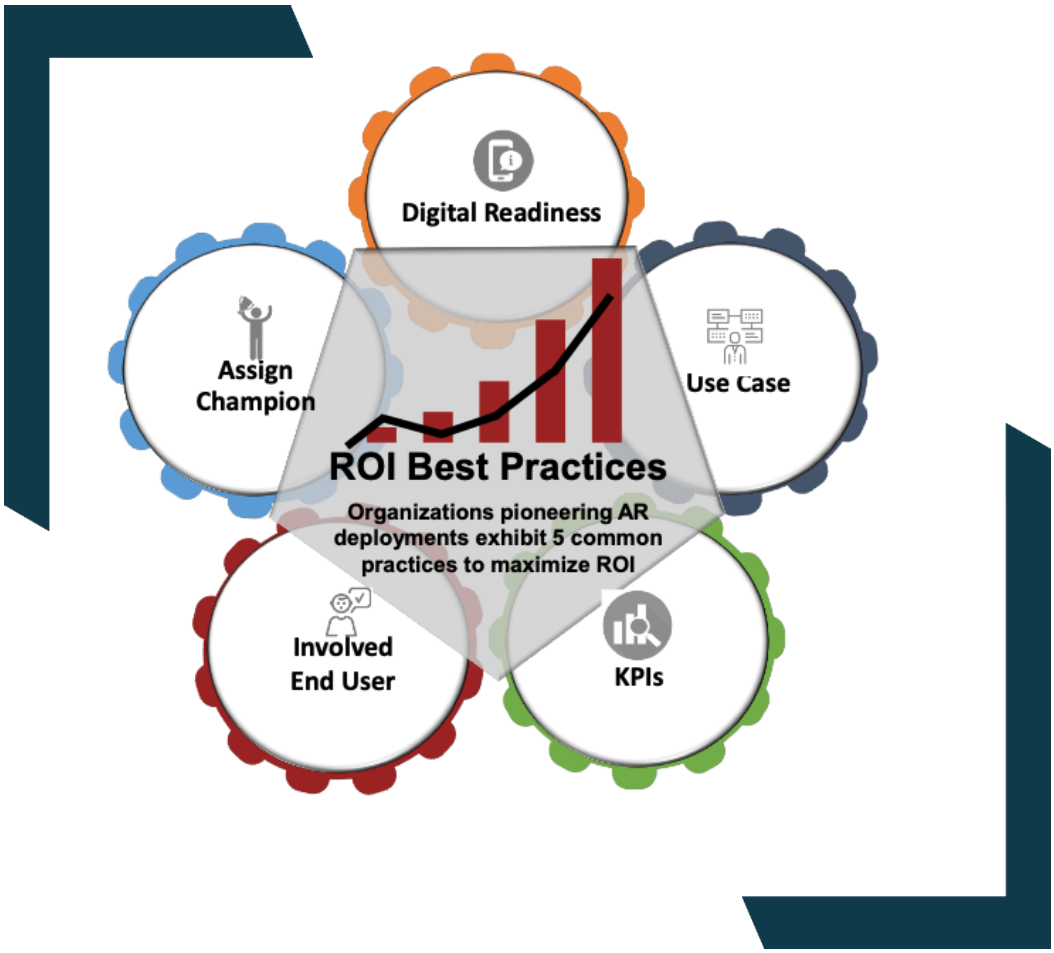
AREA

Augmented Reality for Enterprise Alliance



Best Practices in Measuring Enterprise Augmented Reality Return on Investment

Acknowledgements

The AREA would like to thank all the organizations and individuals who donated their time, insight, and expertise to participate in this study. You are among the leading organizations globally in the use of Augmented Reality technology and the insights have greatly assisted this research.

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OVERVIEW

The AREA is the only global, membership-funded non-profit alliance dedicated to helping accelerate the adoption of Enterprise Augmented Reality (AR) by supporting the growth of a comprehensive ecosystem.

One of the benefits of AREA membership is to be able to define and access research projects. This best practice report was initially provided to AREA members only. To help the ecosystem and provide more information about best practices when conducting return on investment (ROI) analyses, the AREA has agreed to release this report for the benefit of all members of the enterprise AR ecosystem. The AREA has also released the first neutral and Web-based Enterprise AR ROI Calculator and Case Study illustrating how to use the ROI Calculator.

This report prepared by Strategy Analytics identifies the best practices of market leaders in identifying, prioritizing, and managing costs and returns on their AR investments. It provides best practices guidelines for companies to use in performing ROI analyses specifically for evaluating Enterprise AR projects and provides stakeholders with an informed starting point and working framework for conducting ROI analyses of their AR technology investments.

ROI analysis is an important way to measure value and evaluate AR deployments relative to other potential technology investments.

ROI is a measure of the efficiency of an organization's investments, calculated by measuring net cash flows generated by an investment relative to its cost (cash outflows)[1]. When considering typical investments in IT infrastructure and software, acceptable minimum threshold rates of ROI range from 10 to 15 percent depending on the industry.

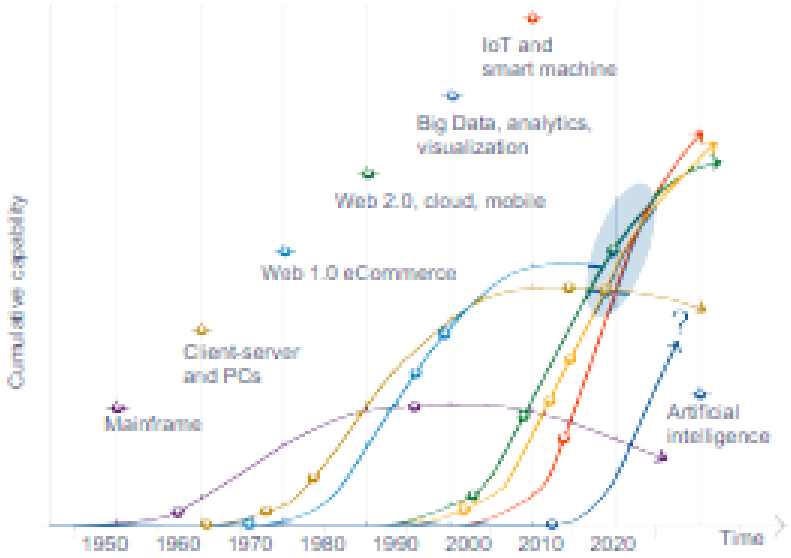
In this report, we first set the context by assessing the mega-trends that are changing the fundamental approach to ROI analysis on technology investments for business decision makers. We identify how conducting ROI analysis on technologies that span information technologies and operation technologies is different from evaluating ROI on more traditional, capitalized IT investments. We then outline the issues that decision makers are facing when evaluating their AR technology investment, and identify the best practices shaping successful ROI analysis.

[1] Investopedia

FACTORS INFLUENCING RETURN ON INVESTMENT

The digital transformation of enterprise through the steady transition to software-as-a-service driven business models, the use of agile development processes, and the rapid rise of new connected technologies like the Internet of Things and Augmented Reality solutions have combined to enable a new era of cost-saving and revenue-driving applications and services. As shown in the chart below, the introduction of these technologies over time has enabled organizations to drive revenues and increase critical capabilities.

Digital Transformation Technologies Impact on Enterprise



Source: World Economic Forum, Accenture

There are significant market forces that are combining to make it increasingly difficult for large organizations to conduct ROI analyses on emerging new technologies like Augmented Reality, Virtual Reality and other connected devices enabled by the Internet of Things.

These forces include:

- *The digital transformation of enterprise IT.* Companies are defining their competitive basis by using digital solutions throughout their organizations. In using augmented reality, these challenges arise in the area of content adaption. The “digital readiness” of a company directly impacts how ROI analysis is performed and can make-or-break ROI performance.

- *The increasing use by large organizations of software-as-a-service (SaaS) business models* has enabled many service-based or linear asset organizations to operationalize new technology costs and free up capital investment dollars. Accounting for these costs as operational expenses bring them forward onto the income statement and shorten the amount of time (amortization period) in which to recover them.

- *The use of agile development processes* allows firms a flexible and scalable solution to align with increasingly rapid, changes in organizational requirements. Enterprise use of agile processes also makes it difficult to define starting and ending points for technology projects, which can dilute actual investment returns.

These trends are impacting ROI analysis for AR in three important ways:

1. ***Significant upfront investment is needed in order for the organization to reach "digital readiness".*** Converting paper-based operations and service manuals to digital, digitizing lists and information on inventory and machinery, digitizing information on supply chain data and processes, and creating digital processes and data for core operational processes can consume significant resources and take years to complete. Organizations that account for these costs associated with digital enablement on a project-to-project basis struggle to rationalize these types of investments.

2. ***Shorter payback timeframes.*** The use of SaaS business models and agile development processes where revenues and costs are realized on a running annual basis is serving as motivation for firms to operational expenses. This brings costs forward, forcing the enterprise to generate the same target rates of return on investment on significantly shorter timeframes. Today, it is uncommon to find financial analyses that amortize assets over more than a five or seven year period on technology investments, with some heavily operationalized companies using three year timeframes.

3. ***Stronger focus on revenue-generating investments.*** Leadership teams are prioritizing investments with revenue-generating impact. Acceptable minimum thresholds for ROI of 10-15% are still the benchmark, but it is increasingly difficult if not impossible to generate these rates of return (on such short timeframes) by implementing cost-cutting or efficiency-driving process automation solutions in back-office or operations alone. Investments that create new revenue potential can increase raw profits and thus returns.

As firms transform to digital businesses and embrace the benefits of new technologies like AR and IoT, agile process development has given rise to more responsive and adaptive business models. Firms that live and breathe agile processes are more familiar with the loosely defined and evolving nature of costs and expense allocation.

The challenge lies in the fact that ROI analysis is not agile – the major challenge in assessing the return on investment in new technologies requires decision makers to define costs that may ebb and flow as systems scale. These factors are making ROI analysis very difficult if not impossible. Many organizations forego cash flow-based ROI or NPV analysis and instead utilize a simpler comparison of direct costs of the technology to the benefits realized from the solution (Cost/Benefit analysis.)

While adequate in identifying the short-term savings or benefits of the technology, this leaves firms exposed to significant, indirect costs hidden in managing the technology across its lifecycle. The table below illustrates the factors of agile processes that complicate the investment evaluation:

Evaluation Drivers	Waterfall	Agile
Process	Well defined, limited time	Undefined, ongoing
Cost	Well defined, limited	Variable, hanging
Scaling considerations	Fixed, linear	Variable, increasing/decreasing
Asset basis	Capitalized investments – hard assets	Operationalized investments – process intensive
Accounting basis	Balance sheet	Income statement

It is important to remember that, like drones and other IoT connected devices, Augmented Reality technology is in its early stages of development. As such, companies seeking to evaluate the return on their AR investment need to consider the issues that arise from implementing newer early-stage technologies. These issues are summarized in the table below:

Technology	Tablet, Smartphones	AR, IoT, Drones
Operating systems	Standardized operating systems	Proprietary
Data formats and protocols	Standardized/integrated	Proprietary
Applications Supported	Multiple	Single/limited
Access to enterprise assets/resources	Standardized, integration-ready	Proprietary/non-existent

1. Operating systems, data protocols, and formats for these emerging technologies are more often proprietary vs. the more widely accessible development platforms offered by tablets and smartphones.

2. Access to existing resources and data assets needed in proprietary formats to develop AR experiences is limited or non-existent. Often these resources are on paper or exist in other non-digital, unstructured formats. The costs of digitizing these assets (especially if the formats are limiting the organizations ability to reuse their existing data) can be significant and can far outpace the actual costs of the technology itself.

3. Use cases for Augmented Reality hardware like transparent, wearable AR displays are limited. Where tablets and smartphones are application platforms, augmented reality devices like glass are single application devices.

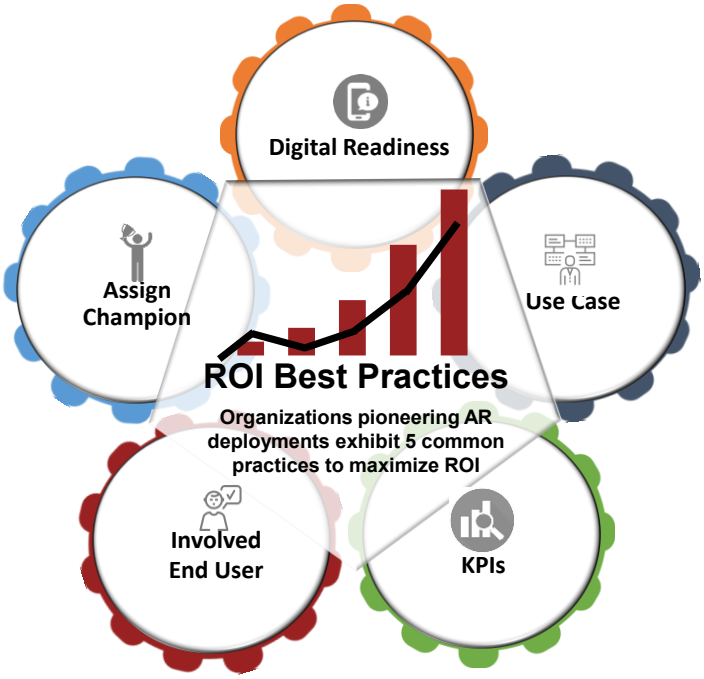
Early adopters of AR are fighting through these challenges because AR offers the potential to seismically shift the efficiency and productivity of process-based operations that drive competitiveness, safety, productivity, and ultimately profitability. These organizations realize that competitive advantage rests in the ability to leverage new, visual interfaces to provide contextual, relevant and timely data that enables workers to maximize efficiency while having the right information available to them. These pioneering organizations are eagerly implementing AR as a fundamental enabler within their operations.

This research focused on a study of such firms, to evaluate their best practices in investing in AR and generating positive returns on investment.

BEST PRACTICES FOR SUCCESSFUL ROI ANALYSIS

Research conducted for this report reveals that organizations pioneering AR technology deployments and realizing superior ROI on their AR investments exhibit five common best practices, as illustrated below. In this section, we explore each of these practices in detail:

AR ROI Best Practices



Source: AREA

Adapt to Organization's State of Digital Readiness

For AR to enable higher efficiency and improvements in productivity, paper-based and other non-digital assets and resources need to be digitized. The digitization of knowledge and assets like detailed process manuals, inventory and parts information, risk reduction policies, time and space studies, and other critical assets can consume significant resources and require a multi-year effort. The impact of the digitization investment on net present value calculations can be huge, and when the costs of resources required for converting assets to digital formats are included, they can diminish ROI analysis and mask the significant benefits of the AR solution.

The sophistication of an organization's digital readiness strategy and their approach to identifying and managing these costs is the most significant challenge facing organizational ROI analysis on AR investments.

Best practice analysis finds that firms executing successful AR ROI analysis do several things:

1. *They have a formal or informal corporate digitization strategy.* Successful organizations have a plan for digitizing their core assets, e.g., operations and training manuals, parts and inventory, raw materials, supplies and other resources. There is a corporate-level tenet that the organization is going to encounter costs to enable 'digital-readiness' for strategic, operational initiatives and that it must find a way to bear these costs when needed. This applies to investments related to a host of technologies, from cloud enablement, security, and Internet of Things, to smart manufacturing, and agile process and application development. They have a plan - formal or informal - for digitizing critical information and resources and have prioritized these assets in conjunction with new technologies they seek to leverage.

2. T*hey account for these digital readiness costs outside of or separately from the project-based ROI.* Organizations with formal or informal corporate digital strategies are proactively splitting these costs out of individual technology projects and absorbing them as overhead and within other, capitalized IT investments. This approach reflects the company's commitment to capitalizing these 'digital readiness' costs to ensure that they do not negatively impact or diminish the benefits of important individual technology investments.

   3. *They digitize resources in 'bite-sized chunks".* By clearly defining the use case and the underlying process details, they enable AR deployments by prioritizing the digitization of the most relevant parts of their paper or non-digital assets needed for the application. They also leverage suppliers with specific vertical or horizontal solutions that can ease this transition by working existing metadata structures and formats (e.g., PTC for computer-added design (CAD) content.)

4. *They can quantify impact within agile development processes.* They assign a beginning and an end to their technology deployments and deploy in controlled, well-defined steps to ensure that these implementations remain manageable and cost-effective. While this approach sounds intuitive, it is important to note that this can be difficult from an organizational perspective. The reality is that in many instances the use of agile development techniques is upending the ability for organizations to perform successful ROI analysis.

5. *They leverage existing digital assets and resources whenever possible* to control costs and manage risk. When evaluating investments in these new technologies, these organizations limit their exposure to expenses hidden in the product lifecycle by leveraging other platforms (e.g., tablets) and by developing their software applications. This enables them to lower risks while maintaining flexibility to develop and manage the solution cost-effectively over time. These companies are careful when trying to repurpose or refactor existing assets, as this can often be more expensive and yield worse results than using new assets. Thus the best practice of reusing assets should

be to carefully evaluate the costs and return of the rework itself to ensure this is a feasible approach.

6. *They identify, pilot and manage AR investments with a firm grasp of the benefits and return that the AR solutions provide*. These firms have a firm understanding of the benefits AR solutions offer, which comes from having explored first-hand the returns that AR enables. To develop this understanding, it is necessary to accurately quantify and assess the returns on the initial pilots. To ensure that benefits seen in the pilots are achieved at scale, these firms also measure returns during the on-going implementation and management of the solution.

Define & Quantify the Use Case

Research conducted for this paper indicates that most businesses can instinctively tell that they are saving time with the use of new technology like AR. However, due to time and resource constraints and the lack of an accepted organizational approach to measuring ROI itself, more often than not these same organizations have not quantified the time and resources needed for many of their core operational processes. There are organizations that are sometimes swayed by the novelty and hype that accompanies AR. Performing ROI analysis on AR solutions injects objectivity by requiring that organizations distill the specific parts of the process where AR can reduce uncertainty, ambiguity, time-drains and the possibility for errors in the process.

Calculating ROI successfully requires that the targeted, legacy process be well defined and quantified, with identifiable start and end points. The process itself also needs to be measurable regarding both times spent on task and all of the additional resources required to complete each step of the process.

To illustrate this point, consider the employee time-savings component of an ROI analysis. In order to estimate process-driven savings in employee time, the new, AR-enabled process also needs to be clearly measured and quantified. Consider the time and resources spent by AR users as well as the time and resources saved by others who are not using the AR app but may still benefit indirectly from its use. For example, the use of AR in product development applications allows engineers to reduce the amount of time needed to implement design changes for the entire team and not just the user(s). The AR-enabled display could automatically send finalized CAD drawings to other design engineers working on a project for review, reducing the need for them to physically come to the design office to review and sign-off on the revised plans changes. These indirect time savings should also be quantified and included as savings in the ROI analysis.

In order to quantify benefits, an ROI study will allocate resources for a targeted time-and-motion study. Conducting a time and motion study will yield significant benefits by

uncovering time drains that are often "hidden" by what appears as an efficient process. For example, shown below is the process description used by plant technicians for maintenance and repair operations (“MRO”).

1. Receive notification of a maintenance order
2. Identify the location
3. Identify the object
4. Diagnose the status of the object
5. Identify the fault
6. Perform repair procedure
7. Notify the user of the successful completion of the procedure

There are a number of third-party time and motion study solutions available. Often AR solution vendors and suppliers have the experience and tools to assist organizations in performing detailed time and motion studies. Pilot tests are also invaluable for fully developing and evaluating the costs, benefits and hidden challenges in each use case.

Target Specific Business Outcomes using Key Performance Indicators

Successful ROI analysis relies on having a well-defined objective, a documented, quantified understanding of the legacy process, and quantified insights into the new AR-enabled process.

These metrics illustrate the effectiveness at the core of a company's business operations and processes. Process-based productivity and efficiency gains like those generated in AR maintenance and repair operations solutions are among the leading benefits being realized from AR today. Successful organizations use activity based costings to measure the time and process-based savings from the application. Being able to quantify the process costs related to service and maintenance should allow you to directly identify the impact on metrics like mean time to failure (MTTF), or mean time to repair (MTTR) for example. These metrics need to be cleanly, quantitatively defined to enable effective ROI analysis.

To perform ROI that stands up to scrutiny from financial experts requires operations teams to establish and protect the fidelity of their estimates. Organizations realizing positive returns on their investment spend time and resources to ensure that key metrics are cleanly quantified and not contaminated by bleed over or overlap with other related or coincidental process. It is critical to document these tasks in detail and ensure that others can repeat the process with similar calculations. Some of the more common metrics utilized in MRO applications are below:

Benefits/Outcome	Metrics
• Lower total Maintenance Cost • Fewer equipment breakdowns & urgent interruptions • Reductions in Maintenance Labor Costs • Reduction in equipment damage • Reduction in inventory for materials and spare parts • Reductions in high priority unscheduled jobs • Level workloads & stabilized workforce • Increase in volume of planned work	• Higher utilization rates • Reduced wait/idle time for machine operators • Reduced scrap/ reject rates • Lower repair costs • Reduced MTTR - Mean Time to Repair • Reduced MTBF – Mean Time Between Failures • Increased expected life of capital investments • Higher OEE - Overall Equipment Effectiveness

Source: Industry, Strategy Analytics

A successful ROI analysis also requires that cross-team collaboration occur before the pilots in order to ensure that there is buy-in to the business problem under scrutiny and the metrics being used to measure it. Meaningful collaboration on these issues between leadership teams that include finance, IT, users and operations along with executive or senior leaders is a critical best practice.

Involve the End User in the Field

Successful ROI analysis relies on implementations that involve the end user through the entire process. From defining and measuring the use case, during the test and evaluation of any pilots and business case, and during the final stages of implementation, effectively engaging with the human end user generates significant benefits to the ROI process:

- *Maximizes user buy-in and empowerment.* Involving end users throughout the process ensures that you are minimizing "human" costs related to ongoing process change during deployment. By giving users the ability to provide input and feedback on the solutions related to issues like the comfort of the glasses, and whether the application creates value, companies can design better solutions and also manage change by minimizing the potentially negative impacts and costs associated with changing long-embraced legacy processes.

- *Ensures integrity of time and motion studies.* Companies gain valuable understanding of the often unexpected and sometimes quirky adaptations that workers make when performing processes and tasks that might seem very efficient on paper. From the physical layout of machinery to the location of parts to the adjustments and settings of equipment, engaging users during these studies ensures that the interactions between environmental and human factors to consider in the design of the augmented solution.

- *Uncovers potentially unforeseen costs associated with different work environments.* It is important to identify differences in working conditions at each workplace that might increase costs, e.g., low light, dirt and grime on machinery, and poor wireless connectivity. Companies planning to roll out their AR solution to multiple facilities should engage end users at each location to ensure that they have captured insights on how the environment may be different from the pilot test environment.

Identify & Involve a Champion

Organizations committed to maximizing their return on investment assign a “Champion” to follow through on technology implementations to ensure that the projected ROI is realized after deployment. These individuals have a sound grasp of both the business and technology challenges the company faces, are familiar with the key stakeholders driving both corporate strategies and business unit priorities, and have inputs into the upfront and ongoing decision making regarding continuing investment in the technologies.

This approach helps to enable efficient ongoing management of issues that could unravel direct and indirect cost estimates. For example, costs related to expanding or adjusting software licenses, and technical support costs. Also, champions ensure that profit-sapping indirect or hidden costs arising from other tangential or secondary issues are actively managed and addressed. For example, additional training costs

due to ineffective process change management, or impacts to support operations like ordering or billing, are two areas where hidden costs often occur after implementation.

ASSESSING ROI ON LARGE DEPLOYMENTS & NEW USE CASES

Once the company has conducted a successful technology pilot and stakeholders agree that the company is ready to roll-out the AR-enabled solution to some other operational facilities, new factors need to be considered. Below is a list of best practice considerations to optimize ROI on larger, enterprise-wide deployments:

- *Evaluate ROI on each pilot and use the same ROI framework with identical cost variables and processes.* If the use case is the same, the ROI framework should not change as technologies are rolled out in different locations or across business units. ROI cost and benefits or savings should be accounted for on a plant by plant or location by location basis, and then summed within the appropriate hardware, software, or process cost variables of the larger ROI model. This approach ensures that cost and impact can be evaluated at both the project level and on a site-by-site basis, and enables an identification of specific cost differences in each deployment by location.

- *Explore how environmental factors that may differ from the pilot.* Do not assume all locations and work environments are the same. Involve end users at all of the facilities to identify any factors that might differ from the pilot and from location to location. Identify and consider the impacts of work environment differences (e.g., insufficient lighting, cleanliness of machinery) or subtle process differences based on human (trainability, attitude), or equipment issues (e.g., older equipment with different operational requirements), or areas where hidden costs potentially exist. Conducting an individual, on-site time and motion study at each location is the optimal approach, and involving at least one team member from each site in the planning and evaluation of the AR solution will help identify and minimize the negative impact of these location-specific factors.

For companies that have successfully deployed their AR technology and are now seeking to add new AR use cases, there are several important considerations, in addition to the best practices noted earlier, that will help in optimizing enterprise ROI:

- *Standardize your approach to business case development and ROI analysis.* Best practices of successful organizations that have rolled out multiple AR solutions in areas like quality control, maintenance and repair, and safety show that these companies have standardized their approach to developing and evaluating the return on their AR technology deployments. They set up and emphasize the re-use of standard test/pilot approaches, they have a systematic approach to managing and conducting time studies, and they collaborate across business teams to develop and evaluate the business case and cost/benefit or ROI analysis.

- *A project-based approach to technology deployments facilitates a clean analysis of ROI.* Successful organizations approach each new AR use or business case as its own project, and measure ROI independently of other AR applications you might be using. Like in our earlier suggestions, define the start-end points and have cleanly quantified metrics specifically relevant to this new business case.

- *Create rules-based frameworks to enable allocation of integration costs.* Forward-looking organizations are integrating AR applications with other business systems. Inventory picking solutions, and maintenance and repair applications, for example, are being integrated into supply chain and customer relationship management systems. Successful organizations are creating rules or guidelines on how they account for and allocate these integration costs across business systems. This approach creates a systematic allocation of costs and is a critical part of an organization's digital strategy.

CONCLUSIONS

Evaluating the ROI of AR introduction in an organization is not a straightforward process. Challenges are in no small part due to the current state of digital readiness of organizations considering AR technology as well as the number of significant challenges facing companies that are implementing early-stage technologies like AR.

It is easy to envision a future where a next-generation of savings will arise from AR solutions. For example, insurance companies reducing insurance premiums for organizations who utilize AR solutions to improve work/user safety in dangerous working conditions, or that prioritize worker safety in hazardous operational processes like electrical maintenance/repair, oil and gas production, or chemical engineering.

To enable these changes to occur, it is important that the companies driving AR development today also perform thorough ROI analysis by quantifying, detailing, and documenting the process changes, impacts, limitations or trade-offs, and ultimate benefits that their AR technology or solution delivers.

It is challenging to evaluate the return on investment of an early-stage technology like AR. However, it is important for individual companies to undertake ROI analysis on their AR investment to enable and justify sound technology spending practices that will aid in decision making, and to enable the organization to accurately measure and thus accrue benefits over the long term from their AR investment. Understanding the potential ROI and following best practices outlined in this report is also important for enabling the broader development of the enterprise AR ecosystem and driving AR solutions into the mainstream.

APPENDIX

This research was conducted for the AREA by Strategy Analytics, Inc. Strategy Analytics is a global syndicated research and consulting firm focused on the automotive, communications, digital media, and enabling technologies industries that are driving consumer and enterprise adoption of digital media, devices and other technology-based innovations.

Strategy Analytics Consulting Practice provides a range of project solutions to help our customers identify and evaluate opportunities, evaluate and develop competitive strategy, and to support go-to-market planning efforts.

Research for this report drew upon Strategy Analytics' IoT Strategies advisory service, which focuses on the digital transformation and business process revolution powered by the ubiquitous internet, pervasive low cost connected devices and the growth in data analytics solutions. This research also incorporated insights from Strategy Analytics' Virtual & Augmented Reality Ecosystems advisory services, which provides demand and supply side research on the Augmented Reality ecosystem.