Seeing is believing

How virtual reality and augmented reality are transforming business and the economy

pwc

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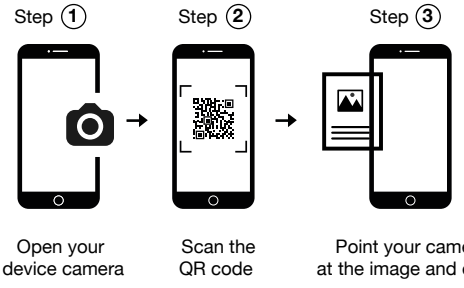

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> Businesses, the economy and society are at a crucial stage in the adoption of virtual reality and augmented reality.
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> Everything is in place for these technologies to now deliver on their promise by improving the way organisations operate, making processes faster and more effective, and creating incredible new experiences.

Jeremy Dalton
Head of VR/AR, PwC UK

Seeing is believing

In this report we explore the impact virtual reality (VR) and augmented reality (AR) will have on the economy by looking at how these technologies can help organisations transform the way they work, engage and inform customers and colleagues, and grow their revenues.

Throughout, we present the views and opinions of PwC specialists and industry figures, sharing their insights on how organisations can benefit from VR and AR and what steps they can take, starting today.

What is virtual reality and augmented reality?

VR immerses users in a fully digital environment through a headset or surrounding display. This environment can be computer-generated or filmed in 360-degree video.

AR presents digital information, objects, or media in the real world through a mobile device or headset. These elements can appear as a flat graphical overlay or can behave as a seemingly real '3D' object.

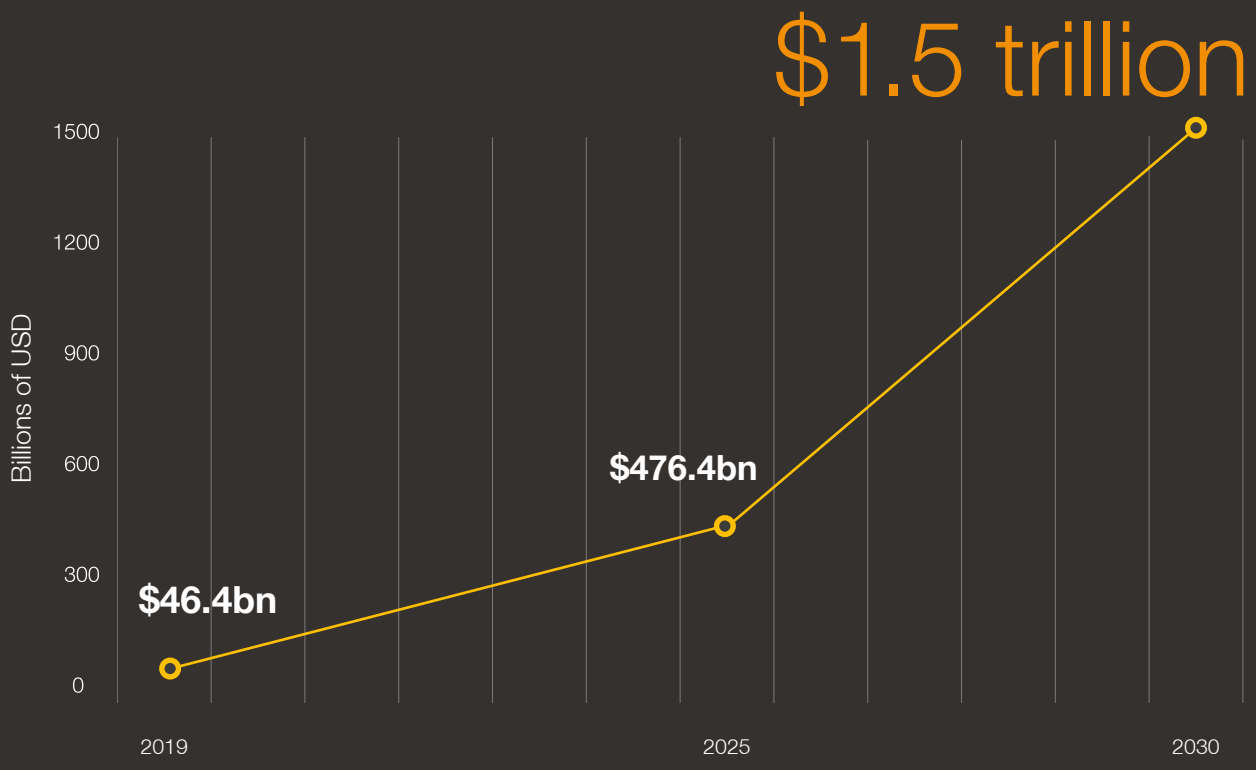
New realities for business and society

VR and AR have the potential to deliver a $1.5 trillion boost to the global economy by 2030.

That's the major finding of the economic impact assessment conducted by PwC economists for this report. From creating new customer experiences to speeding up product development and improving workplace safety, there are many compelling uses for these technologies that promise to drive growth from the current GDP contribution of $46.4 billion.

The rise of VR and AR

VR and AR have the potential to boost GDP globally by 2030 by up to $1.5 trillion.



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Trillion-dollar questions: What will drive change? And why now?

Neither VR nor AR are new technologies, but there are two overarching trends that can ensure their use grows considerably: the business benefits they can deliver are now richer and more attractive; and technological advances are creating an improved user experience.

Business benefits

Business benefits of VR and AR range from improved training to the reduction of risk and speeding up of product design and delivery.

A major benefit VR and AR offer organisations is the training of employees and testing of procedures, including the simulation of realistic scenarios and even high-risk environments. For example, militaries use VR to train soldiers for parachute jumps and bomb disposal.

By bringing together teams from any location into a single virtual space, VR and AR technology may also accelerate product development. Design teams can explore, test and evaluate different concepts easily without having to invest in physical prototypes. This potentially allows organisations to bring higher quality products to market faster.

Automotive companies are using virtual reality to cut the time between initial design and physical modelling from weeks to days.

VR and AR can reduce costs and boost efficiency in all kinds of ways, from improving the picking and packing productivity of warehouse workers with AR glasses, to providing information for engineers and technicians in the field.

And the benefits go far beyond process improvement. Many businesses are starting to recognise the opportunity to create new revenue streams and grow existing ones. Retail, hospitality and automotive are just three sectors already exploring the potential to sell and showcase products via both VR and AR, while gaming and entertainment companies are using the technology to create new experiences and products. New revenue streams are also being created for businesses developing and designing VR and AR services and technologies.

Although it must be underpinned by a sound business case, the use of VR and AR may also help position a company as innovative and forward-thinking within its industry. In turn this should help attract business partners, investment or talent.

At a time when competition for talent – particularly tech talent – is intense, organisations have an opportunity to make themselves more attractive by showing a progressive approach.

Technological advances

Another reason for businesses to explore the benefits of VR and AR now is that the technology is finally maturing.

Some people's past experiences of VR and AR may have been clunky, but the hardware and software are evolving every day, content is becoming more sophisticated and engaging, and improved connectivity is opening up a new range of business use cases.

Headsets are now lighter, cheaper and more comfortable to use and there are significant improvements being made around the field-of-view, resolution and software.

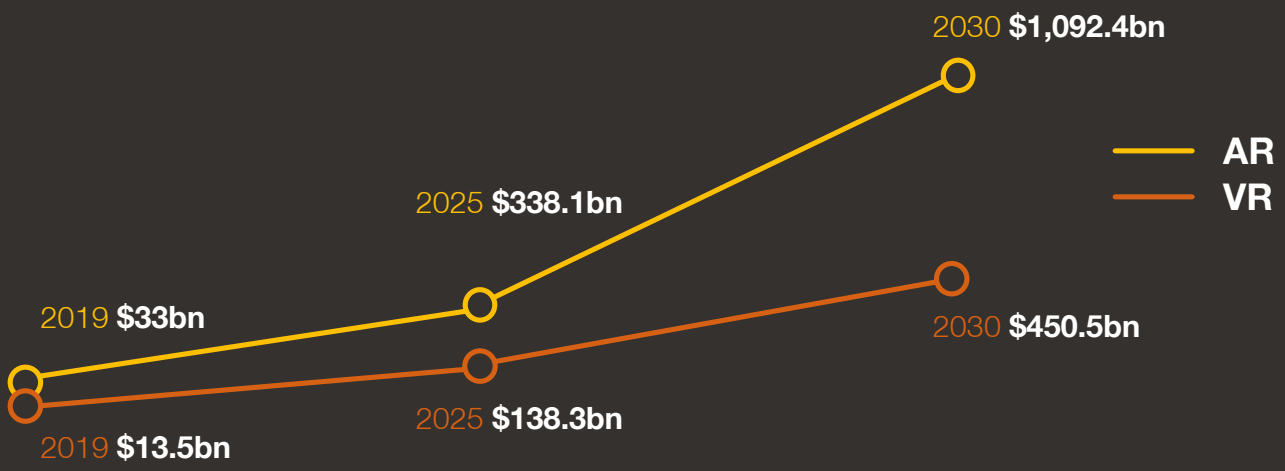
The gigabit per second speeds promised by 5G networks will almost certainly benefit VR and AR through reduced latency, delivering a smoother, richer and more engrossing user experience. 5G will also mean headsets are no longer as reliant on built-in processing or storage, likely bringing down cost and enabling more user-friendly designs. That processing and storage will be pushed to the cloud instead.

Another key area of technological development is haptics, or the use of touch sensation. Applied to VR and AR, haptics allow users to 'touch' things in the virtual world and get instant feedback. It helps users 'feel' interactions, enhancing the virtual experience.

Haptics has the potential to enhance user interfaces with intuitive gestural controls in workstations, which could lead to increased productivity or add an extra dimension to data visualisation. This can be applied in healthcare, engineering, automotive, and other industries to help users interact with digital interfaces in a more seamless way.

VR and AR: Comparative economic contributions

PwC analysis suggests AR will continue to provide the bigger boost to GDP through to 2030, compared to VR.



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Don’t let past experiences and outdated perceptions of these technologies shape your thinking.

Louise Liu
Head of Operations and Delivery, VR/AR, PwC UK

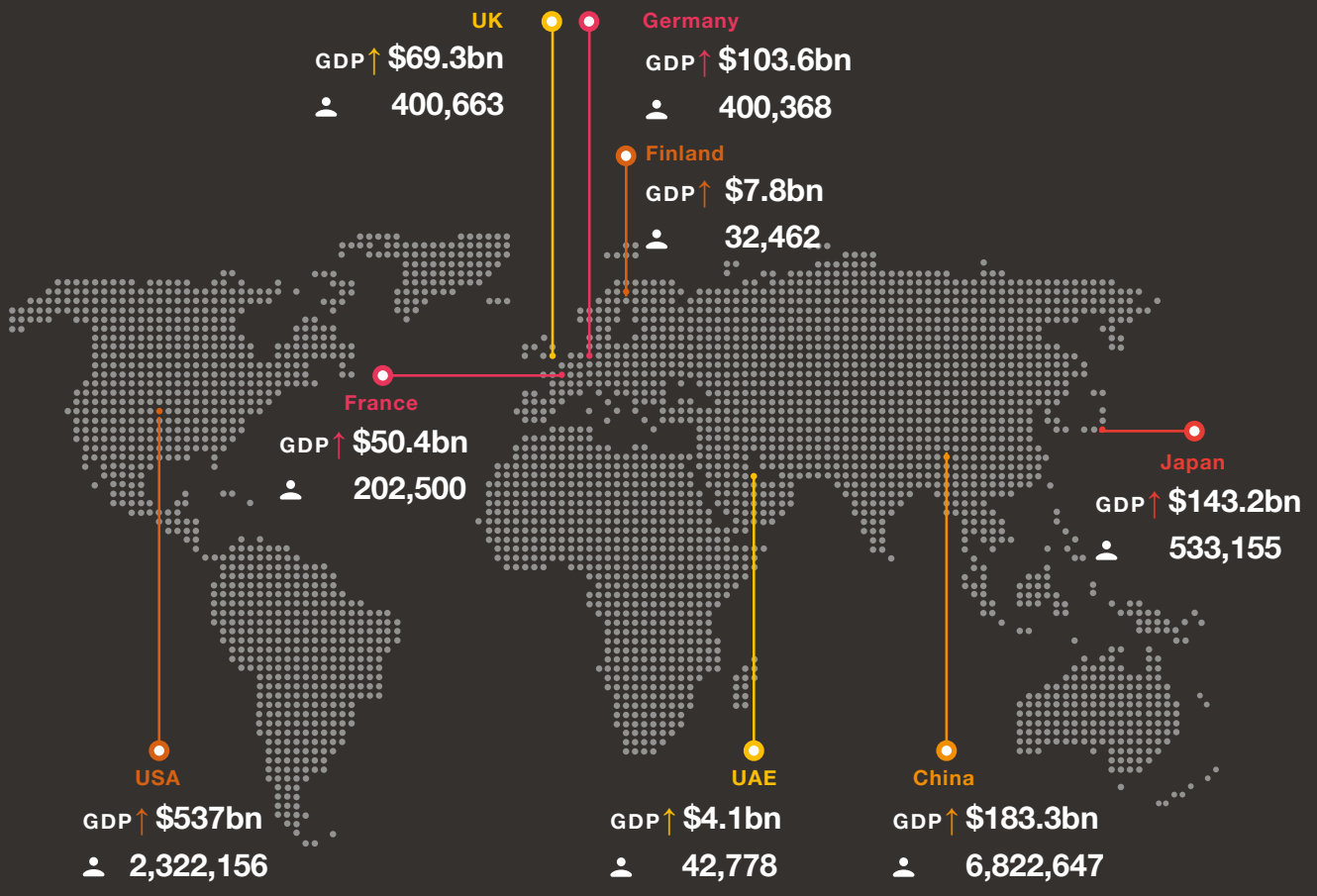
Scan me

The global impact of VR and AR: GDP boost and jobs enhanced by 2030

PwC research shows the potential boost to GDP from VR and AR globally and also the impact that the adoption of the technology will have on employment in different countries.

Scan me

Number of jobs enhanced by VR and AR by 2030



Rest of the world

GDP ↑ $444.2bn 12,603,911

Jobs enhanced globally by VR and AR

2019	2030
824,634	23,360,639

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Ready for business

Our research shows VR and AR represent a significant opportunity for organisations to create value and reduce cost. We have grouped the major use cases for VR and AR into five distinct categories and analysed the contribution each could potentially make.

1. Product and service development

Potential boost to GDP by 2030:

$359.4 billion

VR and AR have the potential to not only enhance and augment existing product design and development but also to enable entirely new techniques. In the automotive sector, for example, VR is already accelerating the creation of more accurate and realistic concepts, shortening the product development pipeline and saving significant time and money.

> “Almost every industry is responding to a growing need to deliver greater innovation, faster and more effectively, at better prices.

That means finding a way to develop products more quickly and more efficiently, reducing time to market while taking cost and complexity out of the process. This is where VR and AR can make a huge difference. They can transform the way businesses develop products. Rapid prototyping and collaboration using VR and AR technology will speed up and enrich the creative process. The time-intensive requirement to build physical prototypes can be reduced dramatically, bringing ideas and innovations to life and products to market far more quickly. But these technologies aren’t just a creative means to an end. They also offer the potential to create new services and engage consumers in unprecedented ways.

Darren Jukes
Head of Industrial Manufacturing, PwC UK

2. Healthcare

Potential boost to GDP by 2030:

$350.9 billion

The impact of VR and AR on the healthcare sector could be huge over the next ten years, for front-line patient care and also for training. VR is already being used to give medical students greater access to operating theatres, where there are restrictions on the number of observers. The technology is also being used to enable consultants based in different locations to collaborate remotely and discuss upcoming surgical procedures.

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I’ve seen first-hand the advances of VR/AR in healthcare. The value these technologies bring to surgeries is not only cost reducing, but life saving and accessible to everyone.

Society and hospitals are evolving, and so must the ways we treat illness. I believe that VR/AR can drive much of that change.

Dr Shafi Ahmed
Advisor in Digital Health Transformation and Innovation, Department of Health Abu Dhabi

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VR and AR have clear benefits in healthcare.

Being able to create operating theatres and realistic scenarios in VR will help train doctors and surgeons and test their decision-making and responses to stressful situations in a risk-free way. VR can potentially be used therapeutically too, creating applications to help people cope with anxiety. AR glasses can overlay scans and x-rays onto a patient’s body, augmenting the view a surgeon has. Similarly, AR can help a doctor see at a glance a patient’s test results and data, at the bedside, there and then, rather than logging into a desktop computer or checking paper notes.

Healthcare is already embracing VR and AR but so much more is possible. As a former doctor myself, I know my friends and former colleagues want technology that creates a better experience for staff and patients, so we need to combine these innovations with the resources and cultural change required to improve productivity and, most importantly, patient outcomes.

Luke Solon
Healthcare and Life Sciences Strategist at Strategy&, part of the PwC network

3. Development and training

Potential boost to GDP by 2030:

$294.2 billion

The use of VR and AR in training boosts engagement and knowledge retention and enables organisations to enforce consistent, measurable standards at scale. The technology also provides a way to train employees where it is not always practical - or safe - to do so in the real world. For example, to simulate emergency situations or asset maintenance in dangerous environments.

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These technologies are no gimmick.

We've delivered skills training and development to over 1,000 people in a day in VR, and immersive experiences are a fantastic way to learn. It can transport the learner into difficult conversations, appraisals or interviews. It can create press conferences or high-pressure presentations. VR can put you on stage, with all eyes on you. And it can remove the need for role-play, reducing costs and making training experiences more convenient and quicker to access.

VR offers almost limitless opportunities to develop people, and at PwC we're exploring a range of ideas. However, there are important factors to consider, such as understanding its capability and accessibility. Often using VR is new for people so supporting and reassuring learners should be well planned. Sessions in VR need to be short and impactful, potentially as a complement to a wider session. But we'd really encourage all companies to look at how VR can enrich the training they provide.

Sarah Potter
Immersive Design Leader, Learning & Development, PwC UK

4. Process improvements

Potential boost to GDP by 2030:

$275 billion

VR and AR are opening up exciting new ways to improve the efficiency, productivity and accuracy of employees and processes. Engineers and technicians can be fed information such as repair diagrams using an AR interface, enabling them to quickly identify problems and conduct repairs and maintenance. In the logistics sector, smart glasses can display picking information for the worker, highlighting location and displaying product details and packing instructions.

> Throughout the energy and utilities sector, VR and AR applications offer huge potential.

Safety is, as ever, a top priority and this is where VR is proving particularly interesting. Take an oil platform, for instance. Organisations are now able to provide training for staff on land by using VR to replicate the platform environment, preparing staff to handle a variety of different scenarios before potentially experiencing them for real in the field. In this situation, VR could substantially reduce cost by bringing different environments to life in the classroom.

AR is also proving important for managing the billions of pounds of infrastructure that generates and transports energy. Engineers can have technical information overlaid when repairs or maintenance are carried out using AR, providing a much more efficient way to work in the field, again bringing cost savings to field operations.

Steve Jennings
Leader of Industry, Energy, Utilities & Resources, PwC UK

5. Retail and consumer

Potential boost to GDP by 2030:

$204 billion

VR and AR offer new ways to engage, entertain and interact with consumers, creating new possibilities in film, gaming and retail. Gaming is one area where many people have already experienced VR and AR, and the popularity of these technologies will almost certainly increase over the coming decade.

VR and AR also offer retailers the opportunity to create exciting new customer experiences, from virtual fitting rooms for fashion stores, to AR applications that let people test how furniture would look in their home before they buy.

Retailers are also using VR and AR for consumer research, generating new insights into shopper behaviours and reactions to product placements, aisle configurations and branding changes.

> VR and AR are opening up fantastic opportunities for retailers at a crucial time for the industry.

In an already competitive sector, there is mounting pressure to innovate in customer experience and respond to digital disruption. These technologies offer exciting ways to bridge the online and offline experience. They can bring mobile and digital interactions into the real world, and push realistic 'in-store' experiences into the online world. This will help retailers deliver incredible omnichannel experiences.

We expect to see more and more retailers looking into the ways in which these technologies can create value. The retail industry has always been at the forefront of innovation and has often been the proving ground for many technologies that have transformed our lives, such as the rise of online shopping. VR and AR look set to drive further dramatic change for the sector and for society.

Sue Rissbrook
Head of Retail, PwC UK

Delivering on potential

There is work to be done to ensure these technologies now deliver on their potential.

The value is there. The use cases exist today. But organisations must not be complacent and must work to understand and address valid concerns and issues around these technologies in order to unlock full value.

Address cultural concerns

Some of the biggest challenges to the adoption and use of VR and AR by businesses may be cultural. Apathy or distrust of new technologies are common reactions. There may also be confusion about how the technology will be used, how it works or what the experience will be like.

With trust a common concern among many in society – particularly where technology is involved – stepping into a company's virtual world may feel too much of a leap of faith for some.

The onus should be on the industry – companies developing these technologies and those consulting on them and implementing them – to do more to educate businesses and society about their many benefits. These conversations need to be grounded in what is possible now, not far-off promises. That means getting more people to try out the technology and take the time to understand, answer and address any concerns.

Focus on return on investment rather than cost

Headset prices have fallen considerably in recent years but the cost of high-end VR and AR hardware, as well as developing applications and virtual environments, is still a deterrent for some businesses. That's especially true while the technologies are viewed as a novelty, a nice-to-have or a work in progress.

The rollout of 5G, which will reduce the reliance on expensive processing power and storage in current headsets, will be one factor driving further cost reductions, while the cost of design, development and delivery will almost certainly come down with more standardisation of platforms and services and more providers.

But even more important than cost reduction will be the development of business cases that focus on returns. Organisations should understand there are cost savings and business benefits to be found today through the use of these technologies and should build their case around a quantitative return on investment, rather than focusing just on cost.

Significant savings on training costs, a quicker time to market with new products, or improved workforce productivity all have a measurable return on investment. Similarly, the chance to open up new revenue opportunities will make an attractive case for investing in VR and AR.

Improve the user experience

Progress is being made on improving the user experience but there are still issues to address to put people more at ease. Some VR users report physical symptoms such as claustrophobia and nausea and can feel self-conscious.

The development of the technology and our understanding of best practices will help to reduce this.

Advances are also being made to improve the visual quality and field of view. Headset design will need to take accessibility and diversity into account to ensure devices are appropriate and comfortable for all.

But all of this still places an onus on businesses to ensure they are making smart choices about the technology they adopt, the ways in which they test it and roll it out, and the experiences they commission or create.

And none of this will matter if there is a lack of quality content for users. Companies developing business applications for VR and AR must create content and experiences that feel rich, rewarding and exciting.

> If technology fails to deliver on its promise, it is often because an implementation was planned without people in mind or a plan to engage them. Start with the people and communicate clearly what the ambition is, what the benefits will be, what changes will be made and what the business case is.

As a society we're going to see more technology-enabled change, and businesses must be honest and open if they are to build trust. Provide clear channels for communication, to listen and gather feedback and questions throughout the process. With technologies such as VR and AR, consider how they can actually be used as part of the communications process. Create VR or AR experiences that not only convey the benefits, but get people using the technology. We have successfully used approaches such as gamification to make those first experiences more fun and engaging.

VR and AR offer incredible benefits, but those benefits will not be realised if organisations don't bring their people along with them.

Alexa Foden
Director, Change Communications and Culture, PwC UK

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VR and AR have already begun to show their potential. These technologies have uses that go beyond gaming that can benefit society and the economy.

Sandra Lopez
Co-Chair, World Economic Forum Global Future Council on VR/AR

Seeing is believing: Time to get started

As our research shows, VR and AR are already contributing over $46 billion to global GDP. There is no reason to sit and wait. The benefits are real and companies can begin exploring today. PwC offers these five tips to get started:

1. Focus on solving business problems

Don't get distracted by the hype or novelty. Focus on a solid business case, such as using VR and AR to speed up a process, improve safety, reduce costs or open up new revenue streams.

2. Think about more than just software

Building the software is only one phase of a VR or AR solution. Understanding the technology and its capabilities, designing the solution to solve a business problem, and creating an effective deployment programme are key to a successful implementation.

3. Create a seamless experience

The positive uptake of a VR or AR solution will be largely dependent on how comfortable and intuitive it is to use. This is dependent on a number of factors including how the user performs actions in the experience, the hardware used, the facilitation of the experience, and even the environment.

4. Get stuck in with a test case

Seeing really is believing when it comes to VR and AR. And while planning and strategy are essential, it should not delay organisations from exploring the technologies. The best way to understand the benefits is to see VR and AR in action: start small and explore the potential with an initial pilot programme.

5. Measure the result and act accordingly

Once you've created a small test case, gather appropriate feedback which will direct your next step: a greater investment in the current solution, a pivot in a different direction, or a completely different path.

There is no failure in being better informed.

Are you ready to join the VR and AR revolution?

PwC applies business understanding, human insight and technology expertise to help organisations experience and unlock the benefits of VR and AR. To speak to us about how VR and AR can help you, get in touch.

Jeremy Dalton
Head of VR/AR, PwC UK

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Research methodology

This study provides a scenario of the impact VR and AR technology could have on the global economy by 2030, if uptake and the quality of products and services available develop as expected.

PwC conducted interviews with specialists in augmented reality and virtual reality at PwC, and third party sources in emerging technologies, to form a comprehensive list of potential use cases for VR and AR technologies that these specialists believe could realistically be implemented by 2030.

For each use case identified as likely to have a significant impact on the global economy, a range of sources and techniques to estimate their productivity impact were used. Existing research on their adoption and associated productivity increases, forecasts from ABI Research, and PwC economic analysis was drawn on to estimate productivity change that could occur with each use case.

Multi-factor productivity figures were incorporated into PwC's dynamic Computable General Equilibrium (CGE) model to estimate the aggregate effects of VR and AR adoption on global GDP up to 2030.

The CGE model captures economic interactions in the global economy including: trade and spending between firms on one another's goods and inputs; spending by consumers on goods; investment decisions, and dynamics in the market such as demand for factors like capital and labour, trade, employment and wage effects.

In order to convert GDP impacts from nominal to real, PwC has used the GDP deflator database from the World Bank. The figures presented are in 2019 prices. Our CGE model uses the Global Trade Analysis Project database, which is based in US dollars.

Countries' internal political issues during the time the study was conducted are not expected to significantly impact our analysis.

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About PwC

At PwC, our purpose is to build trust in society and solve important problems. We're a network of firms in 157 countries with over 276,000 people who are committed to delivering quality in assurance, advisory and tax services. Find out more and tell us what matters to you by visiting us at www.pwc.com.