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# Practical Computer Vision

## Unlocking the power of innovation across the business

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# Dell Technologies Introduction

Organizations from every industry are in a digital race to turn data into business outcomes, faster. Computer vision is playing a more central role in that effort by accelerating time to value with its ability to connect video and other data at the edge with broader centralized networks.

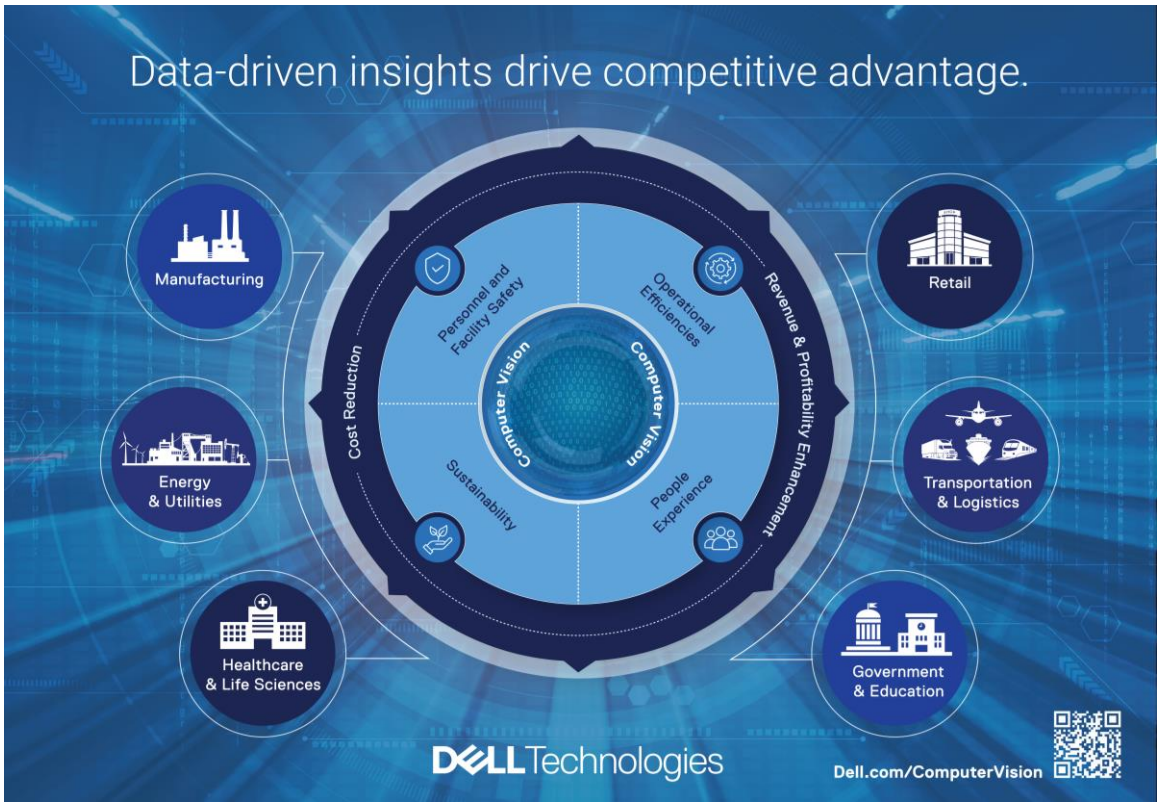
From situational awareness to tracking customer flow in retail to optimizing supply chains, the opportunities to improve outcomes using computer vision are immeasurable. Progress, however, is often impeded by operational and design complexities. How does an organization match the right systems to the right workflows, and subsequently those workflows to achieve the desired outcomes? That's where Dell Technologies comes into play.

At the forefront of the enabling technology of computer vision, Dell Technologies has combined with key industry stakeholders such as Intel, and an extensive partner ecosystem to develop and refine an award-winning process that takes customers from ideation to full-scale implementation, faster and with less risk. Our focus is on outcomes which are driven by transformation across industries. Through this process we reduce the risk, we speed up the implementation process and deliver the workflows that the customer needs. Although our discussions start with understanding the customer's current physical security infrastructure, it evolves into defining their desired outcome(s). After conducting thousands of conversations, Dell Technologies has discovered a universal theme. Regardless of industry, every customer was interested in delivering one (or more) of the following outcomes.

These are:

- Increasing operational efficiencies
- Strengthening safety and security
- Enhancing the people experience
- Improving sustainability
- Generating new revenue opportunities.

**Figure. Dell Outcomes for Computer Vision**




Source: Dell

Each of the five outcome categories entail different workflows depending on the specific industry. The customer may be looking to improve the passenger experience or retail customer experience or fan experience, and they can see how that is impacted. There is pressure on every industry to reduce its carbon footprint. As a result, companies are looking at sustainability, not only for internal operations, but also for how they can improve their impact on the environment in dealing with vendors and outside entities. Still further, from a revenue enhancement perspective, this technology can be used to deliver new services or create new opportunities to generate more business. Operational efficiency is paramount as today's workforce is shrinking, not growing. This process from Dell Technologies enables companies to do more with fewer people while ultimately helping organizations enhance their bottom line.

From a technology standpoint, Dell Technologies delivers the ability to ingest visual and sensor data once, and then provide multiple insights for any one of the five outcomes. Ingest once and use that data in as many ways as possible to deliver the desired insights faster.

With our outcomes-based process, Dell Technologies can help define the workflows that map to the desired outcomes, test the solution at scale, test it to fail, and build it from an ecosystem of industry-leading partners. Through this unique validation process, Dell Technologies and Intel can help you accelerate the adoption of innovation.

# Intel Foreword

Computer vision, which uses deep learning to form neural networks that guide systems in their image processing and analysis, is an increasingly valuable technology across virtually every industry.

With Intel® hardware, you have choices to meet your specific model complexity, pipeline stage, and cost requirements. Choose from a portfolio of CPUs and purpose-built accelerators (including GPUs) to create the right balance of compute performance, AI inference acceleration, power, and cost for a range of computer vision solutions. Intel's oneAPI toolkit supports the most common AI frameworks and the optimization of AI algorithms from other frameworks through the OpenVINOTM toolkit.

Together Intel and Dell Technologies are driving innovation with partners to create next generation solutions, which enables the entire ecosystem to move faster, operate more safely and efficiently, and optimize Total Cost of Ownership.

# Introduction – Computer Vision in AI

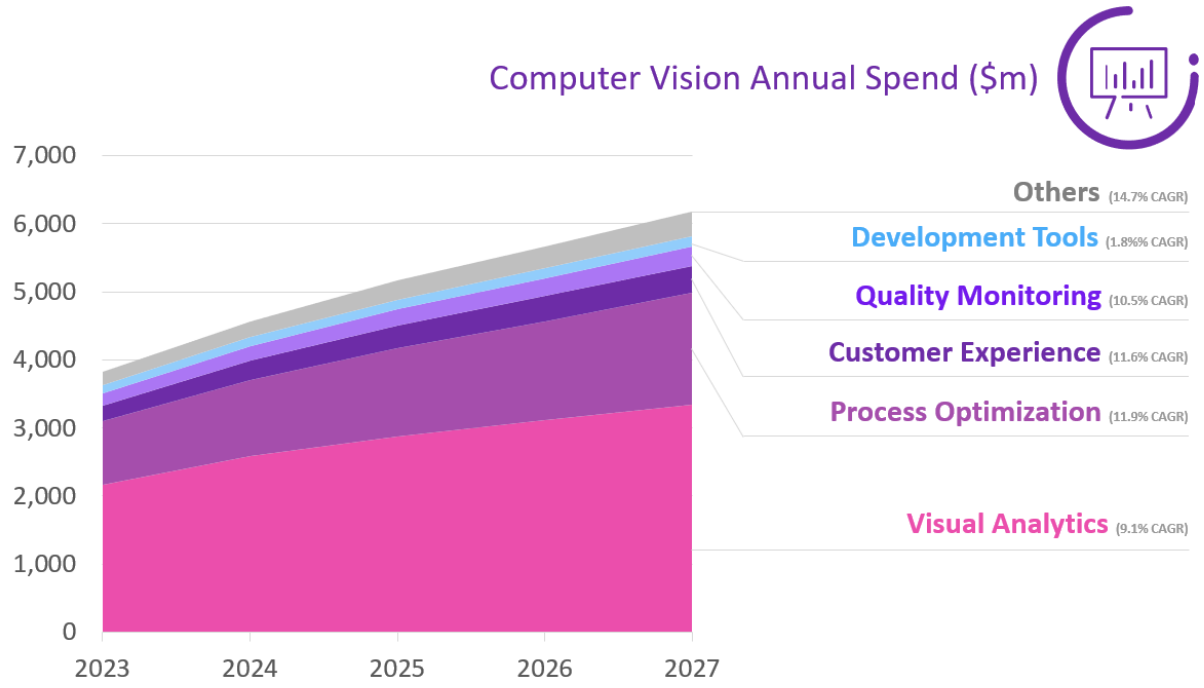
We are currently living in the age of deep learning (DL), as evidenced by current market intensity swirling around generative AI that promises to push the market for AI platform technologies to more than $13B by 2026, growing at a rate of 17% year-over-year. Building on advancements in model architectures and hardware efficiencies, each day, technology researchers discover new approaches and new capabilities that were only dreamt of a few years prior. Nowhere is such innovation more tangible and instantaneous than in the deep learning realm of computer vision, where better accuracy of readings and the ability to measure a wider range of objects are but two of the many new vistas of value revealed in shifting from traditional statistical AI to deep learning technology, when coupled with computer vision management (CVM).

At its very core, computer vision is not complicated – but is so much more than just a tool for identifying and then drawing bounding boxes around objects within computer security videos. Stated simply, computer vision defines the act of imbuing machines with the ability to see, comprehend and then act on visual information from the surrounding world. And from this one simple premise, companies seeking to transform their business have at their fingertips a myriad of possibilities to explore.

*At its very core, computer vision is not complicated – but is so much more than just a tool for identifying and then drawing bounding boxes around objects within computer security videos.*

From facilities management, transportation, or sports and entertainment, a wide array of markets already rely on computer vision to increase operational efficiencies, build stronger ties with customers, generate new revenue streams, work in better harmony with the environment, and of course improve the safety and security of employees and customers alike. Omdia market research estimates that today, companies are spending almost $2.5 billion dollars annually on computer vision technologies, and will grow by more than 150% to reach $6.2 billion dollars in 2027 (see Figure 1).

**Figure 1. Computer Vision Market Growth Rates**

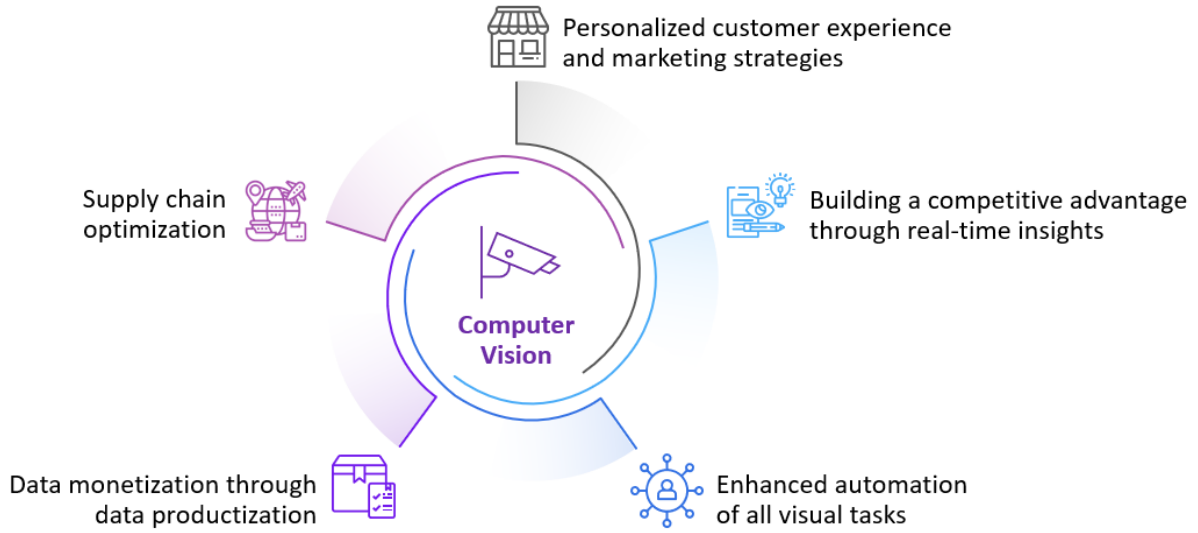



Source: Omdia Artificial Intelligence Software Market Forecasts 1H23

# What's driving this high growth?

First and foremost, data, or more specifically the availability of high-quality data to increase accuracy of computer vision DL models, enables them to effectively tackle many different domains, from security cameras to self-driving cars, and even social media. The rapidly increasing number of data-savvy edge devices serves as a key driver here, helping companies share data previously closed off from the broader business. Second, the rapidly decreasing cost of hardware and edge devices (cameras, sensors, storage/memory, etc.) coupled with new-found infrastructure efficiencies is enabling companies to deploy larger, more capable computer vision models on a grand scale. And third, demand for both corporate efficiency and growth are themselves fuelling the computer vision market because a single platform can drive a wide array of important use cases (for example, video feeds and sensor data). By ingesting and processing data from many disparate sources (not just video), a well-designed computer vision platform can serve analytical requirements across the business, creating a true flywheel effect of ingest once, deliver everywhere continuously. Of course, doing so demands an infrastructure capable of bringing together and synergizing these disparate signals (for example, video feeds and sensor data) (see Figure 2).

**Figure 2. The Computer Vision Flywheel Effect**

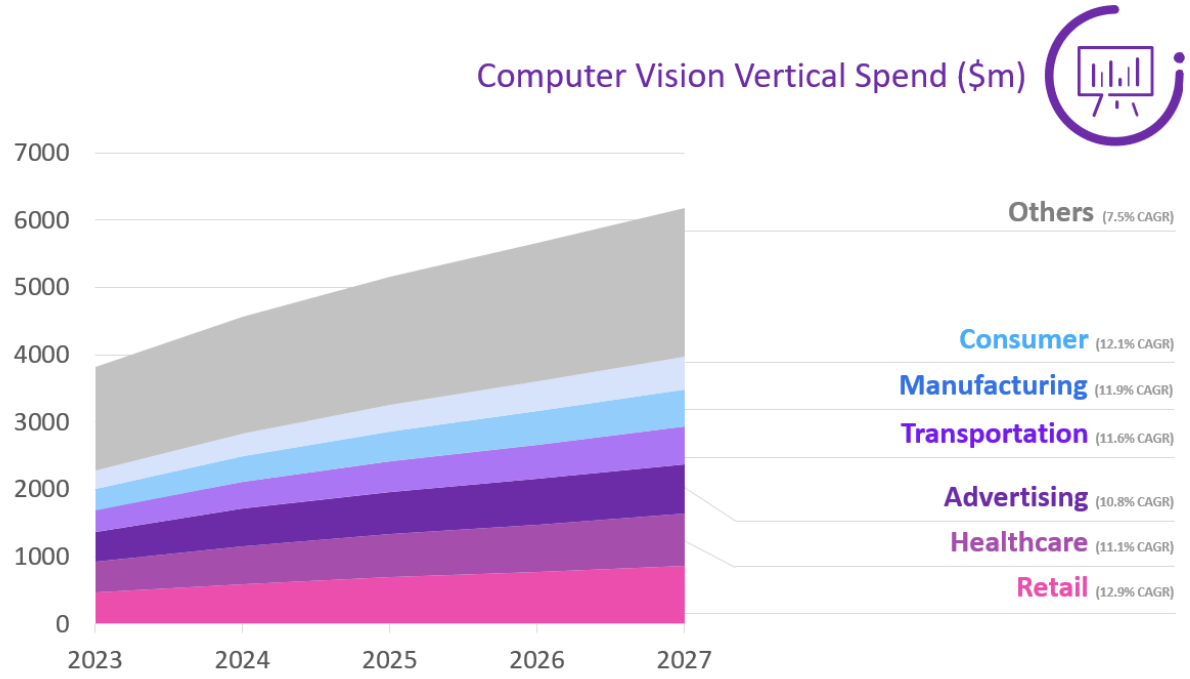



Source: Omdia

Omdia expects this multifaceted approach to create significant opportunity across several markets such as retail, where the combination of vision with language and analytics can drive facility safety, but also streamline restocking efforts and open new streams through capabilities such as augmented reality clothing try-outs. For retail alone, this broad applicability will translate into a 249% market growth from 2021 and 2027. Likewise this wide applicability will drive significant growth for customers working within not just consumer markets but also transportation, manufacturing, healthcare, law enforcement, smart cities and other public sector markets over the same period (see Figure 3).

*Demand for both corporate efficiency and growth are themselves fuelling the computer vision market because a single platform can drive a wide array of important use cases.*

**Figure 3. Key Computer Vision Vertical Market Opportunities**




*Source: Omdia Artificial Intelligence Software Market Forecasts 1H23*

Through the remainder of this whitepaper, Omdia will explore how enterprise practitioners across these, and other vertical markets are building modern computer vision workflows and supportive CVM architectures capable of exploiting the full potential of computer vision solutions for cost reduction, revenue generation, and beyond.

# Putting People First

## Outcome: Strengthening Safety & Security

When it comes to employee and customer safety, access to all the operational and business data in the world is not enough to avoid all potential damage, injury, financial loss, or even life-threatening situations. By leveraging advanced algorithms capable of interpreting visual data gathered from common video surveillance cameras, however, it is possible to go well-beyond basic loss prevention to encompass a host of real-time, transformational capabilities. For example, computer vision can use the idea of anomaly detection to mitigate dangerous situations while simultaneously improving operational efficiency anywhere many people come together - resulting in both improved safety for employees, and reduced costs for the business.

*It is possible to go well-beyond basic loss prevention to encompass a host of real-time, transformational capabilities…resulting in both improved safety for employees and reduced costs for the buisiness.*

## Vertical: Aerospace (commercial)

This need to put people first in terms of safety is most apparent within the commercial aerospace industry, where Omdia data shows visual analytics takes precedence over both anomaly detection and device monitoring (see Figure 4). To illustrate, imagine the movement of passengers and passenger baggage through a major airport where every day, airport personnel must balance safety with optimization; security screeners must make critical, data-driven decisions during the traveler security screening process; concourse security personnel must likewise make the right decision at the right time on how to handle bags and other items left behind by travelers -- all while keeping an eye on cost and carbon footprint alike. A computer vision system built to tackle this use case would combine several critical elements, including

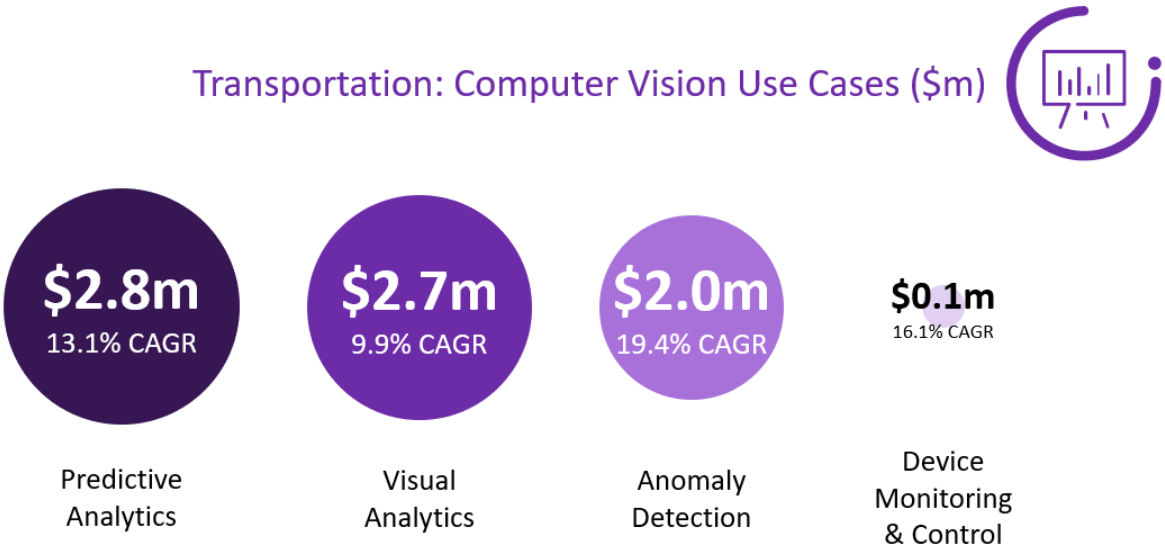
- Real-time monitoring to identify abandoned personal belongings as well as traveler behavior
- Automated alerting mechanism to inform airport authorities and route the most appropriate personal to the correct location in a timely manner
- Data correlation, combining camera data with x-ray scans, historical data, etc. to identify potentially dangerous patterns

Once set up, a system so equipped can help airports both improve safety while also improving efficiency, cutting down on false alarms and ensuring compliance with governmental safety regulations.

## Key takeaway: Think backwards from the desired outcome

To succeed with computer vision in this kind of use case, successful practitioners must think backwards from the outcome to arrive at a workflow and supportive infrastructure capable of putting computer vision to work "in time." Practitioners must architect for what matters most -- the ability to access and process video data in near real-time. With the correct underlying hardware and computer vision DL model inferencing resources, an airport can immediately detect and respond to both functional anomalies and human incidents. The same, timely data can even predict future requirements, for example allowing facilities managers to optimize processes, reallocating airport personnel due to unanticipated flight changes or lost travelers.

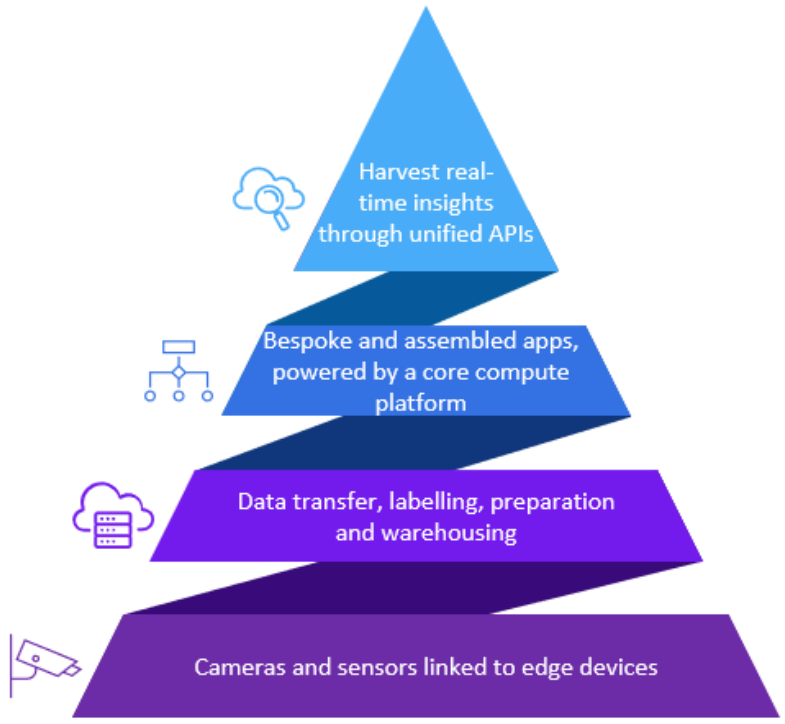
**Figure 4: Top aerospace use cases for computer vision (2023-2027)**




Source: Omdia

This sounds like an arduous task, even for more diminutive endeavors than an international airport. As with any transformative project, doing things right requires careful planning and execution across a complex technological landscape. First practitioners must establish a common foundation of devices. Second, they should focus on properly collecting and curating data. Third, they should open up that data/underlying platform to internal and external systems, data sources, and solutions. And finally, they should link the aggregate of these efforts directly to the business for real-time, ubiquitous access to computer vision insights (see Figure 5).

**Figure 5: Hierarchy of computer vision capabilities**




Source: Omdia

*There are no shortcuts for practitioners building a scalable computer vision architecture to meet the business needs, whether to constrain costs or drive innovation. To achieve full digital transformation, companies carefully design and then continuously monitor the underlying architecture to ensure its ability to adequately compute capacity to handle AI inferencing across numerous workflows. Only by provisioning the right amount of AI processing power across endpoint, edge, and cloud, can companies hope to build a solution capable of making facilities safe and secure in real time, all while optimizing operations.*

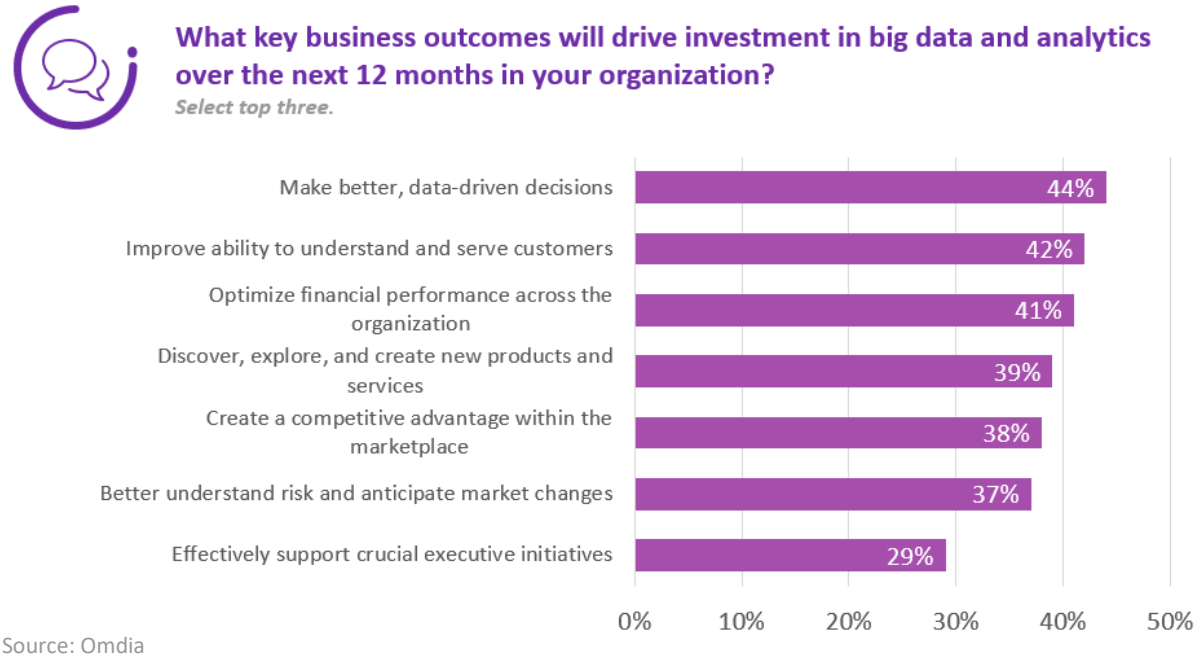
# Personalized Experience

## Outcome: Enhancing the people experience

To succeed in today's ultra-competitive marketplace, players must seemingly read the minds of their customers, guiding them using a highly personalized and entirely frictionless experience, for example, toward the product they often don't even know they need yet. Dauntingly, a good or bad customer experience can not only make or break an individual sale or return of a customer, but through the power of social media, it can go on to alter the course for an entire brand. What is the key to unlocking such personalized and frictionless services? Data-driven insights. A recent study of analytics and data professionals reveals that above all other key business outcomes, the need for data-driven insights tops the list (see Figure 6).

*What is the key to unlocking such personalized and frictionless services? Data-driven insights.*

**Figure 6: The importance of building a data-driven business**




Source: Omdia

# Vertical: Retail

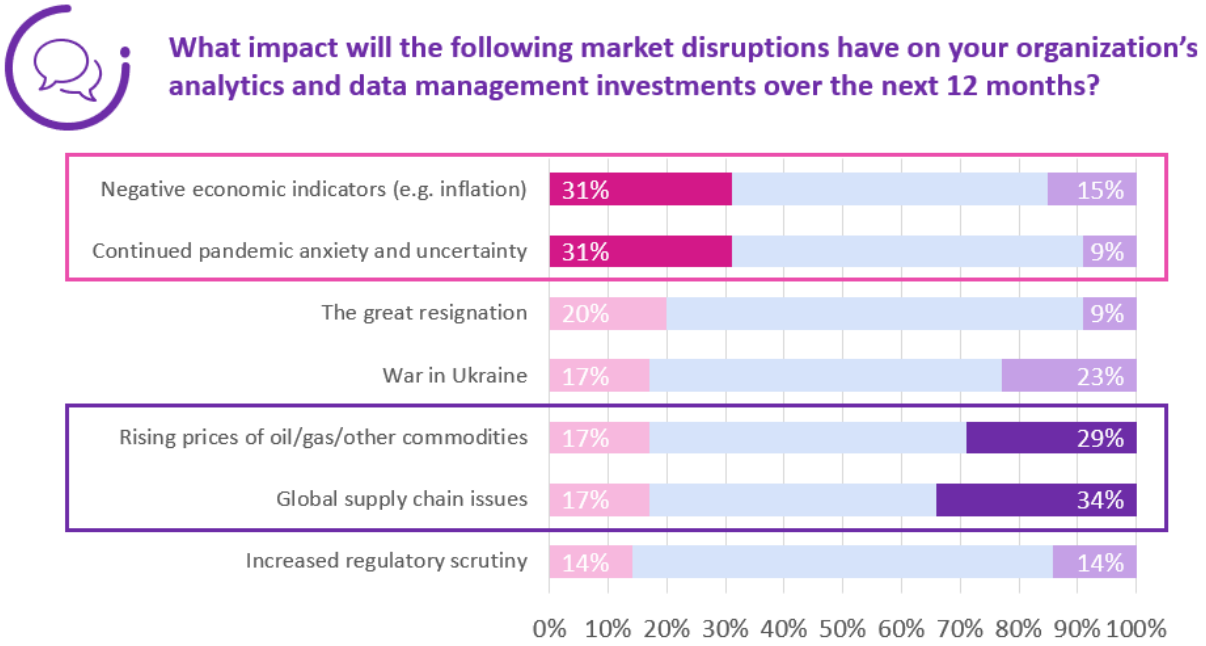
The retail industry showcases the criticality of data-driven insights. Today, retailers must operate across many different points of contact. For that reason, forward-thinking retailers are increasingly turning toward computer vision as a means of engaging directly with their customers, whether digitally or physically. Leveraging combined data from numerous data sources, often employing real-time information, retailers are building a unified, centralized computer vision management platform capable of conducting wall-to-wall retail store services. For example, with in-store shopping, this platform could be used for digital signage to provide immediate access to shopping assistance, personalized and dynamic promotions, discounts, and recommendations. Conversely, a continuing market shift toward online ordering for curbside pickup or at-home delivery is creating a new kind of hub for retailers, one that's both highly automated and highly personalized to serve as both a fulfillment and customer experience center. Omdia expects this new kind of autonomous store to play a critical role in the retail computer vision marketplace, reaching $331m dollars in revenue by 2027.

# Key takeaway: Breaking down data silos

Not surprisingly these new kinds of personalized shopping experiences demand a new approach to data, one that leverages computer vision data at scale and also breaks down silos between disparate departments. Only in this way can retailers create a true 360-degree view of their customers, improving customer outcomes through insight-driven, contextual responses to customer needs whether online or in-store. This ability to leverage computer vision in both worlds has become a market-defining factor. A recent Omdia study of analytics and data professionals, for example, revealed that retailers are just as concerned about continued pandemic anxiety and uncertainty as they are over negative economic indicators such as inflation (see Figure 7).

*This ability to leverage computer vision in both worlds (online and in-store) has become a market-defining factor.*

**Figure 7: Drivers and inhibitors for retail data professionals**




Source: Omdia

How can companies break down their data silos to truly leverage computer vision data in support of customer 360 efforts? Perhaps surprisingly, a recent market trend toward more capable data warehouses that can centralize, curate, and manage data at the edge, data center and cloud. Such a warehouse can more rapidly, securely, and affordably ingest, tag/annotate, store, and query video data.. Once combined under a single analytical roof, these disparate data assets can then be accessed through a unified API in support of many use cases ranging from predictive restocking algorithms to virtual "try on" booths.

# Moving in Harmony

## Outcome: Increasing patron efficiencies

All too often in business, the difference between profit and loss comes down to what appears to be chance but what is in reality a cascading chain of interconnected events. An unforeseen hiccup in a data integration pipeline, may lead to small delay in running a longstanding report, which may lead to an ill-advised or missed decision, which in turn could result in significant revenue loss. Now imagine how these interdependencies might play out on a large scale such as a factory or sports venue, where many people interact with both the environment and one another in real-time. How can a facility owner choreograph all those interdependencies to make the right decisions at the right time to maximize efficiencies?

*Of course, better managed outcomes will bring enhanced customer experience and increased revenue, but the path leading there is through operational efficiency.*

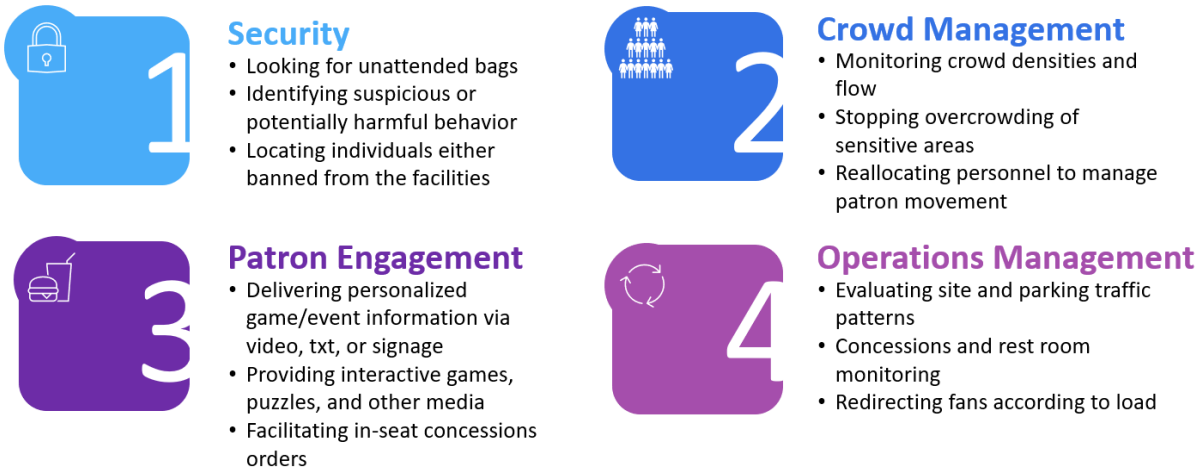
## Vertical: Media and entertainment

It's game day! The stands are packed, and concessions are overflowing…literally, as food buyers have run out of the team's signature fare on the second floor and machines on the first floor have broken down unexpectedly. Word travels fast, and fans are now crowding the staircases to reach a higher concessions promenade level, one not at all equipped to handle the rush. This scenario may sound extreme, perhaps unlikely; however, it plays out time and again across very large sporting venues in the United States and Europe, where 60,000 plus attendees can be the norm.

For facilities owners and their entire ecosystem of food and service providers, game day stands as a gigantic opportunity shrouded in an impenetrable fog of potential risk, not just to concessions revenue and patron satisfaction but also to public safety and a raft of broader concerns (See figure 8). Of course, better managed outcomes will bring enhanced customer experience and increased revenue, but the path leading there is through operational efficiency.

What owners need is a means of gathering timely knowledge of measures like queue length, live heatmaps, GIS coordinates, attendee demographics (e.g., who's here rooting for the home team), occupancy levels, weather info, network loads, and concessions inventory. With such timely data in hand, owners can understand both the reason for and the best response to an emerging concern. Early detection of overcrowding can be used to prompt workers to help steer fans to less-used facilities long before any issues arise.

**Figure 8: computer vision use cases in sports and entertainment**




Source: Omdia

The opportunities are immense for facilities owners. For example, using image recognition, classification, and tagging data together with tools like digital signage and mobile alerts, facilities owners can maximize sales through adaptive promotions and announcements that move in harmony with game day activities. Omdia expects this aspect of the computer vision market to grow dramatically over the next four years across all vertical markets, reaching $185m in annual revenue by 2027, more than a 500% increase from 2021.

# Key takeaway: Validated designs

How can facilities owners maximize these opportunities while responding to/anticipating, aberrant events? As with other use cases, practitioners can benefit from partnering with experienced implementation experts capable of bringing together the lessons learned across numerous installations to distill those into validated deployment design patterns. In this way, companies can create a personal business plan based upon the most appropriate, supportive workflows -- right out of the box. This lets enterprise practitioners focus on desired outcomes rather than worrying about how they might map those outcomes to required data points and the supportive infrastructure as proven out in real-world settings. Many vendors specializing in this area of computer vision can offer certified, often pre-built use cases spanning several important use cases:

- Patron counting and overcrowding mitigation
- Perimeter intrusion detection
- Lost child search

An important factor for practitioners to consider is the need to invest in a partner with ML and DL expertise necessary to support such predictive AI outcomes. A good partner can offset this requirement to a degree, but savvy businesses seek to build self-sufficiency over the long term. That's why Omdia expects to see the market for AI platform technologies reach $13bn by 2026.

# Conservation as Opportunity

## Outcome: Improving sustainability

Reducing energy consumption, lowering CO2 output, and optimizing resource utilization. These are the responsibility of every consumer, corporation, city, and country if we are to pass on a habitable world to our grandchildren. With each action, companies must move beyond “greenwashing” (i.e., offsetting greenhouse gasses by purchasing O2 producing trees) to instead embrace a form of sustainability that focuses on conservation through innovation -- capable of uniting energy efficiency, safety, and environment stewardship.

*By using computer vision in concert with automation, predictive analysis and with support of open data access, facilitators are beginning to drive large-scale change through smaller, more localized projects.*

## Vertical: Smart cities

For both private and public agencies charged with city-wide sustainability, such innovations may seem very forward-looking, something requiring multi-year, perhaps even multi-decade investment. However, by using computer vision in concert with automation, predictive analysis and with support of open data access, facilitators are beginning to drive large-scale change through smaller, more localized projects. For example, many cities are looking to create mixed-function areas that blend work and social life together through projects like bike or automobility sharing.

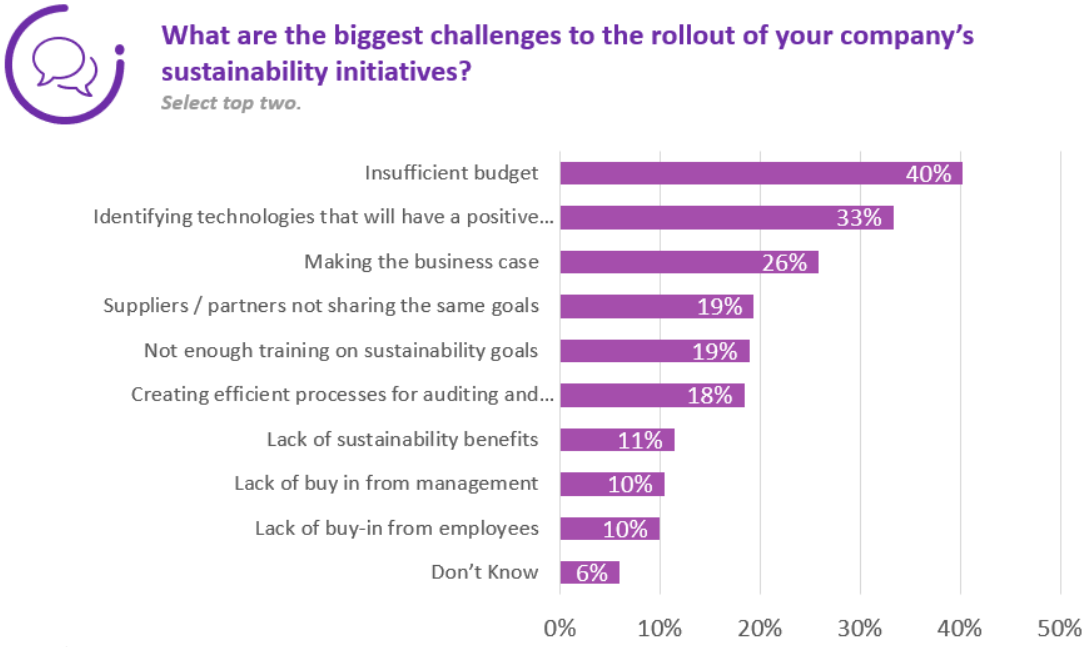
By encouraging walking and biking as a viable alternative to automotive or public transportation, cities are not just cutting down on air pollution, they are also building a more equitable, inclusive, and safe environment for residents, as seen in Bogota Colombia's recent mobility initiative revealed [1]. A solid investment in a computer vision platform can directly enable this kind of urban mobility, citizen health, and smart demand management by creating an overarching layer of transparency into issues such as safety and bicycle utilization fluctuations on a street-by-street basis.

Even at this smaller scale, such solutions demand a computer vision system built for purpose, one that features an infrastructure tuned for efficiency, on-site edge computing capabilities, and cloud-native analytical and storage services. With edge servers positioned strategically, project owners can minimize data movement and greatly accelerate decision making by providing near-real-time tracking and response to issues ranging from public safety and resource availability to air quality.

# Key takeaway: Simplifying technological complexities

The challenge for many organizations looking to embrace sustainability as a driver of innovation, rests in getting the project off the ground. As well-documented across all industries and use cases, the first major hurdle for those interested in sustainability revolves around funding (see Figure 9).

**Figure 9: Sustainability: Organizational and technical challenges**




Source: Omdia

After that point, the challenges become much more multifaceted, led by the difficulty in navigating technological complexities. Building a successful city-wide computer vision implementation demands a specialized set of skills, emphasizing long-term operational stability. Success also demands the ability to select the most impactful technology that can integrate easily with external systems, even if they are managed by various governmental entities/private companies. Tying technology to a business goal is key, that in turn brings the achievement of a sustainability goal – for example, reducing energy cost is great for a business, but plays a part in reducing global energy demand.

Practitioners can best remove such complexities by aligning themselves with a technology partner that itself maintains an extensive partner ecosystem program capable of uniting disparate data sources, even if some of those devices are owned and maintained externally. Such cooperation can serve as a crucial ally for all involved parties. Collected computer vision data can even serve as a means of driving new revenue streams such as targeted advertisements from neighborhood retailers, for example. In this way, computer vision serves as a fundamental, foundational technology in the long path toward sustainability.

# Improving the Morning Commute

## Outcome: Generating new revenue opportunities

Computer vision is uniquely positioned to deliver on two seemingly opposing forces at play in today's enterprise -- the need to reduce operational costs and improve profits. Because computer vision can automate, optimize, and innovate across numerous aspects of both business and IT operations, it is well-suited to achieving both goals simultaneously. As but one example, it can directly reduce costs by automating human processes. Second, it can indirectly surface actionable, data-driven insights capable of generating revenue opportunities.

Whilst so many of the computer vision goals are interlinked, this is most true in the area of revenue enhancement – where for example, operational efficiencies and better customer experience can directly drive an increase in top-line revenue.

*Computer vision is uniquely positioned to deliver on two seemingly opposing forces at play in today's enterprise -- the need to reduce operational costs and improve profits.*

## Vertical: Transportation

Public transportation serves as a critical component of urban life. For both riders and transit providers alike, safety and efficiency form the very tip of the pyramid of solution requirements. These are important concerns, not just in moving people to their destinations but also in supporting local commerce across a myriad of markets. If the trains shut down commerce and people suffer.

But public transport can be so much more, especially if equipped with a modern computer vision system and data stack. A video-enabled rail system, for example, can both engage and entertain travelers while keeping them accurately informed on location, wait times, time-to-destination updates, even station-by-station weather reports. Technology-savvy transportation facilitators are even extending computer vision systems to drive new revenue streams through improved safety, compliance and predictive maintenance. They are also beginning to tap into new, data-driven opportunities such as dynamic advertising, retail partnerships, and in-transit value-added services.

By unifying computer vision data across all transit endpoints (cars, stations, queues, etc.), facilitators can put the resulting situational awareness to work as an innovation engine. For example, using chip-enabled transit cards together with face-matching cameras can kill two birds with one stone, simultaneously providing two-factor authentication for paying users while encouraging users to opt-in to revenue generating programs.

# Key Takeaway: Greater than the sum of its parts

The challenge for facilitators, however, rests in instrumenting things that move and doing so in real-time. Unlike use cases in retail stores, sporting venues, and in smart cities, public transportation does not sit still. Even the most basic computer vision-enabled vehicle requires a significant investment in supportive communications and processing resources that can work with these portable IoT data platforms at scale and in context, e.g., in transit between stations, pulled over at a train crossing, or wheeled back into the garage for repairs.

The path forward for facilitators rests in optimization, in bringing to bear the hardware that can optimize the use and value of data. With public transportation, as an example, companies need to ingest video streams at the edge and process those streams in real-time before moving the pertinent video data to central archive (on- or off-premises), where it can be put to use in supporting broader opportunities.

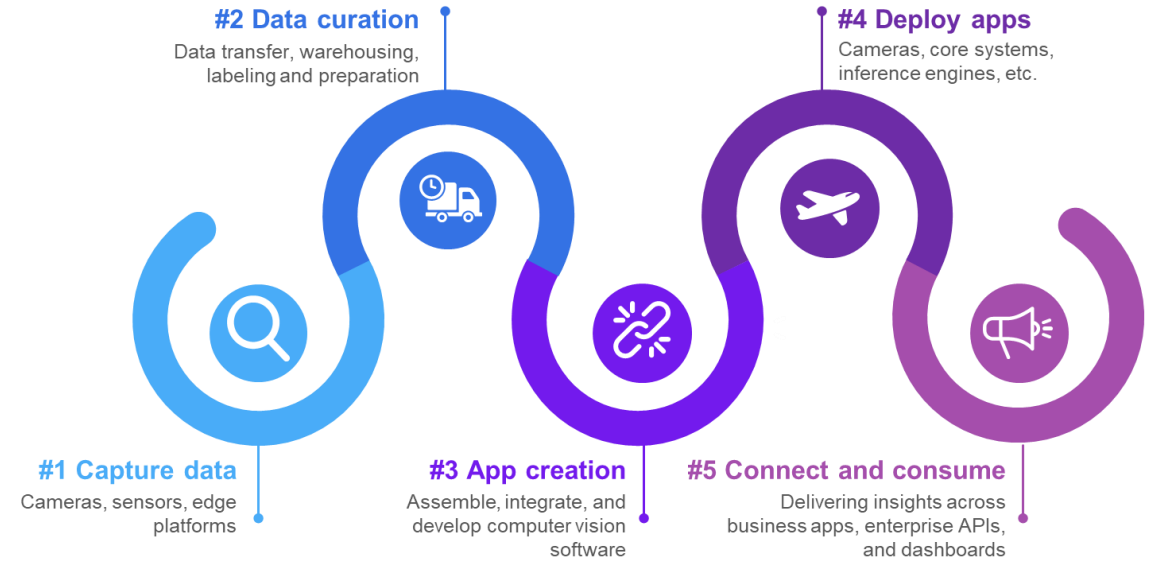
For both edge device and central data warehousing servers, the use of highly integrated, converged systems can dramatically cut down technical staffing requirements. These hardware solutions behave in many ways like cloud-native services in that they are automatically kept up to date, protected against security vulnerabilities and interdependency-induced instabilities. And they do this across edge, core, and cloud through a single management pane of glass. Furthermore, these systems often employ federated AI architectures, where AI processing power can be easily offloaded onto edge and even end-point devices. These combined capabilities can reduce time to market while also shrinking the skills gap necessary for long term operation, enabling affordable and easily managed adoption of demanding use cases at scale.

*These combined capabilities can reduce time to market while also shrinking the skills gap necessary for long term operation, enabling affordable and easily managed adoption of demanding use cases at scale.*

# Overall key challenges to be addressed

Whether speeding travelers to their destination or ensuring fans safely enjoy a sporting event, computer vision can play a crucial role in both minimizing risk and maximizing opportunity, doing so simultaneously across a wide array of use cases. However, companies should not expect to simply swipe a credit card and log into a ready-made cloud service. Rather, companies must approach computer vision with a careful and honest look at their readiness. There are several steps they must traverse in adopting computer vision (see Figure 10).

**Figure 10: The computer vision lifecycle**




Source: Omdia

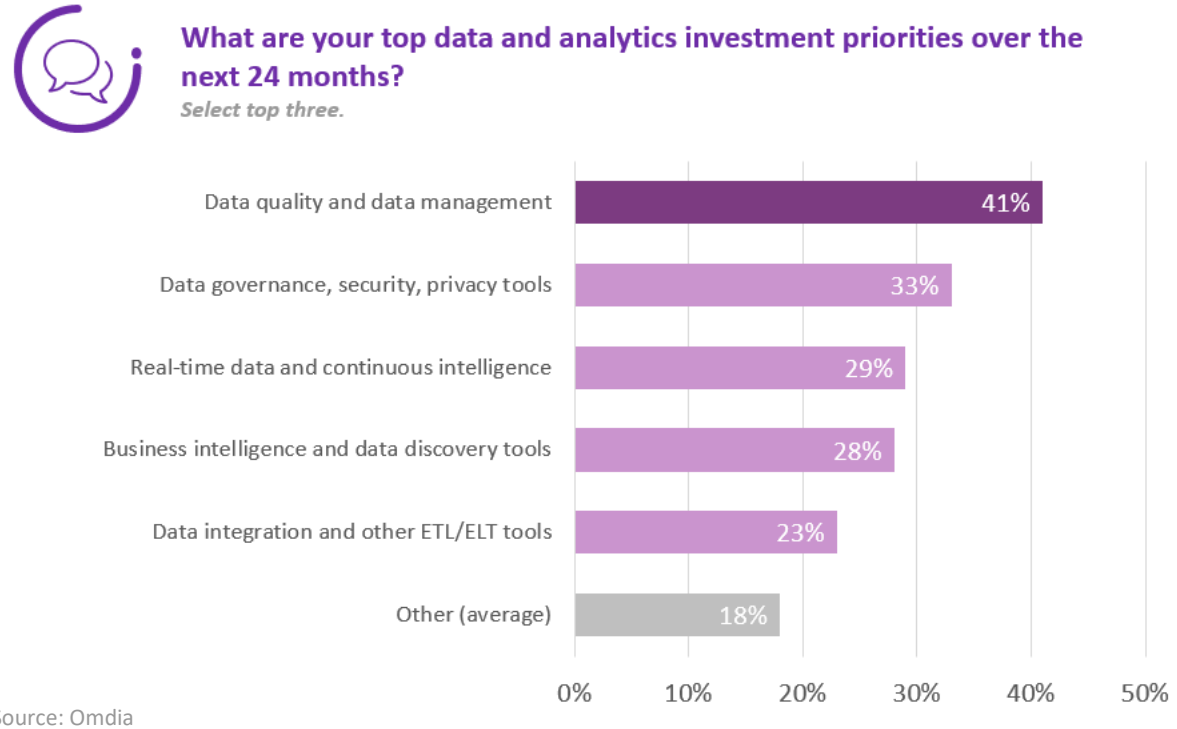
## Technology (data) silos

First and foremost, practitioners must address existing data silos. Each day within every organization, huge amounts of valuable information streams constantly from IoT sensors, cameras, marketing/sales software, customer resource management (CRM) systems and other business apps. Unfortunately, most of this valuable information remains trapped within these systems or departmental data warehouses, many of which were originally designed to bring analytical data together. This creates several issues for organizations:

- **Opaque data resources**. Companies cannot readily understand or control access to data.
- **Data management risks**. Siloed data dramatically elevates data management risks that can prove costly. For example, on an ad-hoc basis, departments often share data, creating duplicate information. This often leads to data quality issues – a major concern for most companies (see Figure 11).
- **Incomplete data**. The inherent nature of siloed data prevents companies from building a full and timely picture of desired measures.
- **Cost overruns**. Given the ever-expanding nature of data and data sources, a failure to overcome silos can keep companies trapped in an ever-growing state of technical debt.

Even more difficult is the task of bringing this data into the hardware and software infrastructure specific to a computer vision solution. It's not enough to create a centralized data warehouse - it must be able to house and make accessible the many different data types (both structured and unstructured) used within a computer vision solution in a way that can create a positive impact on the broader business. This is what companies are after when they invest in computer vision -- rapid access to insights that can serve as both a protection against unanticipated change and an effective way to capture a competitive advantage.

**Figure 11: Data quality trumps all other concerns**

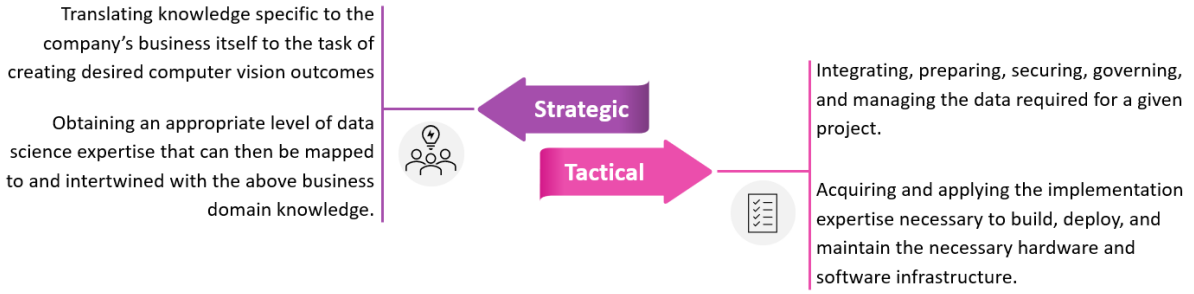



Source: Omdia

# The technological skills gap

Closely intertwined with issues such as siloed data, most companies undertaking computer vision projects find themselves facing a significant skills gap. This gap, which encompasses both technologies and best practices, stems from the sheer complexity of four closely intertwined demands, both strategic and tactical (see Figure 12).

**Figure 12: Necessary skills required for computer vision success**

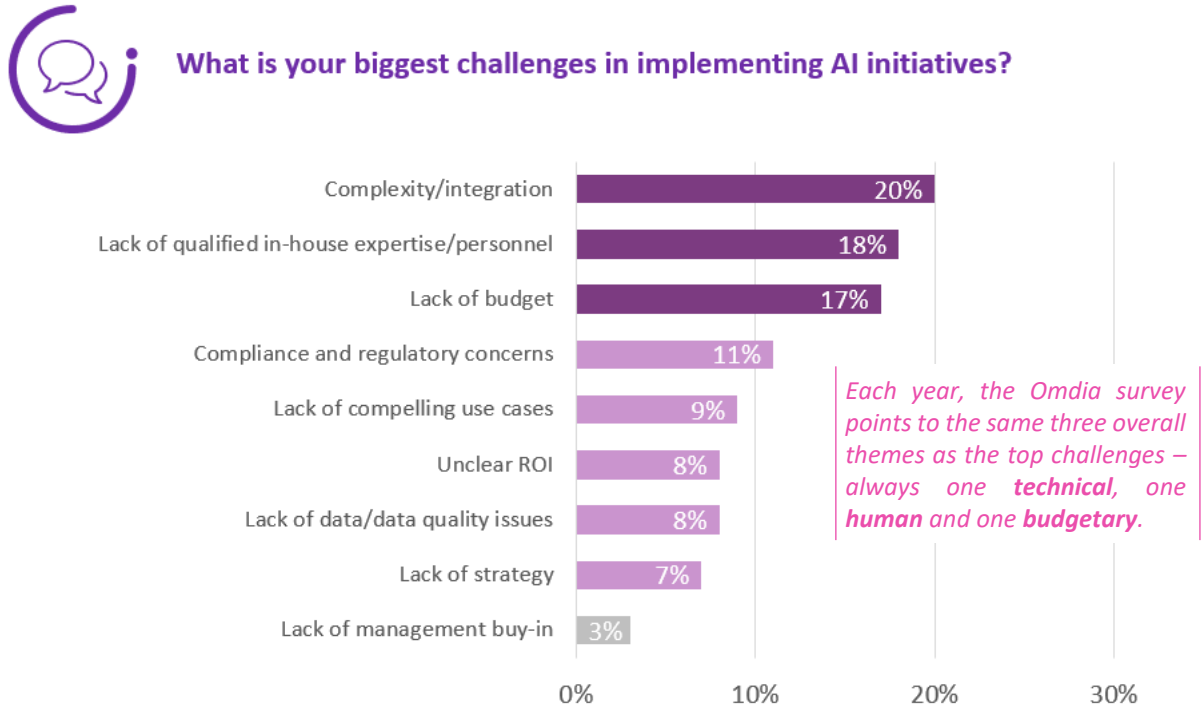



Source: Omdia

A recent Omdia study of analytics and professionals singles out the continuing challenge enterprises face in closing the skills gap between ambition and ability. Perennial concerns over security and privacy aside, the biggest worry for enterprise practitioners revolves around the inherent difficulty in bringing together many disparate tools, technologies, and practices in achieving even the most basic goal (see Figure 13).

Put simply, computer vision demands a high degree of versatility. In response, companies often press employees to work in areas beyond their current role and skill level. This leads to increased cost (training, fixing incorrect work, etc.), lowered productivity, lost opportunities, and worse damage reputation with customers. These issues apply across the solution lifecycle (planning, development, test, implementation, management), making it even harder for companies to keep up with broader issues like the ever-accelerating rate of technological change and disruptions in the workforce (e.g., employee retention and turnover).

**Figure 13: AI Barriers in Enterprise**




Source: Omdia

# Organizational alignment

Even with the right technologies, personnel, and data, enterprises seeking to build a successful computer vision solution must tackle what is perhaps the most difficult challenge of all - achieving and maintaining alignment between project stakeholders and business leaders. Different stakeholders invariably demonstrate conflicting priorities and divergent vested interests in the project. For example, business leaders may ask for real-time information, but without understanding the true implications of that requirement.

In addition, new teams are being formed within the business that bring interactions between previously siloed groups – from IT, to OT and Data Scientists. A recent Omdia study of AI practitioners revealed that while only 30% of enterprises anticipate investing in a commercially deployed, point-to-point AI solution, an equal number anticipate working exclusively with in-house practitioners, while another 30% opt to employ both practices. For those focusing on in-house, the clear #1 reason was that “we have IT/technical resources that we want to leverage for AI”.

As with overcoming data silos, getting everyone on the same page can require a delicate touch in establishing clear lines of communication, accommodating conflicting priorities in scoping out the project timeline, overcoming divergent cultural, societal, even departmental prejudices, and creating a culture of trust among stakeholders and project practitioners.

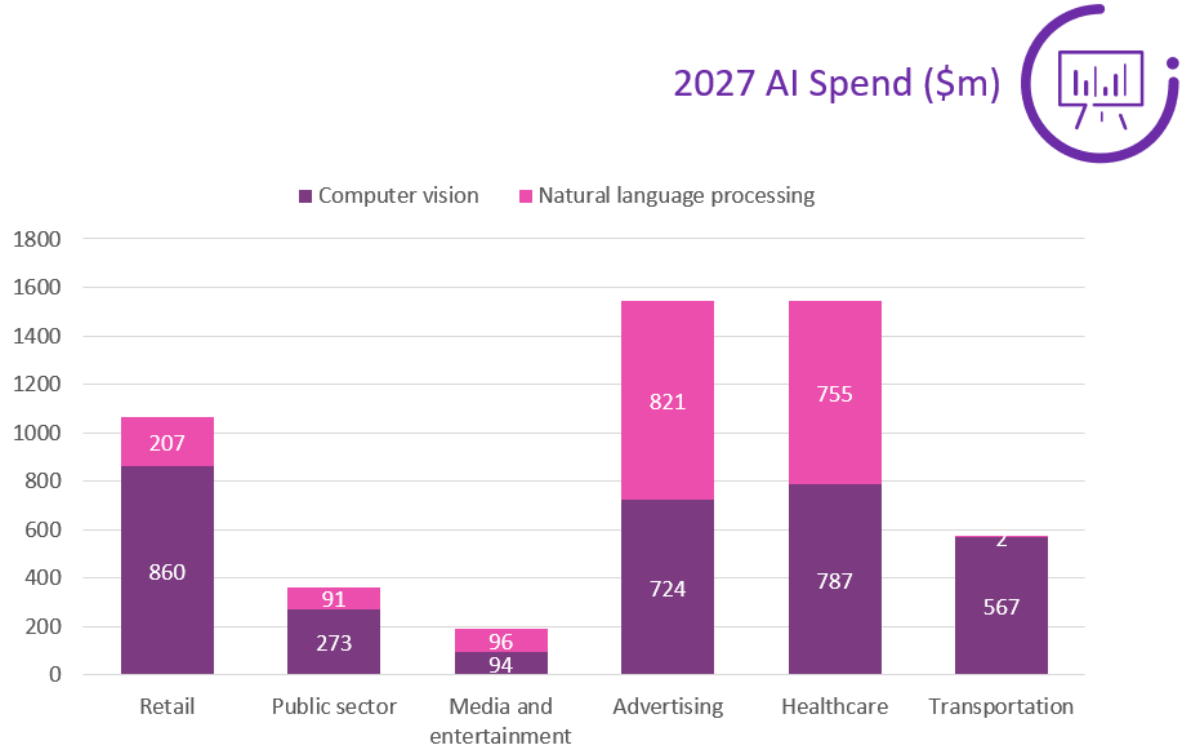
# Conclusions and Recommendations

There is no doubt that computer vision is a worthwhile investment, even given the numerous challenges facing companies just beginning to explore its numerous and multifaceted opportunities. Consider the current market trend surrounding generative AI and large language models (LLMs) in particular. LLMs may dominate the news cycle, but remain very much hype for now. Quite the opposite is true for computer vision, which has already positively transformed businesses across a wide spectrum of industries, driving customer engagement, supporting key sustainability efforts, and enhancing operations. With declining storage and compute costs and increasing AI model accuracy, use cases for computer vision will drive innovation and efficiency across many key markets including retail, sports and entertainment, as well as public sector (transportation, smart cities, etc.).

*Computer vision…has already positively transformed businesses across a wide spectrum of industries, driving customer engagement, supporting key sustainability efforts, and enhancing operations.*

To illustrate the importance of computer vision, consider that on its own, the computer vision software marketplace is set to reach $6.2 billion dollars by 2027. This is only half as large as the natural language processing (NLP) marketplace, the home of generative AI and LLMs. However, in looking deeper into key verticals over this same period, computer vision matches and, in many cases, far exceeds NLP in driving substantial revenue for enterprise customers (see Figure 14). This speaks to the important role played by the underlying infrastructure that powers a typical computer vision solution. It is this infrastructure that enables customers to integrate video and sensor data together with data from other sources (notably NLP), creating a sum that far exceeds the value of either solution alone.

**Figure 14: Comparative market size for computer vision across verticals**




Source: Omdia

For vendors in the ultra-competitive retail market, computer vision stands as a major differentiator, pushing the envelope in what's possible with capabilities like personalized shopping through virtual try-on services. For sports and entertainment venue owners, computer vision can greatly mitigate risks while unlocking new revenue opportunities through predictive concessions planning, and patron observation. Looking to the future, smart cities are putting computer vision to work, adjusting to changes in occupancy patterns and maximizing public resource allocation. And lastly, for public transportation facilitators, computer vision not only keeps infrastructure-critical resources safe and running, it also invigorates commerce and can even entertain travelers.

How should enterprise practitioners prepare to succeed with computer vision? Omdia has found that three intertwined goals can go a long way toward solving issues relating to data integration, skills gaps, and business misalignment.

- **Go back to basics.** Companies should prioritize data quality and data management. This should begin with a centralized and comprehensive effort to create a data-driven culture, elevating data literacy among practitioners and users alike. An investment in data now will open new doors of innovation down the road, allowing practitioners, for example, to blend computer vision data with other data sources to create contextual insights in real-time.

- **Invest in data science as an engineering endeavor**. Advances in AI-led automation and human augmentation have brought data science forward to the point where enterprises can begin to view AI outcomes as an engineering rather than a data science problem. That is, companies should invest in expertise specific to the integration and orchestration of systems, data, and AI resources rather than hiring to build AI outcomes from scratch. Again, this underscores the importance of building a computer vision architecture that prioritizes data centralization and curation, as this will greatly accelerate AI development efforts across the company.

- **Partner wisely**. Enterprises should seek out a computer vision technology partner that possesses domain expertise garnered from numerous customer engagements. Bonus points for partners offering converged and hyperconverged hardware, which can itself accelerate development by cutting down on software management costs over time. Given that computer vision solutions will undoubtedly span both premises and cloud (and often multiple cloud platforms), partners should either integrate with or provide their own vertically integrated hardware, software, and services offering. In this way, the right partner can help companies minimize risk, generate high quality insights, and overall shorten the time it takes to move from project conception to deployment.

This last point is crucial because finding a good technology partner capable of simplifying the front end process can help companies overcome what Omdia has found to be the biggest hurdle to the adoption of any AI-based solution, namely the complexity of AI itself and the difficulties involved in integrating AI into the business. The right partner can even help enterprises translate best practices and domain expertise into actual solutions. By choosing a partner with extensive experience in supporting distinct vertical and use care requirements, enterprise practitioners can benefit from the business and operational lessons learned in helping customers realize business outcomes from their AI and computer vision investments. Further, working with a hardware-savvy partner that can help marry disparate systems together. Together these traits can help business owners tackle current challenges while paving the way for future opportunities and in so doing unlock the power of computer vision systems to increase operational efficiency, strengthen security and safety, improve sustainability, deepen customer relationships, and most importantly generate new revenue opportunities.

# Appendix

## About Dell Technologies

Dell Technologies (NYSE:DELL) helps organizations and individuals build their digital future and transform how they work, live and play. The company provides customers with the industry's broadest and most innovative technology and services portfolio for the data era.

## About Intel

Intel (Nasdaq: INTC) is an industry leader, creating world-changing technology that enables global progress and enriches lives. Inspired by Moore’s Law, we continuously work to advance the design and manufacturing of semiconductors to help address our customers’ greatest challenges. By embedding intelligence in the cloud, network, edge and every kind of computing device, we unleash the potential of data to transform business and society for the better.

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## Omdia consulting

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We create business advantage for our customers by providing actionable insight to support business planning, product development, and go-to-market initiatives.

Our unique combination of authoritative data, market analysis, and vertical industry expertise is designed to empower decision-making, helping our clients profit from new technologies and capitalize on evolving business models.

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