BOM

[**Virtual reality**
Augmented reality]

Hype? Or serious business?

[**2017 report**]

oost nv ::Tanks Innovation Quarter / invest & innovate in West Holland Brainport Industries mikrocentrum opleiden • ontmoeten • ondernemen VR DAYS EUROPE

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1 Introduction

We conducted this survey for the first time in 2016 to answer the following question: is Virtual and Augmented Reality (VR/AR) an exaggerated hype or a business with real potential? Today, one year later, we want to know how the market has developed since then. And if we compare the two polls, what can we say about the future potential of VR/AR?

To answer these questions, we doubled the number of respondents to more than 600 and distributed the questionnaire with the assistance of seven other organizations: Mikrocentrum, iTanks, Oost NV, Brainport Industries, VRDays Europe, VRBase Amsterdam and Innovation Quarter.

This year's market research was conducted by interviewing 613 respondents who are developers or users of AR or VR. Like last year, the respondents are mainly active in the engineering, manufacturing and industry sectors. We included participants from the Netherlands, Belgium and Germany to create an international perspective.

This report is structured as follows. After the introduction we provide a general explanation of the VR/AR market and its current status. Then we analyze the international market by comparing last year's forecasts with the actual results, we discuss the outcome of our own market survey and we conclude this report by circling back to our original question: is VR/AR hype or serious business?

I wish you a pleasant reading. If you have additional questions or require more information, please contact me at **csanderink@bom.nl**, on Twitter (**@sanderink**) or LinkedIn (**coensanderink**).

On behalf of the participating partners,

Coen Sanderink
Business Developer
Brabant Development Agency (BOM)

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2 WHAT IS VIRTUAL, MIXED & AUGMENTED REALITY?

Virtual reality (VR) is about simulating a reality based on 3D-models within a computer.
Mixed reality (MR) concerns the amalgamation of the actual world with a virtual one.
Augmented reality (AR) is adding information to the actual world. This additional information can be presented to the user by means of a smartphone, tablet, beamer, pair of smart glasses or a head-mounted display (HMD).
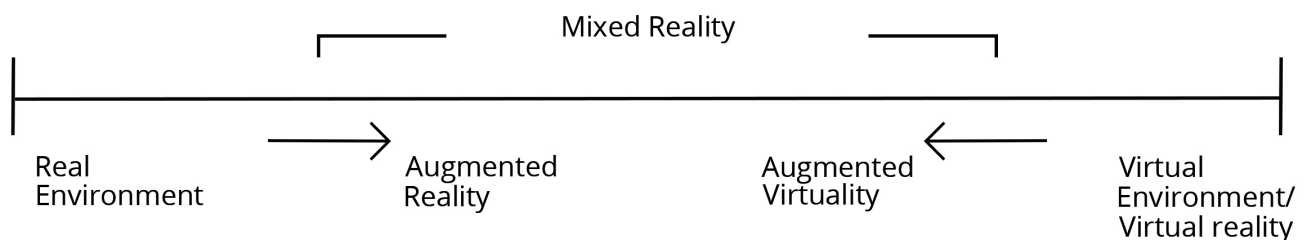
Visual 1 Virtual, mixed and augmented reality.

Development of the first VR-glasses started in the 1960s. At the end of the 1990s, games and new devices like Nintendo's 'Virtual Boy' gave the appearance of a breakthrough in VR. Eventually, technical constraints like weight, inadequate graphics and a shortage of available content hindered development. In the past few years, advancements, especially in smartphone technology, have raised expectations for an actual breakthrough in VR/AR.

It is widely expected that virtual and augmented reality may cause a revolution in technology. At the very least, these technologies will lead to new branches and new ways to work and communicate. Within companies, departments at the end of a process like services will come into direct contact with departments at the beginning of the process like research and development. For example, some companies use VR/AR to train their service technicians in maintaining machines that are still in development (see the Océ / Canon user case on page 7).

One aspect that always plays a role in adoption processes is the so-called horseless carriage syndrome

Some say the adoption of VR and AR technologies can be compared to the emergence of the Internet and the smartphone. One aspect that always plays a role in adoption processes, is the so-called 'horseless carriage syndrome'. In other words, when people are faced with new innovations, they revert to older more familiar technology applications. For example, the first automobiles looked like carriages and the first websites were similar to brochures. Only as time progresses, people can fully grasp the possibilities and unique applications of new technologies.

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The 'horseless carriage syndrome' offers opportunities to first movers since they already experiment with these technologies and they can more quickly understand the potential for new products and services.

"I think there is a world market for about five computers."
- Thomas J. Watson Jr of IBM, 1943

VR and AR technologies enable new ways of interaction and communication. People can enter environments that do not exist in the real world, but at the same time interact with them. Additionally, information and interaction can be added to an actual environment, making it richer by doing so.

The current status of the VR/AR market resembles the Internet around 1995.

In 2016, the first headsets like the Oculus Rift and the HTC Vive were shipped to consumers worldwide. At this point, it can be argued that the international VR/AR market resembles the Internet around 1995. A lack of available and compelling content is a reminder that VR/AR is still an undeveloped market.
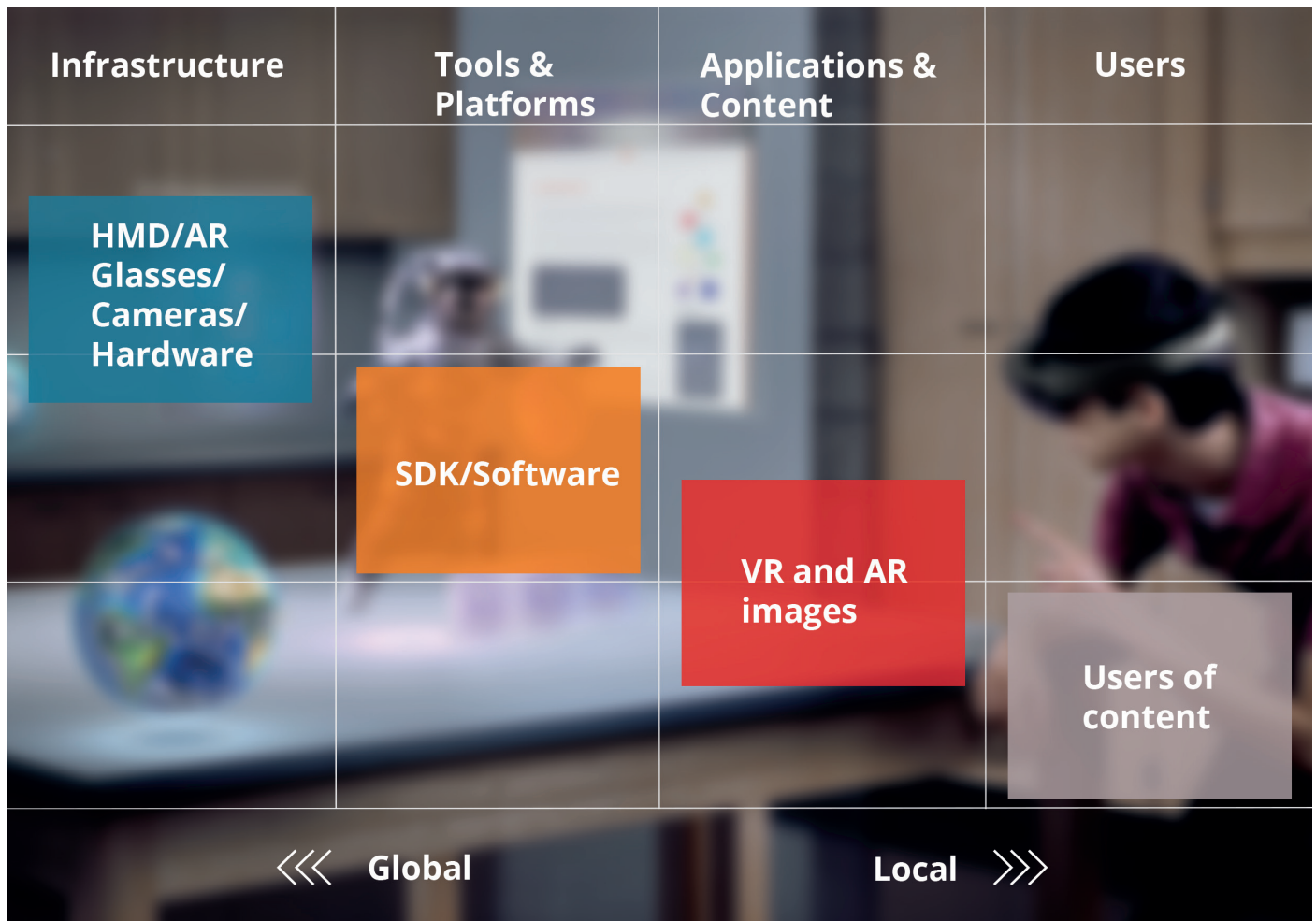
2.2 THE EMERGING VALUE CHAIN

First movers are known for exploring the added value and business cases of new technologies. When the Internet and smartphone emerged, we learned that the value chain can be separated into three segments: **infrastructure, tools & platforms and content**. If all the segments are developed and optimized, added value is created for the end-user. If we analyze these developments by using the Internet and the smartphone as examples, we can better understand the required developments for the VR/AR value chain.

"Study the past if you would define the future."
- Confucius

Infrastructure

Infrastructure is the hardware required to use the technology. The first Internet pages consisted of text because the available bandwidth and computer power were limited. The eventual increase of bandwidth and computer power made it possible to develop more attractive content with pictures and movies. The costs of the infrastructure decreased and became accessible for more people. In 2016, the first consumer versions of VR/AR hardware were released. The hardware and peripherals needed to interact with the virtual world will evolve rapidly in the coming years based on technological improvements and experiences when using the hardware and available content.

Infrastructure	Tools & Platforms	Applications & Content	Users
HMD/AR Glasses/ Cameras/ Hardware	**SDK/Software**	**VR and AR images**	**Users of content**

<< Global   Local >>

Visual 2 The value chain of VR/AR.

Tools & Platforms

The tools & platforms available to develop content are limited at the start of every new technology area. For example, developers needed to know HTML and Javascript to build the first webpages. Editor tools made the coding more efficient, but still the creation of websites was labor intensive and only a few people had the necessary skills. We see the same parallel with VR and AR. Despite the availability of tools like Unity creating content is labor intensive and requires extensive coding knowledge. The result is expensive content. Nowadays, creating content on the Internet is easy and everyone, from a child to a grandma, can be a content creator on platforms like Facebook, Twitter and Snapchat. These applications provide tools for mobile devices to quickly establish a website or profile and share photos and videos. No coding knowledge is required and the creation of content is (almost) free. It is likely that new platforms for VR and AR will emerge or current platforms like Facebook, YouTube and WearVR will evolve. This change will make the creation of VR content easier and cheaper.

Content

In the first half of the 1990s, only a limited number of people had access to the Internet, which had a few niches. For consumers, access was expensive and the available content of limited value. We currently see the same problem with VR and AR. The stores of Oculus and HTC Vive feature limited content. The stores give an impression of VR and AR and what it can do, but the added value is still limited.

BOM [Virtual reality Augmented reality] **Hype? Or serious business?**

Also, the number of people able to view the content is limited because of the lack of available infrastructure. This small audience makes a business case more difficult. Companies like Facebook have said they are investing heavily in content to make it cheaper and more accessible to a large group of people.

> *"The magic of virtual reality software*
> *is this feeling of presence, the feeling*
> *you're really there with another person*
> *or in another place"*
> - Mark Zuckerberg

The available content is limited for businesses as well as for consumers. A big difference for businesses is that the content has to be tailored more specifically to them. Most companies have 3-dimensional designs of their machines, but bringing these models into a world of VR and AR is still time consuming and expensive.

User case

Océ / Canon provides "blended" training to service technicians where virtual and mixed reality training is an important component. The training is developed for engineers to service machines that are still in development.

"'Realistic" virtual reality training on a machine that isn't real is a strong business case. It makes it possible to train engineers without affecting the availability of expensive machines that are already operational. It also creates time to market advantages because business processes, like product development and product training, can be conducted in parallel, instead of sequential.

Benefits:
- Reduces need for expensive "real" training device
- Available 24/7 and unlimited numbers worldwide
- Higher efficiency by assembling or disassembling (rebuild a total machine from its parts with one click)
- Impossible to damage virtual machine parts
- Creates new insights because of easy access to all machine parts and the possibility to have different views that are impossible in "reality"

An additional aspect of VR and AR technology is the perception of a "fun" component. In some situations, training at a location is not possible because of safety issues or availability. With the use of mixed reality, training at a location is possible with a realistic dimension.

2.3 Users and Developers

The value chain shown in Visual 2 on page 6 will be used during this research to understand market developments.

Augmented reality will have a broader application than virtual reality, given its ability to add useful information to an actual environment like operations

To analyze the value chain, we distinguish users (the demand side) and developers (the supply side). Users can deploy virtual and augmented reality in many applications such as training, maintenance, assemblage, production, logistics, leisure and healthcare. Augmented reality will have a broader application than virtual reality given its ability to add useful information to an actual environment like operations. Significant markets are expected to develop for VR and AR applications in entertainment, healthcare and engineering.

Developers of VR and AR applications are involved in creating infrastructure, tools & platforms and content. The infrastructure sector is a global market with large players like Oculus and HTC that focus both on businesses and consumers. The developers we surveyed for last year's report focused more on creating content for the (international) B2B market. In the process, they also developed tools & platforms, mostly for internal use to increase their own efficiency.

Developer case

BlueTea, a Dutch-based software company, developed VirtualStudio® to make 3D-models smart. Starting with an interactive 3D model, the multifunctional toolbox VirtualStudio® easily helps develop virtual training and simulates processes for learning or teaching purposes.

3 International market

In last year's report, we compared the forecasts from Goldman Sachs, Piper Jaffray, SuperData and others to better understand the international VR and AR markets. This year, our aim is to compare 2017 forecasts to the 2016 forecasts and the actual numbers to understand the current market and its potential direction.

Most projections used last year were not updated. Available data consisted of short press releases or summaries of reports, which are detailed in the reference list. Full reports were expensive while the reliability of the data remained questionable. Data about the VR and the AR markets in particular were difficult to obtain, causing difficulty in correctly interpreting the state of the market.

We did find enough information for examination in reports by SuperData, Citi Research and Digi-cap. However, forecasts in these reports featured large discrepancies that were difficult to explain.

Apart from the inevitable variables that caused differences in projections -- like publication date, quantity of resources and level of expertise – there was another factor: **lack of uniformity in terminology**. For example, we saw projections made about dissimilar markets, but were presented under similar names.

Another difficulty was the sloppy use of "virtual reality" and "augmented reality," which were often not defined clearly enough. Some reports used "virtual reality" as an umbrella term for the entire spectrum of VR and AR; other reports used only VR or AR. Furthermore, when forecasting "total VR/AR revenue," the reports often did not clearly state whether applications and content were included or not.

A clear and uniform distinction between all these definitions is needed in reports to simplify meta-analysis and prevent contradicting news headlines about the potential of the VR and AR markets.

Although it was difficult to compare reports from 2016, it was still possible. For 2017, besides copying the numbers of the reports, no additional analysis was possible with the forecasts found. It also was impossible to compare them with our weighted forecast of last year. **Therefore no update of the forecast is given in this report**. The studied reports of SuperData, Citi Research and Digi-cap are included in the reference of this report.

Nevertheless, we wanted to present an impression of the market based on the available information. First, we will give a short summary of the main findings from our 2016 report[1]. After that, we will provide an overview of the VR developments in 2016 based on information from SuperData including a market forecast. Unfortunately it is only one source, which increases the risk of misinterpretation. This overview is concluded with an analysis of international AR market developments in 2016.

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1   http://bom.instantmagazine.com/bom-special-issue/vrar-hype-of-serieuze-business/

3.1 FORECAST REPORT

In 2016, projections for the international VR/AR-market varied substantially for both the hardware and software markets. Much information was absent, while the available pieces of information often contradicted each other. To obtain a clearer view on the market, we calculated the unweighted averages of the available forecasts of reports from Goldman Sachs, Piper Jaffray, CCS Insight, AMD, TrendForce and KZero.
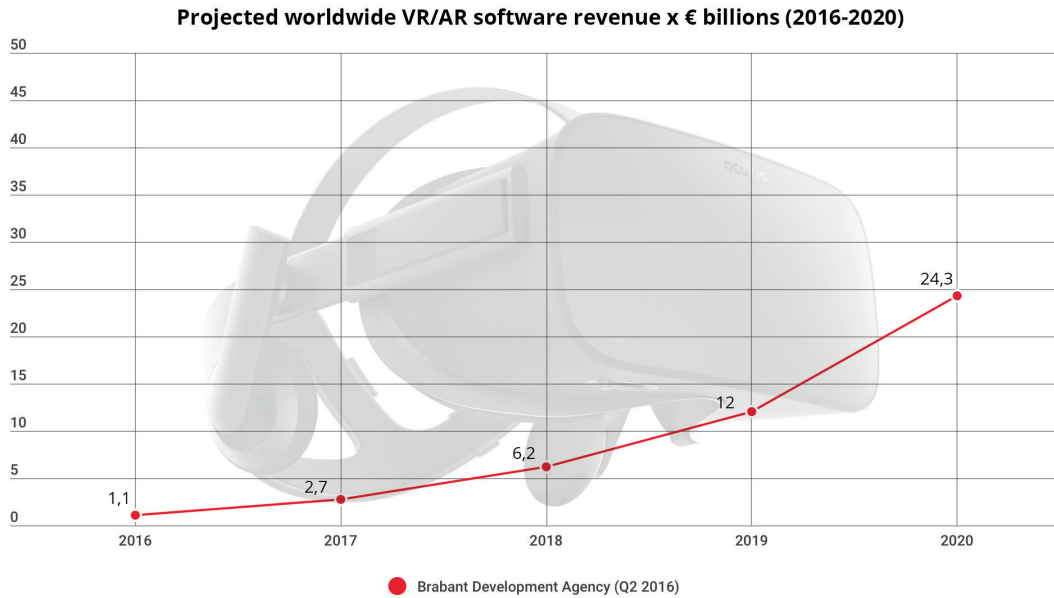
Hardware

Based on this average, the hardware market will **increase 20-fold** during the period 2015 to 2021. The most explosive year should be 2021 when the average estimate is for 82.5 million headsets shipped – nearly double the expected 42.9 million in 2020.

Projected worldwide VR/AR headset shipments in millions (2015-2025)
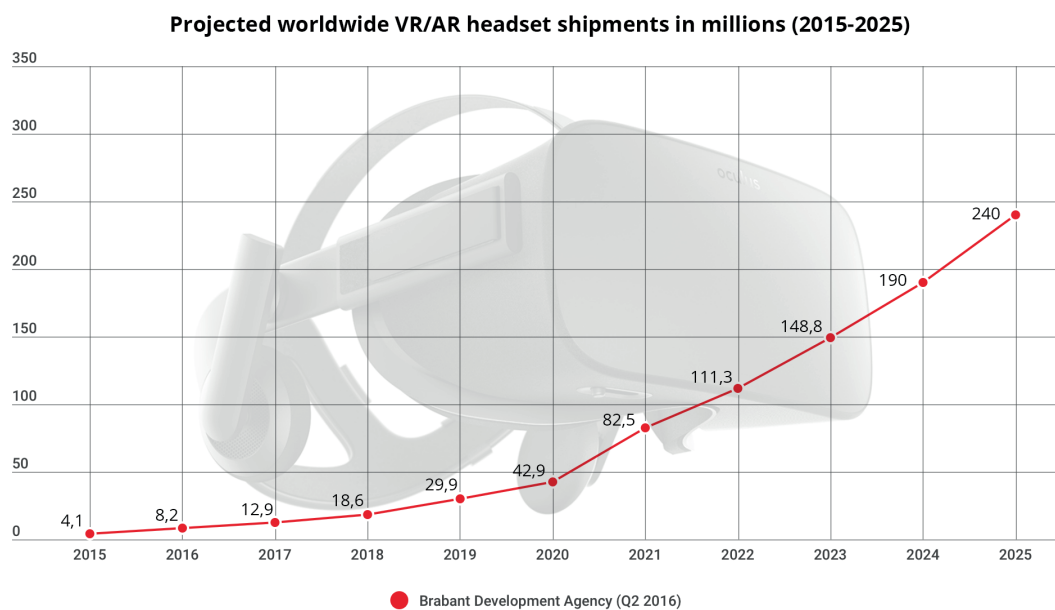
Graph 1 Worldwide VR/AR headset shipments (2015-2025). Source: Market survey 2016.
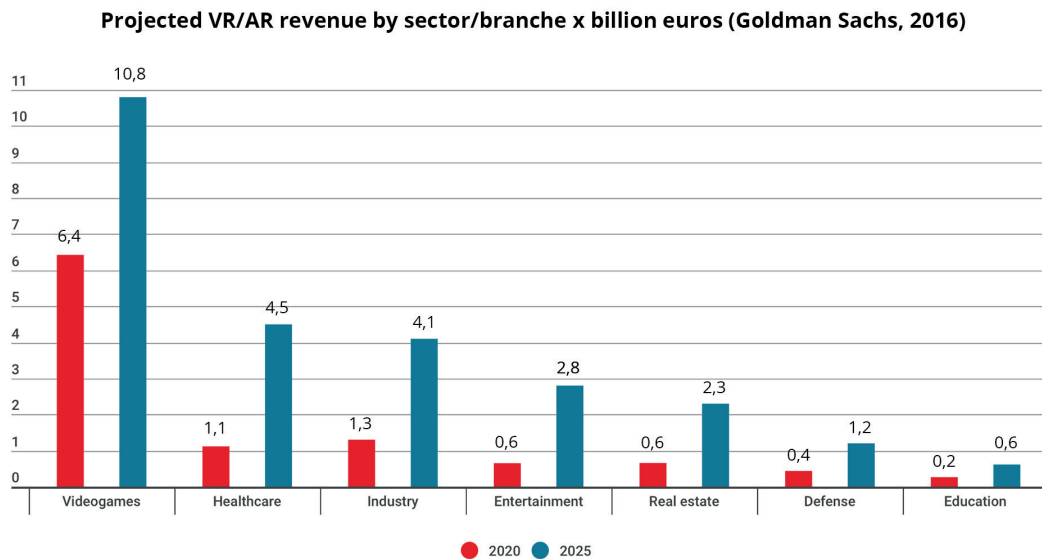
Software

The future of the software market is unclear since reports on VR and AR were not always consistent in their usage of the definition. Based on the unweighted average of the aforementioned projections, this market will grow more than 20-fold from $1.1 billion in revenue in 2016 to $24.3 billion in 2020. The first big software markets will be in **videogames** and **entertainment**. The expected **exponential growth** is based on the assumption that the software market will only truly develop if the hardware market has established itself.

Projected worldwide VR/AR software revenue x € billions (2016-2020)

● Brabant Development Agency (Q2 2016)

Graph 2 Projected worldwide VR/AR software revenue
(2016-2020). Source: BOM report 2016.

Goldman Sachs expects the following nine sectors to drive the software market: videogames, live events, video entertainment, healthcare, real estate, retail, education, engineering and defense. The three biggest markets in both 2020 and 2025 will be entertainment, healthcare and engineering.

Projected VR/AR revenue by sector/branche x billion euros (Goldman Sachs, 2016)

● 2020   ● 2025

Graph 3 Worldwide VR/AR software revenue forecast by
sector (Goldman Sachs, 2016).

3.2 HOW DID THE VR MARKET PERFORM IN 2016?

In this section, we compare the projections of research group SuperData in the first quarter of 2016 with the actual sales data given by the same research group at the end of 2016.

Oculus Rift

Despite high expectations and lots of media coverage, the Oculus Rift has not yet lived up to the positive forecasts from recent years. Oculus, which was purchased by Facebook in March 2014, encountered unexpected component shortages in early 2016, which led to delayed shipment dates for early adopters. The cost of VR may also be hampering sales because a consumer must also own a high-end gaming personal computer of at least a thousand euros For example, UK adults are only ready to spend €158 for a virtual reality device, according to The Foundry, a global software company. Both the delay and the cost have resulted in fewer headset shipments than was projected.

HTC Vive

The HTC Vive stands out as the leading headset as evidenced by developers working on their next games. With **420,000 units** shipped, the HTC Vive has outperformed its own projections and outsold the Oculus Rift. These numbers show that there is a demand for the Vive, despite the requirement for an expensive PC. Analysts debate whether the HTC Vive outsold the Oculus Rift because of the latter's component shortages or shipment issues or other problems.

Google Daydream

Based on reports from SuperData, Google sold **260,000** Daydream Views in 2016. However, Android's built-in statistics for apps shows that the software for these units did not sell well; a lot of Daydream apps had not yet passed **5,000** installs as of this writing. According to various reports and market analyses, a lack of compelling content was to blame. People using Daydream-ready phones/headsets were watching about 40 minutes per week, Google's VP of VR recently said.

Samsung Gear VR

While VR hardware sales were off to a slow start, Samsung Gear VR outperformed projections by shipping at least one million more units than was initially expected. At CES 2017, Samsung Electronics America President Tim Baxter said the company has sold **5 million** Gear VRs to date.

Samsung bundles its mobile business with the Gear VR in certain smartphones. This way, their product appealed to mainstream consumers as well as to tech enthusiasts and core gamers. Additionally, the Gear VR was priced far lower than HMDs like the Oculus Rift and the HTC Vive; Samsung even gave away Gear VRs for free to new Galaxy owners in 2016.

PlayStation VR

The number of PlayStation VR shipments was disappointing compared to projections. SuperData predicted **2.6 million** PlayStation VRs would ship in 2016, but Sony only sold **750,000**. The main reasons for the delay of the headset were technical issues and supply problems. A lack of compelling content also slowed sales. The most popular games on the PlayStation 4 are first-person type games like Call of Duty and Battlefield that don't translate well to virtual reality gaming due to problems with nausea. About 12% of VR users indicated the technology made them feel sick.

Difference between projected & actual number of shipments x thousands (2016)
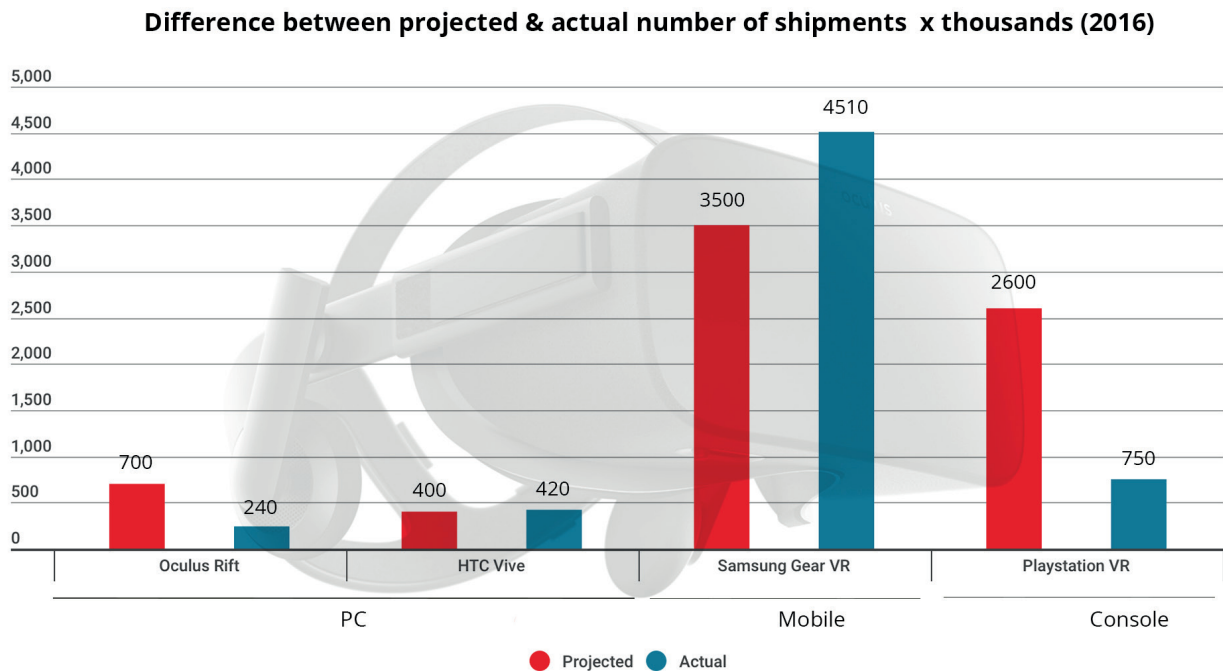
Graph 4 Projected & actual worldwide VR shipments by platform (SuperData, 2016).

Forecast and actuals 2016 compared

In the first quarter of 2016, SuperData projected a total VR revenue (software and hardware) of **2.65 billion euros**. The firm said the console platform would generate 43% of the revenue compared with 36% from the PC platform and 21% from the mobile platform.

Projected & actual worldwide VR revenue by platform x € millions (SuperData, 2016)
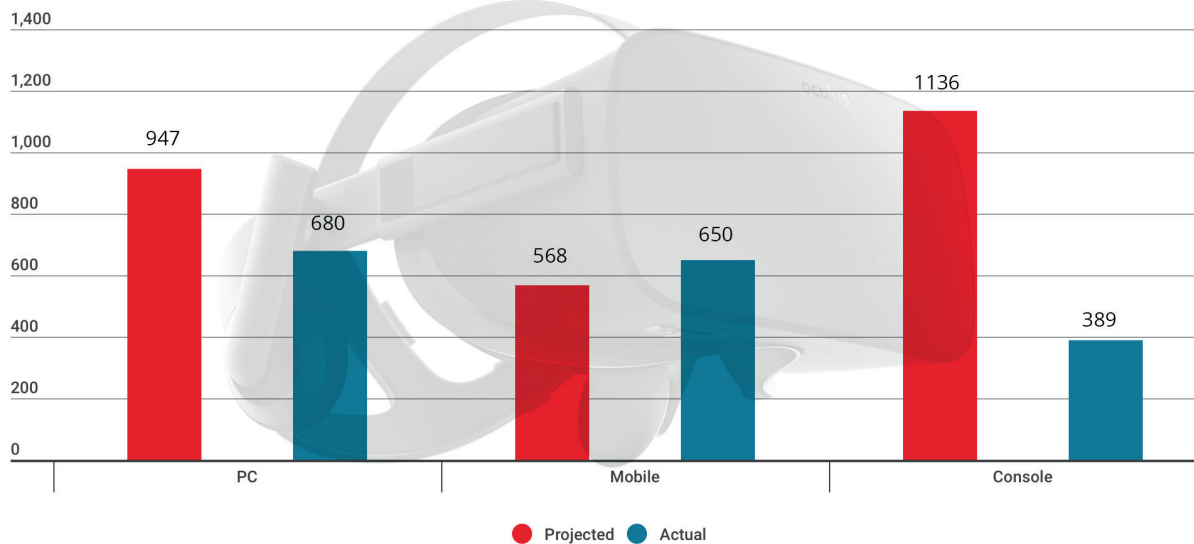

Graph 5 Projected & actual worldwide VR software and hardware revenue by platform (SuperData, 2016).

When looking at the actual numbers from SuperData, the PC platform generated the highest VR revenue in 2016 **(680 million euros)**, while the mobile platform came in a close second (650 million euros). **With 389 million euros in revenue**, the console platform did not live up to its expectations, which were about three times higher.

SuperData had predicted total VR revenue of **2.65 billion euros** for 2016, but the actual revenue was **1.719 billion euros**; only 65% of the original projection.

The PC and console platform showed disappointing sales numbers, mainly caused by the delayed shipments and insufficient supply of the Oculus Rift and PlayStation VR. The mobile platform outperformed its forecasts, mainly due to the Samsung Gear VR, which sold a million more units than projected by SuperData.

SuperData also made an update in Q1 2017 about its forecast of the total VR market. In Graph 6, the forecast of 2016 and 2017 are compared, giving an interesting view. The forecast for 2017 is 15% lower than in 2016. The forecast for 2018 and 2019 are higher than in 2016 while the forecast for 2020 has been cut by 7%.

Projected worldwide VR revenue x € billions (2016-2020)
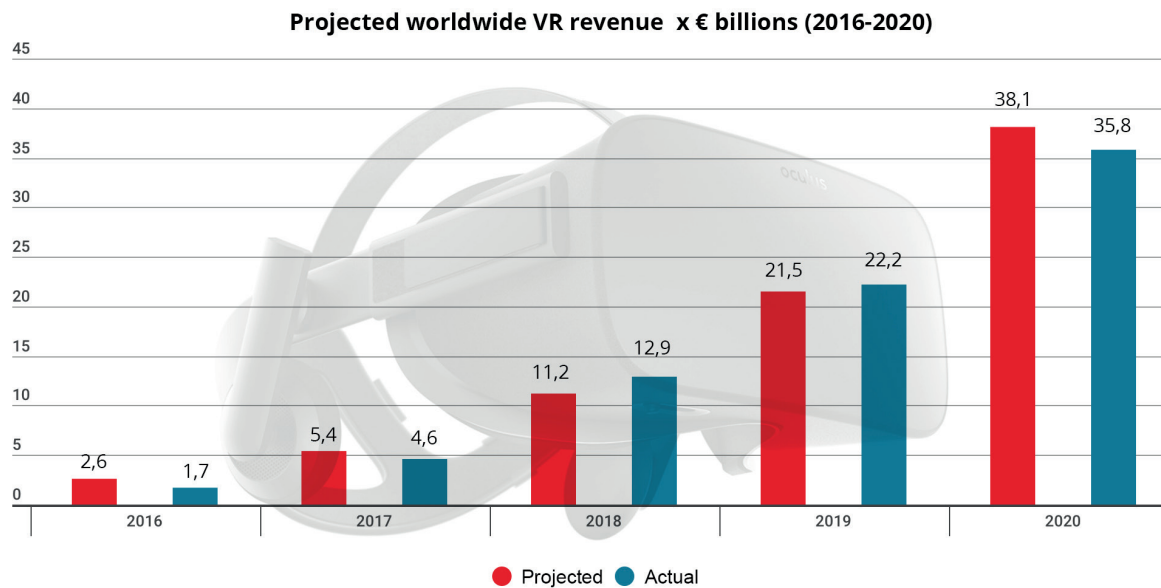
Graph 6 Projected worldwide VR revenue (SuperData,
Q1 2016 & Q1 2017).

3.3 HOW DID THE AR MARKET PERFORM IN 2016?

Much information about the AR market was available on the Internet. Unfortunately, this information was based on fragments of articles or comments from press releases. During our research, we found no free reports on the AR market. Therefore, an impression of how the market developed in 2016 may be incomplete.

The consensus is that by 2019 or 2020, the AR market will be bigger than VR. Since the AR market currently is much smaller than the VR market, one must ask if this is a realistic assumption. A "sneak preview" of the growth potential of AR is given by Pokémon Go. Digi-Cap's Tim Merel told Techcrunch in January 2017:

"At the start of the year, we thought 2016 could deliver $4.4 billion VR/AR revenue ($3.8 billion VR, $0.6 billion AR); the launch year's issues resulted in only $2.7 billion VR revenue. This was counterbalanced by Pokémon GO's outperformance helping AR to an unexpected $1.2 billion revenue, for a total $3.9 billion VR/AR market in 2016 (we were 11 percent optimistic)."

Compared to VR, AR is missing the infrastructure to build the tools, platforms and content. The current generation of smart phones and tablets are capable of handling AR technology. The problem that prevents a large-scale adoption of AR is that for each AR interaction, an app like Pokémon Go has to be downloaded. Native support on smart phones and tablets is required to create the infrastructure for mass adoption of AR.

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Here is an analysis of what top tier tech companies are doing:

Apple

Based on patent filings, Apple has been investigating virtual and augmented reality technologies for more than 10 years. It is rumored that Apple has teamed with Carl Zeiss to develop a pair of smart glasses, which will include mixed/augmented reality functionalities. Tim Cook, Apple's Chief Executive Officer, has stated that the company will continue to invest in augmented reality and that the company is "high on AR in the long run." If Apple launches AR glasses, it is likely the company will include AR support in IOS.

Business Case

Gemvision creates a platform that helps all business sectors optimize processes by using augmented reality glasses or smart glasses. This platform gives support to a technician on-site, providing all the necessary information and the possibility of a video conference with colleagues from around the world so they can see what the on-site engineer is doing. These features give the possibility of live and virtual training for technicians or engineers. Gemvision can supply insights of big data solutions with real-time data.

Google

In 2016, Google officially launched Tango, which integrates native AR support in Android, the largest operating system for smartphones. Based on this technology, Lenovo unveiled its first phone with native support for AR in November 2016 and announced a second phone in 2017. Other manufacturers like Asus are also announcing smartphones with Tango support this year.

Another way to use augmented reality is through glasses like the Google Glass introduced in 2014. The introduction was too early and the project officially stopped in early 2015. Rumors say Google is still developing the Google Glass, mainly for industrial purposes. Besides Google, other manufactures like Epson, ODG and Vuzix are developing AR glasses. For pilot purposes, these glasses are good enough. But for implementation in production environments, the glasses have disadvantages like comfort, battery life and display angle.

Two interesting companies to watch in 2017 are Microsoft HoloLens, which brings high-definition holograms to life in your world, and Magic Leap, which features magical images like whales jumping out of the floor of a gymnasium.

Microsoft HoloLens

The HoloLens is a mixed reality device, according to Microsoft, which describes it as follows:

"Microsoft HoloLens is the first self-contained, holographic computer, enabling you to engage with your digital content and interact with holograms in the world around you."

The HoloLens was launched in 2016 in America. It's currently a developer version and not available for the consumer market. Before unveiling a consumer version, Microsoft wants more information about how the device will be used by businesses, potential markets and minimum requirements for device adaptation.

Magic Leap

Magic Leap is a stealth startup, but it has received attention to the tune of $1.4 billion in investments from companies like Alibaba, Google and Warner Bros. The company currently doesn't have a product on the market. Rumors suggest the first market launch sometime in 2017. The product might include a new type of computing platform and a device that can create an AR experience never shown before. Whatever the product might be, the amount of the investment by the tech world's biggest players indicate that Magic Leap might have a huge impact on the market.

4 Market research

As we remarked in Chapter 3, there wasn't much data to track international developments in the VR and AR markets. Emerging markets often have this problem of inconsistent data. Nevertheless, it is important for VR and AR startups, investors, end users and government bodies to gain insight into market developments to define their strategies, reach customers, secure investments and create policies to stimulate the VR/AR market. In this chapter, the market development in the period 2016-2017 is described with a focus on international engineering, manufacturing and industry.

4.1 RESEARCH VERIFICATION

More than **600 respondents** participated in our research; we made a clear distinction between **developers** of VR and AR hardware, software and content on the one hand, and **users** of VR/AR on the other. Interestingly, more respondents, 14%, indicated they see no use for VR and AR, a 5% increase compared with 2016. A possible explanation is that respondents showed more familiarity with the field and a growing percentage was not impressed by its possibilities.

86% of the respondents think AR/VR is useful for their businesses compared to 91% in 2016

In **Visual 3**, one can see that the majority of the respondents were concentrated around Rotterdam (19) and the Eindhoven region (42). The remaining participants were distributed across the Netherlands, Belgium and Germany. The research was done in sectors and with companies that are widely recognized to have an international presence and supply chain. Therefore this research provides an indication of the industry's international market development.


Visual 3 The known geographic locations of the developers/users of VR/AR who participated in the market research. Their location was an optional question in the survey, which explains why the total number of respondents is higher than the sum of the numbers shown in this visual.

The purpose of this research is to compare the results of our 2016 and 2017 reviews to gain insight into market developments. To make a valid comparison, the respondents in both years needed similar characteristics such as user or developer.

Graph 7 shows which sector the users (the demand side) are active in. Of the users who participated in the survey, **45%** operated in the industry sector, an 18% increase from 2016. Correspondingly, the "other" sector decreased by 14%. Last year's respondents in the "other" sector indicated they were active in manufacturing or industry. To improve the research, we specified the manufacturing, engineering and industry sector as one market (Industry) in the 2017 questionnaire. Other than that, the respondents in both years had similar characteristics.
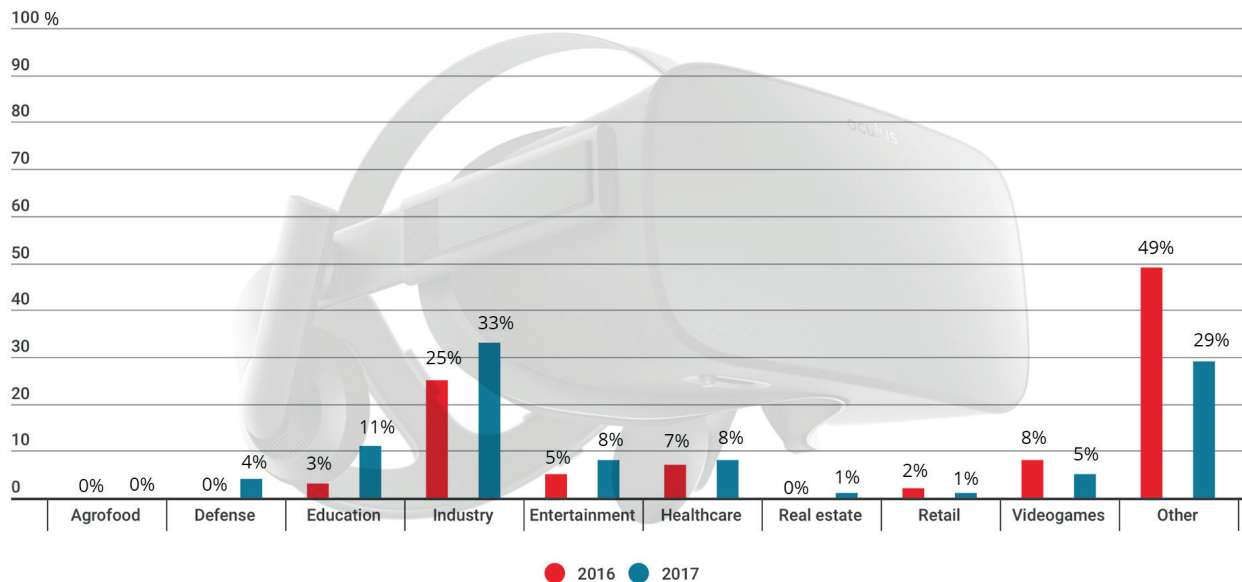
[Users] In what sector are you currently employed?
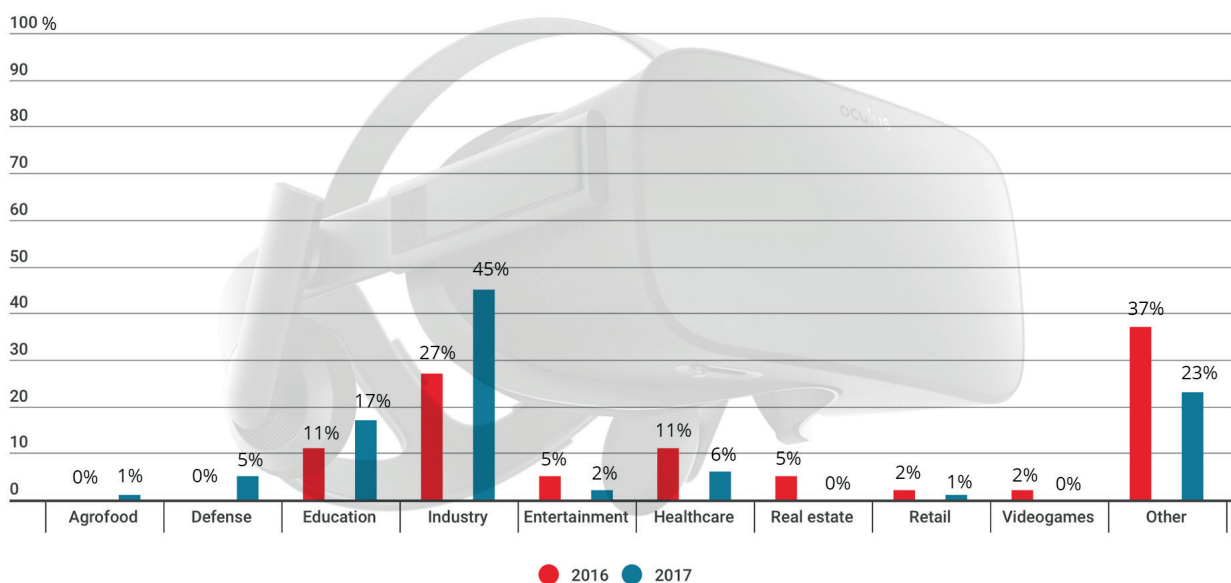
Graph 7 Users: in what sector are you currently employed?

For developers, the biggest differences were in industry, up 8 percentage points, and the "other" sector, down 20 percentage points.
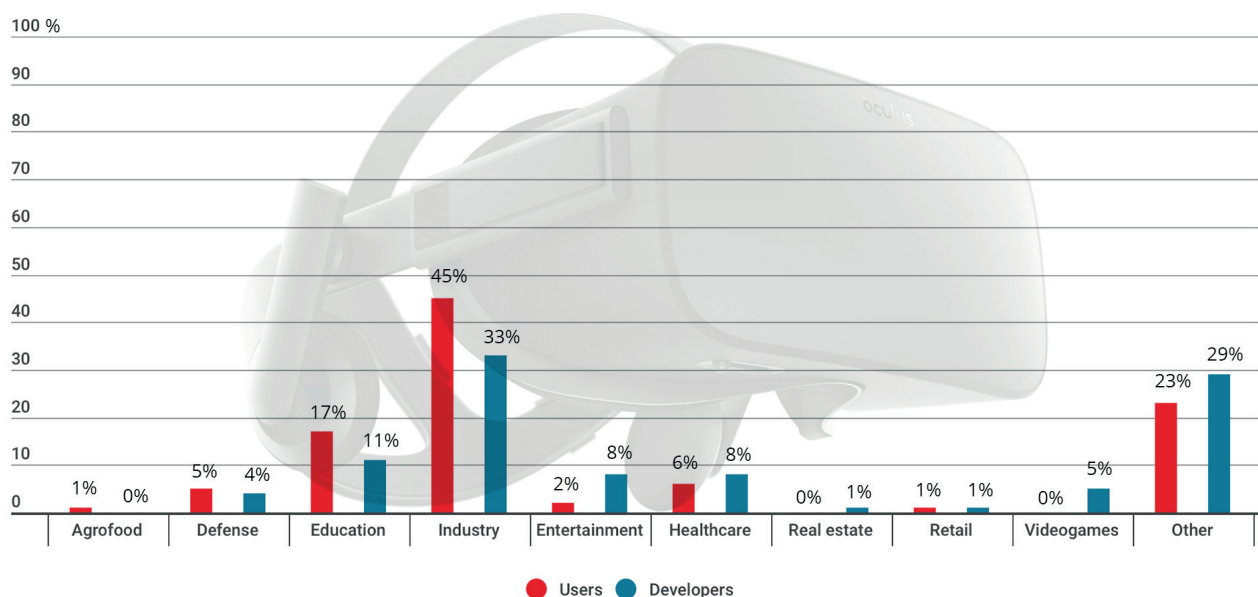
[Developers] In what sector are you currently employed?

● 2016 ● 2017

Graph 8 Developers: in what sector are you currently active?

When we compare the sectors between the users and developers, both were divided in the same sectors as shown in graph 9 with only minor differences. The question of whether it is valid to compare both years is a solid yes.

[Developers/Users] In what sector are you currently employed?

● Users ● Developers

Graph 9 Developers/users: in what sector are you currently employed?

4.2 USERS

Applications for VR and AR can add value to various markets, including education, healthcare and engineering. By using this new technology, employees can work more efficiently and effectively in their daily jobs. In the primary processes, different applications can be found for VR and AR. Table 1 shows the different phases of the primary process.

59% of the companies that do not use VR/AR yet will start within two years

	R&D 2017: 36% -17%	Design 2017: 41% -4%	Prod. Oper. 2017: 29% +16%	Serv. Main. 2017: 40% +15%	Sales 2017: 35% +5%	Training 2017: 62% -1%
Production 29% +3%	Behavior	Interior	Complex tasks Defense	Remote Maintenance	Extra Experience	Simulation complex tasks
Pilot 71% -3%	Improve tasks Communi-cation	Building Design	Exposure therapy Order picking	Complex tasks	Efficiency	Order Picking Safety instruction
Future	Virtual R&D		Real time info Immersive control			E-learning
Model Based Enterprise						

Table 1 Overview of AR/VR by users.

Respondents who already use VR and AR applications mainly employed these technologies in Design, Training & Simulation and Maintenance & Service. Two changes compared to our 2016 research were remarkable: the use in R&D decreased significantly from **53%** (2016) to **36%** (2017), and the usage in operations rose from **13%** (2016) to **29%** (2017). The increase in operations is an indication that the AR market is developing rapidly. In operations, AR as a technology is known to be more useful than VR.

This could be an indication that the AR market is developing rapidly. In operations AR as technology is more useful than VR

Some **71%** of the respondents that are using VR and AR are still in a pilot phase. The other **29%** already using VR and AR are in a production environment, a **3%** rise over 2016.

The number of participants who indicated that they were planning on starting with VR/AR within one year increased from 20% (2016) to 26% (2017), an indication of rising interest among companies.

More companies are interested in exploring the possibilities with AR and VR.

Projected budget versus actual results in 2016

The average user's budget for VR/AR in 2017 was significantly lower than was projected in 2016. The projected VR/AR-budget decreased from **€41.000** to **€24.000** in the 2017 survey, which at first glance appeared astonishing. However, users actually spent an average of **€22.000** in 2016. Based on this insight, the projected budget for 2017 is slightly higher than what was spent in 2016. The structural VR/AR-budget of these respondents for the coming years is approximately **€28.800**, **below the** €67.400 projected in 2016. Although the budget projections are remarkably lower in 2017 versus 2016 they are more realistic, indicating serious business.

Although the budgets are lower in 2017 they are more realistic, indicating serious business.

Graph 10 shows how actual expenditures differed from the projections. The expenditures on applications and content increased by 11% and the spending on tools & platforms was lower by 12%. This remarkable shift is because creating content is still expensive and has only limited availability. As indicated in the international market chapter, a lack of good content is a challenge in the current VR and AR landscape.
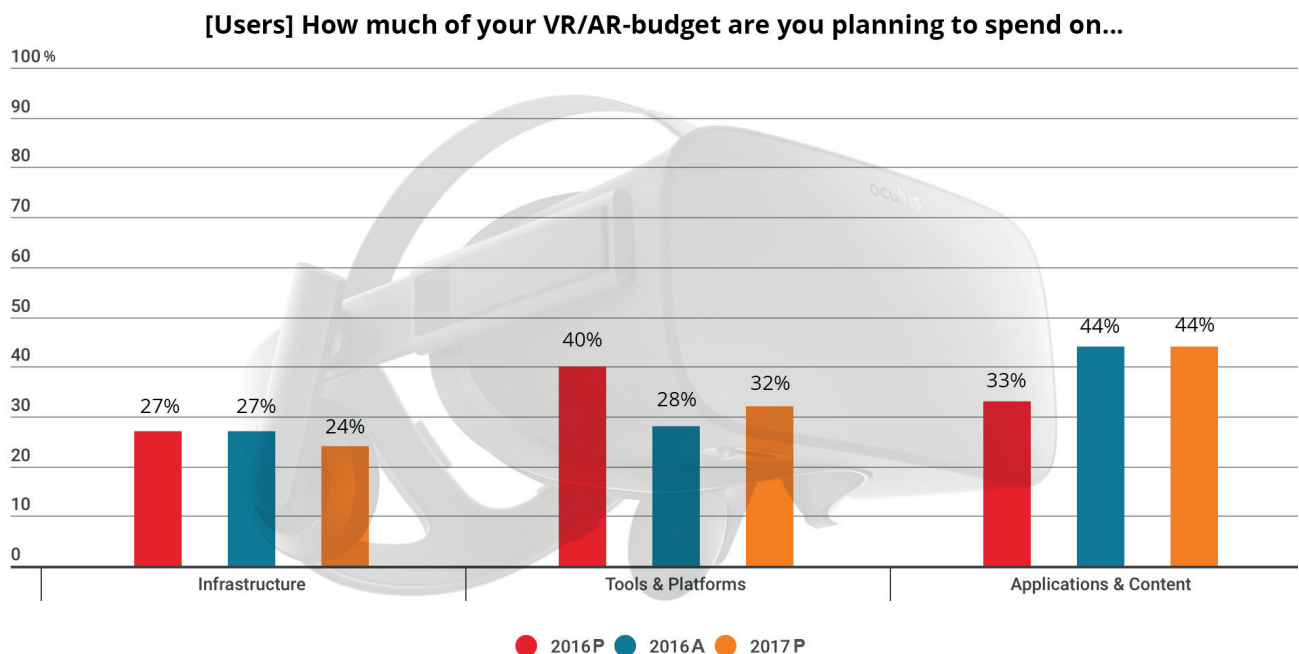
Graph 10 Users: how much of your VR/AR budget are you planning to spend on...?

Furthermore, Graph 10 shows applications & content has surpassed tools & platforms as the activity that users plan to spend the most money on. This was in line with the actual spending of 2016, indicating a more reliable forecast.

Business case
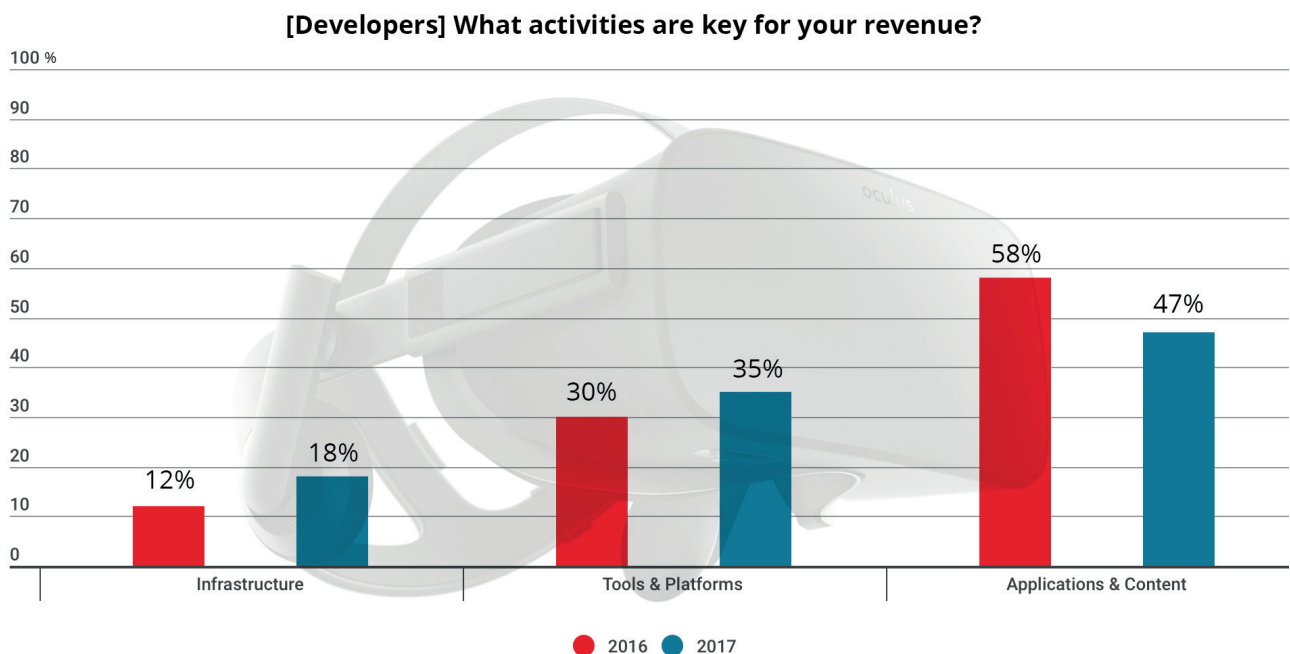
Empowering the operator of the future.
WEMO believes in the further cooperation of humans and machines to achieve the highest level of production and efficiency. With the arrival of the industrial "Internet of Things," we will add intelligence to our tools, our machines and their operators. We will employ Microsoft HoloLens, which is a real step forward. HoloLens will connect all available and useful data directly to our machines and their operators. Tomorrow's digital workplace? That is being generated today at WEMO.

WEMO's application makes use of Mixed Reality. Relevant holograms are projected into the real world via the intelligent headset. This creates a digital workplace. Via a simple application, the operator gets immediate access to data that provides a significant efficiency boost in the field of analysis, processes and maintenance.
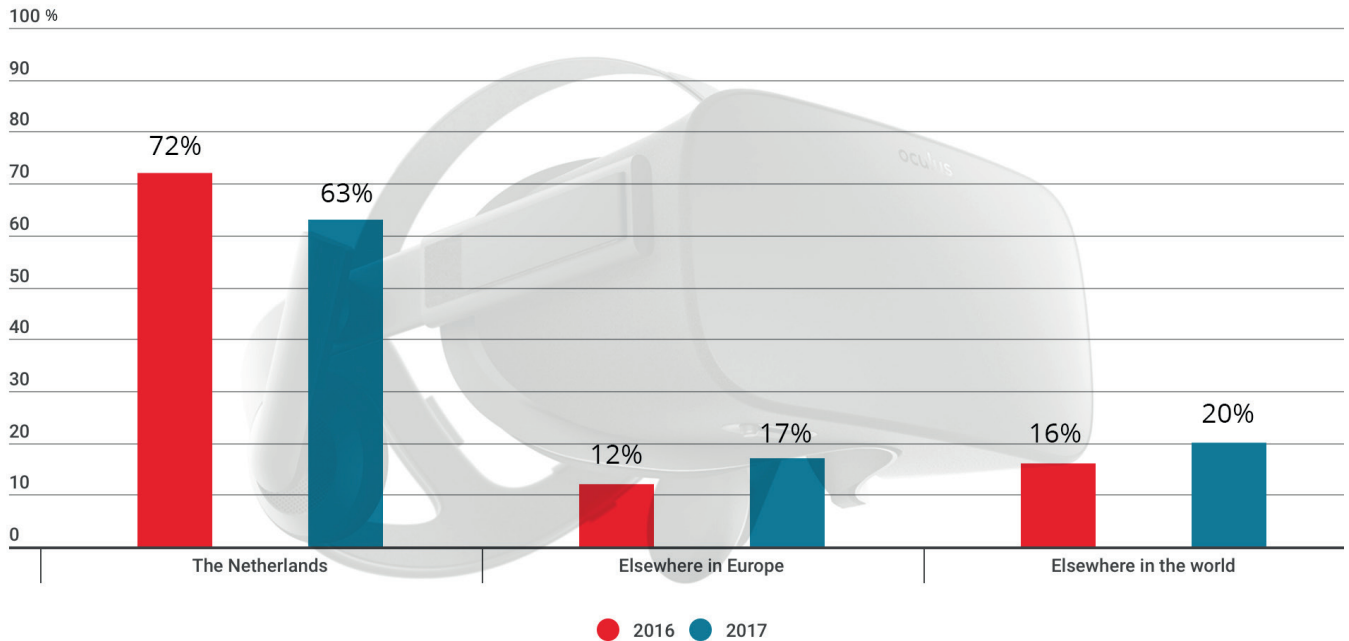

4.3 DEVELOPERS

Actual revenue versus projected revenue

Like 2016, applications & content continues to be the largest source of revenue for VR/AR-developers **(47%)**. However, the tools & platforms sector is closing the gap, only 12% behind applications & content. Last year, tools & platforms was 28% behind. This change indicates that developers were not only developing platforms, but also creating revenue from those platforms.

[Developers] What activities are key for your revenue?

|	Infrastructure	Tools & Platforms	Applications & Content
2016	12%	30%	58%
2017	18%	35%	47%

● 2016 ● 2017

Graph 11 Developers: what activities are key for your revenue?

[Developers] Where do you clients come from?

The Netherlands: 72% (2016), 63% (2017)
Elsewhere in Europe: 12% (2016), 17% (2017)
Elsewhere in the world: 16% (2016), 20% (2017)

● 2016 ● 2017

Graph 12 Developers: where do you clients come from?

In 2016, we concluded that Tools & Platforms provided the best opportunities to scale in an international market. The numbers from this year imply that developers were indeed shifting to platform developments instead of content. This analysis was supported by the increase in the number of clients in Europe by 5% and elsewhere in the world 4%. Furthermore we saw an increase in the popularity of international collaboration: 63% of the developers worked together with international partners in developing VR/AR, up from 54% a year ago.

[Developers] How much revenue did you have and/or do you expect in...

2014: *, 218
2015: *, 271
2016: 410, 344
2017: 596, 499
2018: *, 808
2020: 947, 1.331

● 2016 ● 2017
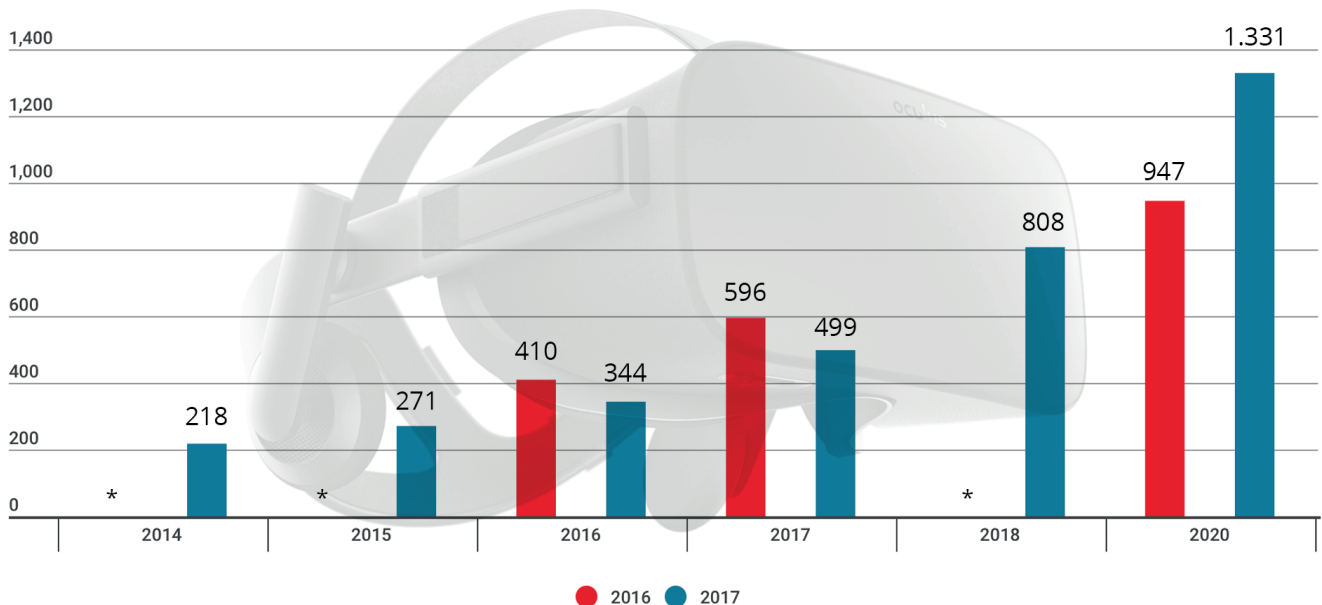
Graph 13 Developers: how much revenue x thousand € did you have and/or do you expect in...
*No data.

The **actual revenue** in 2016 was **17%** lower than forecast. If we take into consideration a 50% decrease in the users' actual spending, this was a remarkable performance. The expected revenue increase in 2017 is 45% while the average budget increase was only 10%. This implies that developers expect to grow by serving more customers in the same period, which is in line with the expected growth in the international market.

If we take into consideration a 50% decrease in the users' actual spending, this was a remarkable performance

The number of FTEs grew from 10 in 2016 to 15 in 2017 with an average revenue of €33.000 per employee. The revenue per employee was expected to grow to €60.000 in 2020. This is still low compared to €150.000 to €200.000 that a profitable company has to earn per employee.

External financing

The low revenue per employee means that these developers require external financing to reach break-even and create a sustainable business. About **40%** of the developers that took part in our survey made use of external financing while 39% of the developers raised more than €1 million. **Venture capital (53%)** and **angel investors (43%)** were the most dominant forms of external financing. More than 77% said they will require more investments in the future. Of the developers requiring more financing, 50% said they require another round of more than €1 million and 92% cited venture capital as the preferred form of financing.

"VR is not going to be really profitable for us for quite a while. So investors be patient"
- Mark Zuckerberg, 2017

In the table below, the growth in customers is shown in relation to the projected revenue and expected budget spending. Compared to the SuperData projections, the growth percentages were realistic, but not ambitious, especially when compared to the amount of external financing required.

Activities	Supply €	Demand €	Needed Customers
2016 (actuals)	344.000	22.000	16
2017	499.000 (+49%)	24.000	21 (+31%)
2018	808.000 (+38%)	28.800	28 (+33%)

Table 2: Growth in supply and demand.

Business case

VRee, a Netherlands-based startup, developed a platform for real-time, full-body natural motion & behavior in VR. The company has secured a seed investment from the Brabant Development Agency (BOM) and startup accelerator LUMO labs.
The VRee platform enables third parties to easily develop and publish full body VR content for product design, training & simulation as well as for VR games. This makes the VRee business case quickly scalable. VRee also brings a new game category in existence: active VR eSports.

The platform contains proprietary algorithms that optimize mocap suits and other VR peripherals, making full body VR possible without using line of sight technology.
VRee is using the funds to further develop its revolutionary platform, which involves hiring more programmers and visual designers at its Eindhoven-based headquarters. The company also invests in sales and marketing and is opening a U.S. office to secure traction in that country.

4.4 MARKET NEEDS

Market maturity
VR and AR are still new technological developments for most companies. Therefore, we asked both users and developers about the most important obstacles to investing in VR/AR. Developers and users defined "unfamiliarity with the possibilities" and an "insufficient business case" as the main obstacles.

Shared facilities
The survey revealed **57%** of the developers in 2017 saw a need for shared facilities, up **3%** from the prior year. About **71%** of these developers would be willing to pay for a demo center to visit with clients, **65%** for sharing hardware and **60%** for a combined office for companies working in VR/AR.

[Developers] For what facilities are you willing to pay?
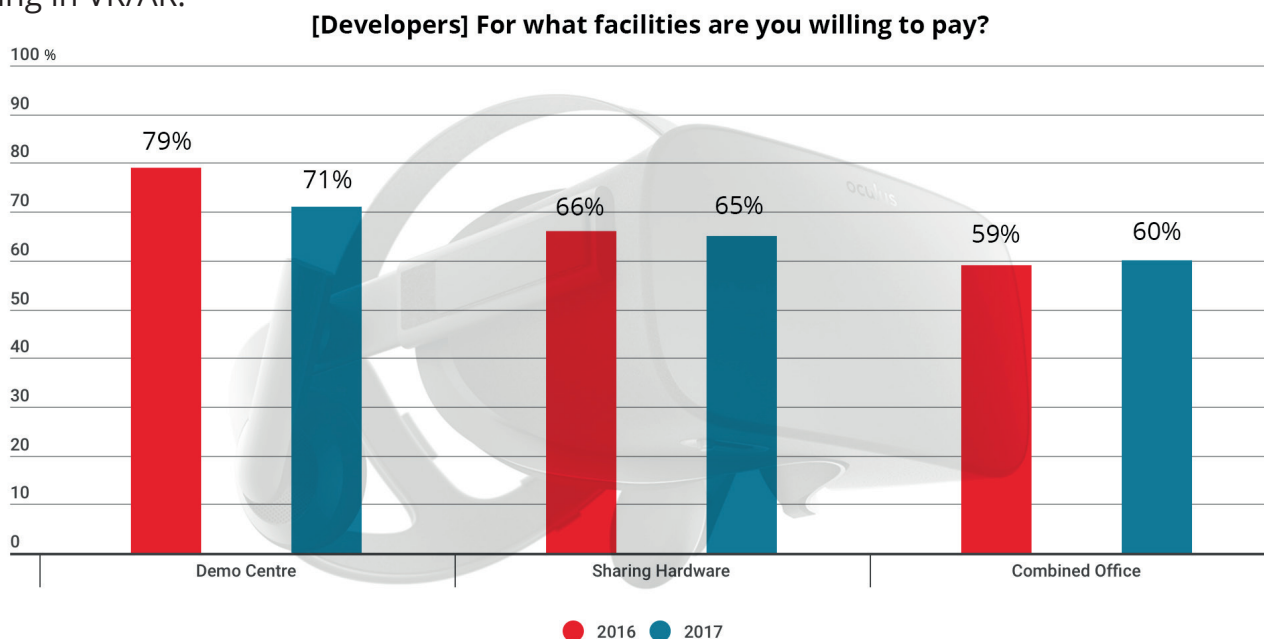
Graph 14 Developers: for what facilities are you willing to pay?

Support and collaboration

Some **63%** of developers work together with international partners in developing VR/AR, an increase from **54% a year ago**. About **76%** of developers who participated in the survey work with local partners, an increase of 12% compared to last year. Developers who don't work with local partners cited the fragmented landscape, **44%. About 24%** said they didn't know who to call, a decline from **42%** a year ago.

[Developers] Why aren't you working with regional partners?
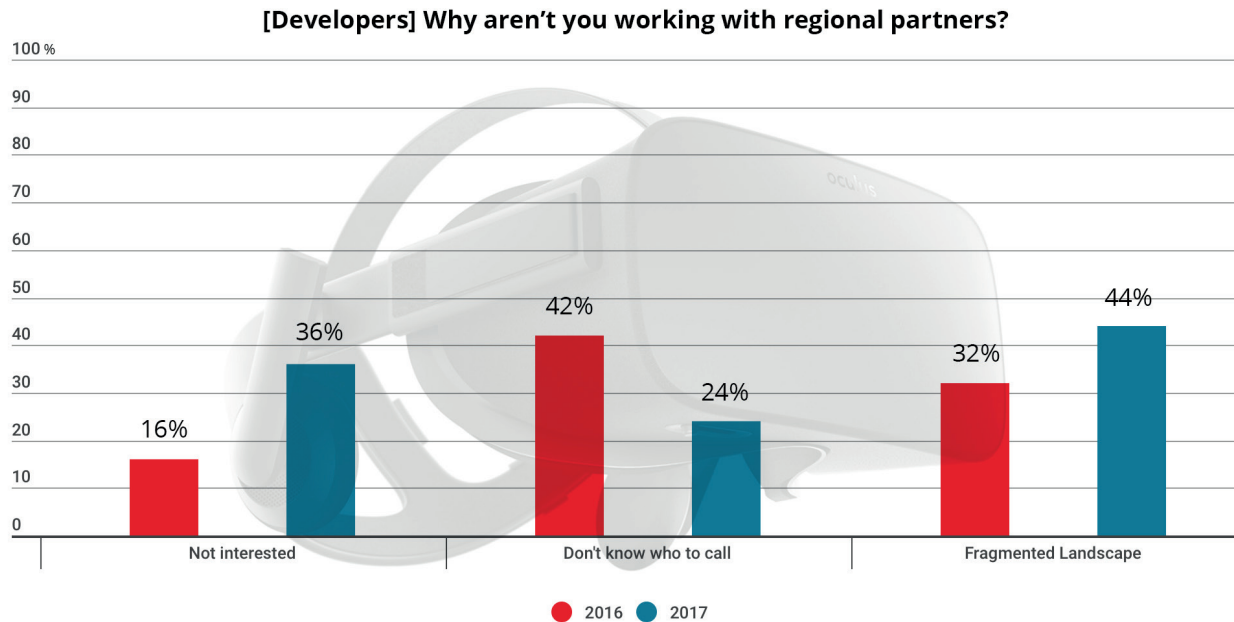
Graph 15 Developers: why aren't you working with regional partners?

5. Conclusion

International market

For VR, 2016 was an important year. The total market revenue in 2016 was €1.7 billion, which was only 65% of the projected revenue. The first impression is that VR/AR was hyped in 2016 and the actual demand was much lower. A closer examination painted a different picture. The main reasons for the underperformance were technical delays (Sony) and supply problems (Oculus). We did not find that the demand side was substantially lower than expected. The revenue from the HTC Vive and Samsung Gear VR were as predicted or even better. Users only complained about the lack of good content which is a problem that the industry must solve to be successful in the long term.

Forecasts

An important insight of this report is the difficulty in comparing different forecasts with each other. Many numbers used within blog posts, investment proposals and policy documents may be inaccurate, leading to incorrect decisions or market expectations. A good place to start is a clear definition of the terminology used within the reports to enable industry experts to discuss and compare the forecasts from different firms.

Market survey

In general, we can conclude that results were in line with international developments. The forecasts of 2016 were optimistic compared to the actual results and might indicate a lower demand and slower market developments. A closer look provided interesting insights.

Users

The users were overly optimistic about their budget in 2016 as they actually spent 42% less than they anticipated. This difference is an indication of hype in the early months of 2016.

We also saw an increase of AR/VR use in production environments and more companies are expected to start experimenting with VR/AR within the coming year. These are strong signs that AR/VR is here to stay. There is also a significant increase of the use of VR/AR in operations. These signs indicate AR is increasing in primary processes because the technology is better suited than VR, which is in line with expectations because the international forecasts show that AR will be bigger by 2020 than VR.

Developers

A positive sign was that the revenue of developers was only 17% below expectations in 2016. When compared with a larger decline in users' expenditures, it's a remarkable performance. And it shows business instead of a hype!

Developers have a clear need for external financing, preferring venture capital investments. This need is a normal development at the start of a new technology wave. However, the required capital of more than €1 million does not match with the expected revenue in the future. Companies that require investments of more than €1 million need to have the ambition to achieve at least €10 million in revenue within 5 years. This is not in line with the revenue expected by developers in 2020 (€1.3 million) or with the international market growth. This ambiguity is interesting.

Based on our own experiences at BOM, a reason for this ambiguity is the risk-averse attitude of investors in the Netherlands/Europe compared to investors in North America. The ambition of creating a €10 million plus company within 5 years in an early stage market like AR/VR is perceived as risky. Dutch/European investment funds are not likely to invest in those businesses. The risk-averse attitude of investors will also impact the ambition of startups.

An ambition of €10 million plus revenue in 5 years is difficult, if not impossible, to realize in the Dutch market and therefore requires international expansion. It's an additional hurdle for startups in Europe (not only in the Netherlands) because the home markets are relatively small compared to the large internal markets of China and North America. This obstacle will be easier to overcome if experienced investors help startups with their international scale-up plans.

To be successful in emerging markets like AR and VR, investors and startups need to create a network of less risk-averse investors and developer skills to access international markets successfully.

Hype or serious business?
The main question of this research was: is AR/VR hype or a serious business? Last year, we saw a clear hype in the expected budgets of users for AR/VR. This year the budgets are in line with the actual amount spent in the prior year and we also see more companies interested in using AR/VR. On the developer side, the revenue was lower than forecast in 2016, but this was in line with the international markets that are not developing as fast as predicted because of growing pains. Based on this market survey, we see strong signs that AR and VR are serious businesses that are here to stay.

Colophon

About BOM

BOM is an economic development agency committed to supporting the continued growth of companies in the Dutch Brabant region. BOM provides knowledge, capital, talent, market and facilities to ambitious entrepreneurs with growth potential who focus on finding solutions to economic and social issues. By doing this, BOM contributes to the sustainable development of Brabant's economy.

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▶ **BOM** [Virtual reality Augmented reality] **Hype? Or serious business?**

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