability of the application. Here participants commented mostly on the speed of AR applications, one participant mentioned, "I want short quick experiences" and "the barrier to entrance is to high". Secondly content was an important issues for not using AR applications more, notably the lack of content, but also more interesting content, more relevant content, one participant suggested, "making it easier to filter and sort content. Technical limitations was a third reasons for not using more AR, especially accuracy of the positioning. Lastly most participant within the infrequent use of mobile AR applications group commented that it didn't add value all together, they found it too gimmicky, and would like to see it being used in a practical meaningful way.

Frequent use of mobile augmented reality application

Continuing with the proportion of respondents that indicated that they frequently used mobile augmented reality application (see chart 5.4) (n=50) we see in contrast to the non frequent users a much larger part (74%) which uses a combination of both map style augmented reality and visual recognition. 18% of the participants indicated to use a map-style augmented reality application and 8% to use visual recognition style augmented reality.

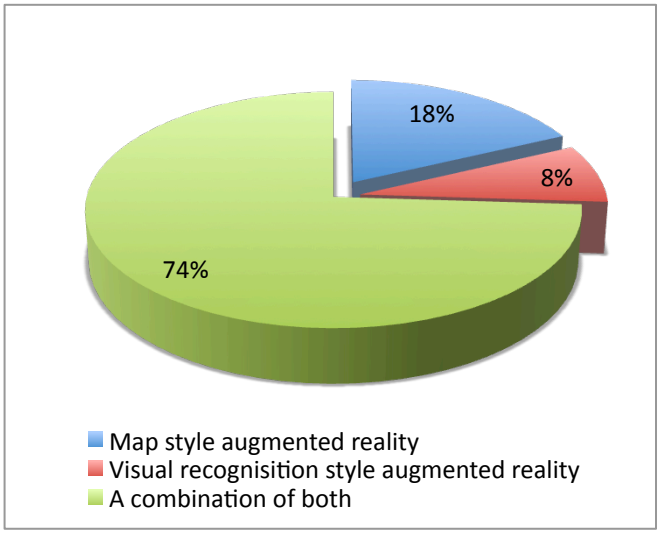


Chart 5.4 Overview of users of mobile augmented reality applications frequent use.

When being asked what the main reasons were for using this augmented reality application over a non-augmented reality applications (as can be found in chart 5.5) the main reason (42%) mentioned that the AR application could help them find content which couldn't be obtained through non-AR applications. Furthermore a majority (38%) indicated that the content had more relevance when being accessed through an AR application. Both the practicality of the AR application as the ease of use of the interface was indicated next (both 34%). Lastly how quick the content could be obtained (28%) and only 6% of the participant within this group mentioned the accuracy of the content as a reason of using AR application of non-AR applications. Also a large part of the respondent (36%) had reasons to add of why they used AR applications over non-AR ones particularly focusing on ease of use "less typing", "easier consumption of conceptual data". Furthermore some respondents within this group found mobile AR application to be "a more interesting way of gathering data", "more spectacular" and " a cool gadget".

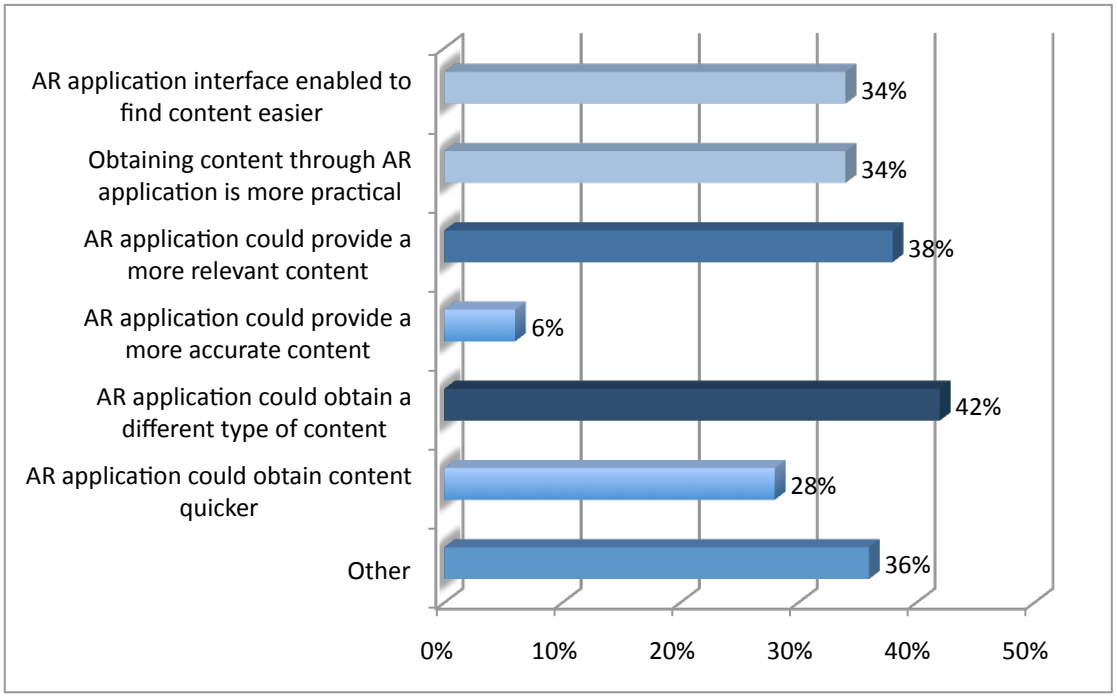


Chart 5.3 Overview of answers given when asked if participants reasons for infrequent use of mobile AR application.

Lastly the respondents within this group were asked how mobile augmented reality application could become even more useful to them. Answers here again focused on similar topics as were found by the non frequent users, firstly focusing on usability the lack of speed of the applications was mentioned, as well as having less options and simpler use. Furthermore multiple people stated that in order to use augmented reality applications more they would like to see it better integrated with already existing applications. On content the same things were mentioned as before, namely filter content on relevance, more and higher quality content, but also notifications of relevant content when nearby and the other types of content as for example sound. Considering the technique most of the comments are centered on the accuracy of the GPS. Lastly considering the value of augmented reality application participant in this group would also like to see applications that make life better, that are useful. One participant mentioned he would like to see an easy way to link object in the real world to AR based object by means of a web based service to create educational facilities.

5.7 What business-to-business opportunities does mobile augmented reality facilitate?

During the interviews it also became clear that mobile augmented reality, as a technique is not only used to fix consumer pains, but also to fix business pains. Especially here it didn't seem to be a goal, in contrast, one interviewee mentioned "applications that jump on the augmented reality bandwagon and use augmented reality as their primary selling point will fail". Augmented reality seems to be a way of making processes in the value chain more efficient, in some cases as a way of visualizing multiple streams of data in such a way that business processes ran more efficiently. This way "augmented reality is a technical part of something that is a lot bigger and it basically is about improving business processes in a very innovative way. It is a tool, yes, but that doesn't mean that there is an ultimate way of how it should work."

"For a company that manages and maintains traffic signs we created a mobile application that not only shows engineers where the traffic signs are located, with one click it also navigates them to those signs. Furthermore pointing their tablets camera at the signs enabled the engineers the pull up data on past repairs and current issues, enabling them to make their whole flow of work more efficient. This is where the extra value comes from, enabling certain companies to transfer different parts of their supply chains in to one application".

And:

"Everyone in retail should embrace augmented reality as a way of more efficient local based advertising, as a more efficient way of customers specifically looking for a product to find you. Through augmented reality we'll see that people will have to go back to physical locations because content has a lot more relevance there, that if I look at a certain product I can see that in my proximity I can get it cheaper. Information gathering, which from the stores on the street got transferred online this way comes back to those same stores, as sort of a wave."

Lastly:

"for a German science quiz on television we developed an augmented reality application through which people could instantly partake in the show. Viewers could scan an image in the corner of their TV screen, through which the application got activated and viewers could instantly partake in the quiz. They could answer questions, receive feedback and see how good you did in comparison to other players. Having such a system makes voting through text messages obsolete, which saves money for both the show and the viewers. Also it's a brilliant way of keeping your viewers connected to the show whilst having a commercial break."

5.8 How can augmented reality be monetized?

During the interviews two ways of monetizing augmented reality were mentioned, the first being through some sort of trigger. A trigger that is linked to something "which is measurable by a mobile device. One interviewee mentioned for example "a combination of text recognition, augmented reality and mobile would open up a unique way to make money for mobile". Another interviewee mentioned, "we make money based on visual matches within our system, a match is created when through augmented reality a visual input is matched with an image on our server."

The second way the interviewees made money with augmented is adding it to existing processes and selling that as a package. This happens through "linking pieces of value chain, enhancing them with augmented reality to make them more efficient". This could for example happen for company processes as mentioned above, but interviewees also mention extending already existing mobile application as for example travel guides.

5.9 Ways of doing business through/with mobile augmented reality

As already portrayed above there are several ways of monetizing augmented reality. During the interviews several very specific examples were given of monetizing augmenting reality applications and using it to enable either consumers or businesses to view data in less time consuming / more effective way. Most of them were already mentioned above and therefore it has been chosen not to duplicate them here. They will however be mentioned again in the next chapter.

6. Conclusions

In this section firstly the evidence is presented either in accordance with or in contrast with the propositions as presented in the theoretical framework above. Also in line with these propositions the answer to the main research proposition is given.

6.1 Proposition 1 – Definition augmented reality

In proposition one it was suggested that augmented reality should be considered a tool that can be used for digital interactions with objects in a physical context, which should help solve problems more effectively. From the interviews it was found that mobile augmented reality 1) should be used as a data-visualizing tool, 2) must interact with reality, 3) should use sensors connected to a mobile device, 4) should be used to solve a problem is such a way that it adds value.

In line with proposition one, mobile augmented reality is considered to be a data visualizing tool for interacting with physical world objects (or physical context) to solve our problems more effectively.

6.2 Proposition 2 – An augmented reality browser is a specific case of a web-browser

Web-browsers and augmented reality browsers can be used to visualize content with, and people can use it to connect to one another. This and the fact that the interviewees knowingly or unknowingly often used the word 'browser' to describe what mobile augmented reality is, namely "a contextual browser", strengthens the idea that web-browsers and augmented reality browsers are indeed similar and comparable based on their functionalities.

However based on the content that can be visualized there are some differences when comparing to 'traditional' web browsers. An augmented reality browser can for example based on a visual input project certain information that is not possible with a regular browser. It does work the other way around though; augmented reality browsers can show certain information based on a textual input, just as regular browser can. Another difference between augmented reality channels and webpage's is that augmented reality channels aren't interchangeable between browsers.

In line with proposition two, augmented reality browsers can be considered a specific case of a web browser. It does enable the user to perform similar functions as with a web browsers, however enables that for a wider range of content, which though mobile use is also based on context through visual and location data.

6.3 Proposition 3 – Extent business opportunities through technical functionalities

In proposition three it was proposed that mobile augmented reality through the functionalities of a smart mobile device could extent existing business opportunities. Although it was found that the technical functionalities enable new augmented reality services to be developed, business opportunities should not be reasoned from a technical perspective. What this means is that although something is measurable with the sensors of a smart mobile device it doesn't necessary means that it should be visualized through an augmented reality application. Business opportunities should be reasoned form a consumer a consumer perspective, i.e. how can a problem be solved through augmented reality by adding value for the user.

In contrast to proposition three, extending business opportunities should not be done from the technical perspective of mobile augmented reality. This doesn't mean however that mobile augmented reality can't be used to extend business opportunities.

6.4 Proposition 4 – Mobile augmented reality can be used for value chain innovation

In line with proposition two it was found that mobile augmented reality browsers are a specific case of web browsers. In line with this proposition it was also found that that today mobile augmented reality developers already use it to bundles different streams of company data in order to visualize it in such a way that it enables a company to lower coordination and transaction.

In line with proposition four the results show that mobile augmented reality applications can be used to innovate separate parts of the value chain by transferring different parts of the value chain in one application. This by visualizing multiple streams of data and enhancing them within augmented reality in such a way that business processes run more efficiently.

6.5 Proposition 5 – Current augmented reality browsers insufficiently provide value

Within the additional survey that was undertaken in order to find data for this proposition, a difference was made between frequent and infrequent users of mobile augmented reality browsers. Within the group of less frequent users, their biggest reasons for doing so was that non augmented reality applications could obtain the same content quicker and the way of obtainment was more practical. Also what was found that applications were too gimmicky and didn't add value, even leaving out the argument that the GPS couldn't provide an accurate enough experience.

Looking at frequent users their number their number one reason of their frequent use was that through these augmented reality applications they had the possibility to obtain a different type of content than would be possible using non-augmented reality applications. Relevance of content was found an important factor, as well as ease of finding and practicality (e.g. less typing) of mobile augmented reality applications.

Looking at the type of augmented reality application that was used by these different groups, within the group of frequent users the majority used a browser, which is capable of both map and visual style augmented reality. These same is true for the less frequent users however the percentage was much lower, and the percentage of just map style augmented reality was much higher. Although this doesn't lead to any hard conclusions, it might indicate that users perceive certain types of augmented reality less useful.

Since several types of mobile augmented reality browsers exist today no conclusions can be given on proposition five. Differences between the frequent and less-frequent group of users might indicate that certain types of augmented reality is perceived more value adding.

6.6 Main research proposition – Utilizing augmented reality leads to new business models

As has been shown above mobile augmented reality can indeed be used to innovate separate parts of the value chain. Also from the interviews several ways of doing business through mobile augmented reality were found, this enabled companies to achieve superior through value chain innovation, i.e. a superior way of making an already proven product or service. However what seemed to be lacking is a way of monetizing such services in a business to consumer setting. The rest of the observations seemed to use mobile augmented reality purely as a way of innovating already existing business models in order to make them more efficient.

Although in turn this might lead to lead to new business models, in contrast to proposition 6 it is too early to conclude that mobile augmented reality already leads to new business models.

7. Discussion

In this section, the results of this research are discussed in the context of the theoretical framework. Based on this review, nuances can be made regarding the results. The results and conclusions of this research are discussed as well as the theoretical foundations of the studying accordance with the main research question: does use of mobile augmented reality lead to innovative business models?

During the course of writing this thesis it became clear that it is not only in the academic world that there is little known on mobile augmented reality in relation to innovating business models and improving value chains. Based on the figures of people that actually use and re-use applications it seems that some practitioners also have a hard time figuring out how to apply and build augmented reality applications in such a way that it provides value for end-users. Therefore the discussion below will not only include suggestions for future research, but also suggestions for developers. Starting with the implications of a new definition of mobile augmented reality, followed by what the implications are of current consumer thoughts on augmented reality. Lastly will an overview will be given of what it means that no augmented reality business models have been found.

7.1 New definition mobile augmented reality

Mobile augmented reality was defined by the participants in this study in such a way that it is line with the one suggested in the literature. However the definition as put forward by Benderson and Druin (1995), seems to be missing some clarity and could be fenced off more clearly. This based on four properties as put forward in the conclusions: 1) should be used as a data-visualizing tool, 2) must interact with reality, 3) should use sensors connected to a mobile device, 4) should be used to solve a problem is such a way that it adds value.

Looking at these four properties more closely it is possible to explain them in accordance with the interviews in order to 'translate' them in to a framework to put a fence around which conditions an augmented reality application should have. Based on these pieces a new updated definition of augmented reality is given.

1) A data-visualizing tool

In accordance with what Bimber and Raskar (2005) argue augmented reality should be used as a '*tool*' to solve a problem with. Following the expert's interviews the word '*tool*' in the instance of mobile augmented reality applications should be interpreted a 'way of visualizing data'. Augmented reality should be used as a tool to visualize data with, just like a drill is used for drilling holes. Because augmented reality should be considered a tool, augmented reality in itself shouldn't be used as a primary selling point; just as a drill is not sold for being a drill, but for the holes is can drill.

2) It should be used to interact with reality

Mobile augmented reality should be used to interact with reality, i.e. as a two-way street between what happens in a physical context and what is visualized. Keep projecting or visualizing data on top of reality regardless of what happens in context is not interacting with, but rather using augmented reality as a one-way street. Mobile augmented reality should '*interact*' with the physical world, because only that way it make the data that is visualized relevant.

3) Reality is that what sensors can measure

Azuma (1997, p.356) talked about stimuli (visual, sound, physical sensation) in relation to what could be augmented with augmented reality. During this research however and in contrast to proposition three only visualizing was f ound as a way of augmenting reality, i.e., no augmented reality system was found that could for example instantly translate from sound one language in another language and neither a system that could augment physical sensations

Only augmented reality applications were found that could visualize based on what on what sensors housed or connected to a mobile device could pick up from what was happening in a '*physical context*'. In theory this could mean virtually everything, in practice however only a couple of things were uncovered, notably linking content based on GPS coordinate, linking content to a specific visual input or a combination of the two. Another form that was mentioned was visualizing information based on a sound input.

4) It should be used in order to solve problems in such a way that it adds value

Lastly and maybe most importantly augmented reality should be used to solve user problems more effectively than can be done using other systems that can visualize data. Instantly having a translated text from one language to another on your screen just by pointing your phone to a document for example is more efficient than having to type it in into Google translate for example. What this means is that although something is measurable with the sensors of a smart mobile device it doesn't necessary means that it should be visualized through an augmented reality application. An augmented reality application should add value for the user and according to the expert interviews they should happen by enabling the user to either save time or money in comparison to what can already be achieved using alternatives.

So although the literature provides with a definition of augmented reality that is sufficient it lacks a bit in clarity and therefore feels a bit outdated. Based on the above findings the following definition is therefore proposed:

"Augmented Reality should detect and interact with contextual data in order to visualize content in a way that not only enables a user to solve a problem, but does that to such an extent that it is more efficient and effective than would be possible using alternatives."

7.1.1 Practitioners - Just projecting content on a GPS coordinate is not augmented reality

Looking at the proposed definition of augmented reality as above, it is possible for developers to see what properties an augmented reality application should have. It is also possible to see that map-style augmented reality, visualizing digital content and linking it to a GPS coordinate can't be considered a form of augmented reality. Although it does visualize data en uses mobile sensors to do so it misses out on two important characteristics.

Firstly it doesn't interact with reality, but only projects on to reality based on a GPS coordinate. As mentioned strikingly by one of the interviewees "if you place your finger over the camera it would blissfully unaware keep projecting data" i.e. it doesn't base its output on a visual input. Because the application is not using visual input, it's very hard to make the data that is shown more relevant, except if you would filter content based on keywords. Secondly, it doesn't solve a problem in a value adding way. It might solve a problem, however it doesn't solve in such a way that it adds value over other alternatives as for example a map style application that also filters searches based on keywords and location.

As an augmented reality application this would make it unappealing to use it over the long term. That doesn't mean that it has no right to exist, but since it has no obvious advantages over for example applications as Google maps, it might fit better as an extension to such applications, letting the user decide when results are more relevant in video see though.

"Projecting data on a GPS coordinate is not augmented reality, and to prevent further confusion between the two, it might be beneficial to call it 'projecting data on GPS in video see-through'

7.1.2 Scholars – An extendable augmented reality framework

For scholars studying business models in relation to mobile augmented reality this framework provides them with context within they search for potential augmented reality case study objects. Although Azuma (1997) suggested that augmented reality should mix several stimuli (visual, sound, physical sensations) with real ones, during this was found that right now only visual and sound sensations are augmented in a visual way. This doesn't mean that sound and physical sensations can 't be augmented with digital counterparts, it only means that this research suggests that it's not happening right now in a business context. For future research topics scholars might investigate both sound and physical sensation augmented reality for business models.

The augmented reality description provides academics with a framework, which they can use to find potential augmented reality subjects. This framework now focuses on augmenting content in a visual way; however from the literature and the interviews it is predicted that others forms (physical and sound) might also emerge. Scholars should be on the lookout for these and where necessary extend the framework.

7.2 Consumer perspective on current mobile augmented reality browsers

The results of the consumer survey revealed some interesting perspectives on how they think of current mobile augmented reality browsers. The most significant results of the less frequent users group was that they saw non-augmented reality applications as a way of obtaining a similar content quicker and more practical over augmented reality applications.

Although not making a difference between types of augmented reality browsers, in contrast to what augmented reality should provide according to Mackay (1996), apparently less frequent users don't feel that current augmented reality browser add any value. Also as proposed by (Bimber and Raskar, 2005), one of the building blocks to get a believable augmented reality experience across, accurate tracking and registration, is perceived as inaccurate by users.

7.2.1 Practitioners – What should a mobile augmented reality application entail?

During the interviews it became clear that "mobile augmented reality is not a goal, but a means of solving a problem more effectively". In other words developing augmented reality applications that don't solve any direct user problems don't make any sense. Therefor it isn't logical to try and visualize everything that can be recognized by the mobile devices, because users might not desire it. In line with what Benderson and Druin (p.3, 1995) argue the key into designing augmented reality applications lies in clearly specifying how people interact with physical objects in the real world and indentifying the problems that additional computational support would address.

Think of the example of how people interact with a broken washing machine, namely through their physical manuals. Now according to the interviewees effectively solving this problem through augmented reality, would have to mean solve it in a value adding way, i.e. saving time or money by doing so, which is in line with what Mackay (1996) argues. By pointing your phone at your washing machine, hereby projecting the manual over the washing machine on your screen, instead of having to read the separate steps the application projects every step interactively in order to fix what is broken.

Examining from the survey what frequent users considered as their biggest reason for doing so, in line with what the experts argued was that through these augmented reality applications they had the possibility to obtain 1) a different type of content than would be possible using non-augmented reality applications, 2) which had relevance, 3) was easy to finding and practically accessible (e.g. less typing)

When developing an augmented reality application, practitioners should not reason from the technical functionalities a smart mobile device has, but rather from a consumer perspective. The question the should ask themselves: "How can I enable the user to save or money by providing them with augmented reality application that 1) provides a unique content 2) which is relevant 3), and accessible and findable in a easy and practical way?"

7.3 No augmented reality business models

7.3.1 Scholars – Almost all properties in place for mobile AR business models to emerge

This research contributes to existing literature on several points: in line with Amitt & Zott (2001) it was found that augmented reality, just as a web browser is used by companies as an interface to data, which also indicated it leads to an increase in communication possibilities, which makes a augmented reality browser a 'type' of web browser. Furthermore from the interviews in line with research from Osterwalder, Pigneur and Tucci (2005) mobile augmented reality was found to enable companies to lower coordination and transactions costs. Through this it seems that companies are able to innovate separate parts of the value chain by transferring different parts of the value chain in one application. This by visualizing multiple streams of data and enhancing them with augmented reality in such a way that business processes run more efficiently. Although research done by Magretta (2002) suggested that it is these kinds of developments that lead to the emergence of new kinds of business models, this research didn't find new any emerging business models that use mobile augmented reality.

Although this research didn't find any specific mobile augmented reality business models almost all the properties – increase communication possibilities, interface to data, lowering transaction costs, innovate value chain -, just as happened with a web browser are in place. Scholars might want to focus on augmented reality as an interface to data as starting point for future research on business models.

7.3.2 Scholars - No way to monetize mobile augmented reality services

So although no new augmented reality business models where found during this study, all the factors seems to be in place for the emergence of new business models. A crucial part however within business models is a way of generating revenue (Osterwalder et. al (2005; 2009) and it seems for mobile augmented reality such a way is non existent. Sure it is sellable as a complete package, which happens in a business-to-business setting as a value chain innovation, but what's missing is way to monetize augmented reality service directly from a phone, with a single click as would be possible from a website. A way of doing so was described by one of the interviewees as creating visual matches system with an image our server. However this still has to be linked to some type of mobile wallet.

The absence of a way to monetize mobile augmented reality services might be one of the reasons why no new business models have emerged yet. Future research on mobile augmented reality should carefully assess if a way of making mobile payments exist which might facilitate the emergence of new business models.

7.3.3 Practitioners / Scholars - Look at existing web services which can be innovated

As mentioned before a mobile augmented reality browser can be considered an instance of a web browser. The difference being that augmented reality browsers van show content which is based on and interacts with measurable contextual data. An interesting thought here is that since they are both in essence ways of visualizing data they could very well act as extensions to each other. That this type of mutual beneficial relationship might come to exist is strengthened by the interviewees that predict that when mobile augmented reality browsers will standardize more, they'll be integrated with mobile web browsers, as we already know them. What this would mean is that considering mobile augmented reality as a way of value chain innovation, it could be used to make existing web services more effective. When data that is visualized has more value coming from interaction with the context of a user, the augmented reality view could be enabled in favor of the web-based view. An interesting example was given by one of the interviewees: "if standing an waiting on the train stop it would make a lot more sense, instead of typing in where you are and seeing how long it takes from the train to arrive, to based on GPS see where you are and visualize by the actual locations of the trains how long it will take them to arrive".

Mobile augmented reality is considered an instance of a web browse, and a way to innovate value chains with. Developers should look to innovate/extend already existing web-services with augmented reality, switching to augmented reality view when presenting data that way provides more value/ is more relevant for the user. Since augmented reality is not a goal, but a means of presenting data more relevant, scholars researching emerging new augmented reality business models, might want to focus on those services already presenting data as a starting point.

8. Reflections

8.1 Limitations

The present study is not without limitations. Foremost, because of the explorative nature of this research, several different topics emerged, however since this research focused on possible emerging augmented reality business models this can't be considered a limitation.

Firstly considering limitations concerning internal validity, from the literature it was found that apparently a lot of different ways of doing business through mobile augmented reality exist. However, discussing all the topics with the interviewees took a lot of time, and not all topics could be discussed in each interview. A preliminary interview was conducted however to find out if the right questions were extracted from the literature and theoretical framework. From this several topics were developed through which it was tried to find answers to the research questions. From this some contradictions arise, considering reasons why people should use mobile augmented reality applications and actual usage. To triangulate and keep the internal validity up, additional data from secondary sources were collected. This limits the research since in limits the amount of data, on the other hand it does provide a bit more depth since interviewees came from different 'viewpoints' (e.g. investor, developer, platform) in the augmented reality industry. One consequence of having several topics to discuss is that interviewees tend to get enthusiastic with augmented reality idea's however it is not always clear which idea's are already functional.

To triangulate the data further a survey was developed from the data collected from the interviewees and the secondary sources. A downside of such a survey study is that there is a limit in the number of questions that one questionnaire can contain if you are trying to ensure a good response rate (Saunders et. al, p.138-139). Because of this the number of questions was kept to four and a new way of gathering data was tried, namely by finding and contacting participant through Twitter. One might think that finding people based on keywords on Twitter might lead to biased views, this research specifically was interested in people that actually had used augmented reality. This proved to be a rather successful way since within 48 hours, 182 people from 24 countries clicked the link. Eventually of those 182, 83 people filled out the survey.

Future research however therefore should better focus on already implemented solutions, and might be better of interviewing well-established bigger players in the market, to get a more coherent view. Another consequence of discussing several topics

is that interviewees tended to slide from mobile augmented reality browsers, towards mobile augmented reality applications in general, augmented reality gaming and stationary augmented reality solutions. Although they were really interesting it didn't always match mobile augmented reality opportunities. For future research it might be beneficial to clearly state up front which sub sector of augmented reality you are interested in.

Another limitation of this explorative research is the availability of business literature on the subject of mobile augmented reality. Because of this presumed that new business opportunities for augmented reality would come from the non-stationary functions of mobile devices, after that I presumed it came from the technical functionalities of mobile devices, however new business opportunities arose when mobile augmented reality could provide a more efficient way to present data for a user in a problem solving way. Because of this it was hard constructing a coherent literature framework and propositions, which might lower the overall construct validity. Up-front in wasn't known in which of the taxonomies as presented by Rappa (2010) mobile augmented reality would fall (it ended up didn't falling in any), therefore it made it hard to become more specific towards one specific business model. It is because of this that the theoretical framework developed from the literature could come across as a bit shallow. However because so little was know about the two subjects in relation to one another that a broad approach seemed most fitting.

Finally taking into consideration the overall reliability it was tried to unfold as much of how the research was done in the research methods, also including how participants were found, around what themes the interviews were conducted, what questions were asked to participants in the survey. This all so future research can use the findings presented in this paper as optimal as possible.

8.2 Contributions

In this research it is explored if implementing mobile augmented reality leads to new business modes. To find an answer to this, insights are provided the several ways of doing business with augmented reality today, from viewpoints from investors, developers and platforms are provided linked to various propositions. This resulted in an overview of how mobile augmented reality is viewed upon, an how this vibrant market is still undergoing rapid changes. Despite its limitations, this research has a practical as well as a scientific contribution.

The practical contributions can help developers in several ways. Firstly it provides them with a fenced of contribution of the term augmented reality. When developing mobile augmented reality application this might be beneficial in order to find out if the service you are providing is to be classified as augmented reality, or more importantly not augmented reality. Some platforms that exist today in contrast to what is known call themselves augmented reality platforms, however they are lacking on one point namely interactivity. It doesn't interact with reality and therefore is can't be considered augmented reality. Another contribution for practitioners is that in this research consumer perspectives are included, which might help developers ask themselves the right questions when they are developing applications. Notably an augmented reality application should focus augmenting a unique type of content, in a practical way, which actually solves a problem. Lastly for practitioners this research gives direction into where opportunities might be found, since mobile augmented reality is considered a type of web browser, showing a different content and used for value chain innovation; a mutual beneficial relationship might come to be with existing web-services. Switching over to augmented reality view when presenting the web services data provide more value.

The scientific contribution is threefold: first, it enhances the current body of knowledge regarding mobile augmented reality. This research based on in-dept interviews gives a more clear description of how mobile augmented reality is to be interpreted within a academic setting. For those studying mobile augmented reality this gives them the opportunity to test if it is actually augmented reality. This framework might be extended to include other ways of augmented reality, notably through sound and physical sensation in line with Azuma (1997). This is a scientific contribution since it enables other researchers to make their own judgment on the finding of their own research. Secondly this research provides a contribution to the literature in a way that indicates that a mobile augmented reality browser is to be considered an instance of a

web browser. Just as a web browser, a mobile augmented reality browser can be used as an interface to data, used to connect with each other, lower transaction costs and innovate value chains. This mayor contribution to the literature since it was for these same points that new business models started to emerge through web browsers. However no way of monetizing was found for mobile augmented reality yet, so no new business models either. To conclude, besides providing an answer to the research question and sub questions, this research has a scientific contribution since it provides numerous suggestions for future research and thus a starting point for future research. These suggestions for future research result out of discussing the research from various perspectives and theories.

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Appendix I – General overview interview questions

Introduction

- My background
- Subject of research

  1) Finding out if augmented reality business models exist

  2) Your view on the following subjects: augmented reality meaning, augmented reality browsers, augmented reality stimuli, augmented reality monetize, augmented reality content, augmented reality sensors, augmented reality value chain and augmented reality business models.

  3) Your view on these subjects

  4) Permission to record interviews.

Questions:

Although this was the set of initial question that were used for every interview, most interviewees took in their own directions giving examples there where necessary.

1) Could you please indicate what mobile augmented reality means to you?
2) Could you give some examples of mobile augmented reality applications?
3) In what ways does mobile augmented reality facilitates linking digital content to physical context?
4) Is there any way to monetize this linkage?
5) What type of trigger could be used to monetizing such a service?
6) What do you consider to be the value proposition of augmented reality ?
7) Can augmented reality, next to a way of linking physical context to digital content, also be seen as a distribution channel?
8) Looking at online business models as we know them now are they transplantable to mobile AR?
9) What are the differences between 'traditional' online browsers and AR browsers?
10) What are the differences between 'traditional' webpage's and AR webpage's looking at content ?
11) What would for mobile AR be comparable to a click on a website?
12) An AR channels can be seen as a website that is not only placed on, but also based on physical world surroundings?

13. Do you think that augmented reality channels will become interchangeable between browsers?

Appendix II – Overview interviewees

Jeroen Mol (the Netherlands) – CEO BuzzAR / CTO Beyond Reality BV

Jeroen Mol, started in 2001 with Mitridate BV (record company specialized in Opera music), real traditional brick and mortal company and shifted to the internet with it. In 2006 he started OwnSite. Building web applications and contracting work generate OwnSite's revenue. Most of the income was invested into new ventures/ideas. In 2007 he founded Touching Media BV. Touching Media has a strong focus of delivering innovating technology and surprise the audience. In February 2009 Touching Media started the brand 'Beyond Reality'. In September 2009 'Beyond Reality' was adopted by ProSystems to take Beyond Reality to the next level. In April 2010 Beyond Reality BV was born. November 2010, OwnSite started with a new revolutionary product buzzAR; mobile visual search. buzzAR is a visual search platform. It will allow publishers, advertisers or anyone that has a printed image/logo and want to connect it to online content. Beyond Reality's main strength is image recognition. All their products use a (web)cam to recognize images and trigger some kind of event. We are focussing mainly on Augmented Reality projects.

Remco Vroom (the Netherlands) – CEO Tab World Media, Founding Partner AR experience

Remco Vroom is co-founder and CEO of TAB Worldmedia. Vroom also previously served as a commercial and strategic director at advertising agencies Euro RSCG, Grey Worldwide, TBWA\ and Young & Rubicam. Vroom lead several brands to commercial success and he received numerous awards for his work: 2 Cannes Lions, 3 Effie Awards, 2 New York Festivals, 2 ADCN Lamps among others.

In the year 2010 Vroom decided to take commercial communication to the next level with mobile augmented reality and he founded TAB Worldmedia together with his

business partner Johannes la Poutré. His new found company is the first full service mobile augmented reality agency in the world that helps international brands get insight and knowledge in how to use this powerfull personal marketing tool. TAB Worldmedia has contracted several international brands and is now one of the leading companies on augmented reality and augmented media strategies in the world. Customers include TedX, National Geographic, HornBach.

Ken Blakeslee (England) – AR Investor Webmobility Ventures,

Ken is one of Europe's leading experts on Mobile Services and Applications with particular focus on the emerging new media content, applications and commerce methodologies, and the merging of these with the ubiquitous, personal access of mobile. Using his unique combination of business, industry and investment experience, he has built, nurtured and managed diverse teams to develop consumer and business oriented solutions, and brought these propositions to market. His experience in developing telecoms, IT and web commerce business strategies spans 25+ years. He is frequently a keynote speaker and chairperson at global industry events, authored numerous articles and is regularly quoted in the press. In 2004 Ken launched and produced 'Cool and Connected' a Wearable Technology Fashion Show at 3GSM World Congress in Cannes.

Ken's Company, WebMobility Ventures, focuses on advising companies on bringing innovations in multimedia mobility to market. Prior to that he was Chairman of WirelessWorks with The Vesta Group, managing the investments of one of Europe's top networked venture capital funds, Frontiers Capital. Now fully invested, this $85M fund focused on Mobile Internet enabling technologies and was a joint initiative between Vesta and the Carphone Warehouse. In addition to being a venture partner, he established and was Chairman of their Board of Advisors. He has served on the board of directors of Picofun, eDispatch, and Cybiko, and is on the board of advisors of AirIQ, BrainMedia, Cartagena Capital, Hutchison Harbour Ring (i.Tech), Informa, IXI Mobile and Microvision. These companies are all innovatively active in various sectors of mobile investment, product definition and service delivery.

Noora Guldemond (Germany) – Head Sales Europe Metaio Inc

Noora is Head Sales & Marketing at metaio GmbH based in Munich. Metaio is considered a pioneer in the area of augmented reality (AR) technology. Metaio develops software products for visual interactive solutions seamlessly combining real and virtual elements. Based on the software platform Unifeye, 3D-animations can be integrated seamlessly into the real-user's environment. Metaio is also involved in numerous federal, national and international research projects in this field. Our vision is to become a standard in performance and availability at the cutting edge of the real- and virtual world.

For Metaio amongst others she opened the office for metaio in California; business development and marketing to increase the awareness of metaio and its presence in the US. She headed the SF office of metaio, including business development, project management and evangelism of metaio's Augmented Reality platform "Unifeye" by speaking at conferences.

Lester Madden (England) – Founder and Director Augmented Planet

Lester Madden spent 10 years at Microsoft evangelizing the latest Microsoft developer products. During that time Lester helped Orange launch the first Microsoft power smart phone in the UK, championed Speech.NET technologies in the UK, and released several multimedia training DVDs to help developers build .NET applications and take solutions to market. Several of these DVDs were nominated for industry awards in the creativity industry. After leaving Microsoft, Lester joined Skype and launched their developer program increasing the developer base from less than 5 to over 500. During the 3 years at Skype Lester launched the Skype extras manager project and enabled 3rd party developers to achieve over 38 million application downloads from the application store in under 12 months. Lester has also worked at Symbian Software Limited, Nokia Devices R&D and Symbian Foundation, working with thousands of developers to help bring applications to market. In 2009 Augmented Planet was created as a blog to catalogue the ever-increasing growth of augmented reality. In 2010 Augmented Planet Consulting was created to utilize over 15 years of industry experience helping developers and organizations use cutting edge

technologies and bring new products/services to market. Now augmentedplanet.com is considered to be the leading authority in blog space on latest augmented reality applications.

Chetan Damani (England) – Co-Founder AcrossAir

Co-founder of acrossair, a company dedicated to building advanced iPhone games and augmented reality applications. acrossair has recently launched a number of iPhone application on the iTunes app store, including Nearest Tube.

Prior to acrossair, they launched multiple successful companies in the Internet space. In 1997 they co-founded Imano, a full service interactive agency, working with clients such as Nestle, Citibank, Sun Microsystems and KLM helping brands make the most from the Web. CommerceNow, founded in 2003, provides a SaaS e-commerce solution targeting Small and Medium-sized businesses that want to outsource their sell-side e-commerce operation. They soon followed with the launch of TVguide.co.uk, the largest TV listings site in the UK. The TVguide Web platform currently operates in the UK, India and Ireland with the US due to launch in the next few months.

Alexander Ribbink (Netherlands) – Partner at Prime Ventures Invest

Alexander Ribbink (Amsterdam, 1964) is a partner at Prime Ventures, a leading technology venture capital investor in the Benelux. He was chief operating officer and statutory director of the navigation company TomTom. He studied law at the University of Amsterdam and obtained his MBA at the Rotterdam School of Management, Erasmus University. He worked ten years for Unilever, including in Paris and London, and three years for Mars, Inc., before joining TomTom. He swapped Unilever Mars since he joined the Dutch multinational "dynamics" was missing. After three years he was vice president of brand development at Mars, he went in November 2003 to work for TomTom, the marketing of the growing

family of products. TomTom Go, a stand-alone car navigation device, was in the spring of 2004. He is a member of Royal Tichelaar Makkum, the oldest Dutch company, and at the Rotterdam School of Management at Erasmus University, Greetz, Augmented Reality Platform Layar and CInt. He is also director of the Amsterdam Lyceum and the Friends of the Amsterdam Dame Montessori School.