

THE ROBOTICS REVOLUTION AND YOUR CLEANING BUSINESS

How facility managers and building service contractors can boost their business by upgrading to robotic cleaning machines



INTRODUCTION

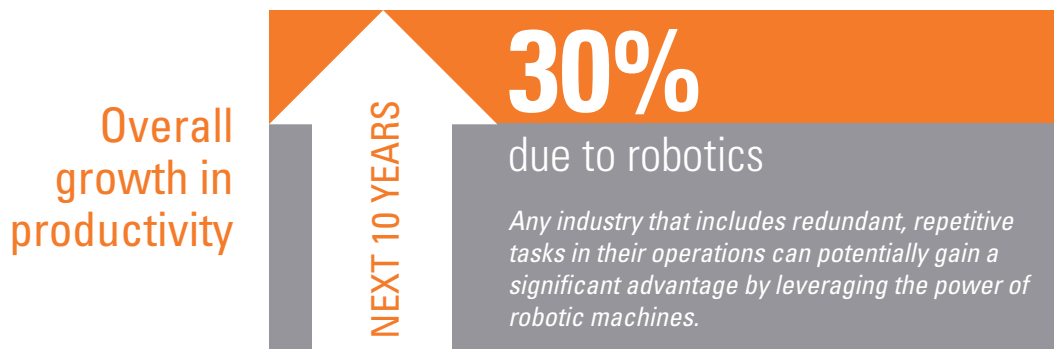
THE GROWTH OF ROBOTICS TODAY

We all know technology is growing faster than ever. Computers, the Internet of Things, robotics, and other types of automation are changing the way businesses operate—from the way goods are manufactured and distributed, to the way people work and the kinds of jobs they do. And as technologies evolve, they typically become more affordable, more advanced, and more universal. This is especially true of robots.

Today's sophisticated robots are used in more ways than ever. And their growth is accelerating. Of course, robots have been around for a long time. Since the mid twentieth century, companies have realized the value of machines for completing simple, repetitive, heavy, or hazardous tasks—as well as how they can create opportunities for employees and free them up to spend time on higher value tasks.

Increasingly, companies of all kinds are recognizing the impact that robotics and innovation can have on making their businesses—and even their employees—more productive and efficient. Any industry that includes redundant, repetitive tasks in their operations can potentially gain a significant advantage by leveraging the power of robotic machines. In fact, in terms of productivity, the Boston Consulting Group predicts that robotics will account for a 30% increase over the next 10 years.¹

Robotics can also help companies become more competitive. This is particularly important for small-to-medium-sized businesses that are the backbone of both developed and developing country economies. The added boost to productivity and efficiency helps these smaller companies compete on a larger scale, or where the labor market is tighter. Automation helps large companies compete as well—giving them an edge by increasing the speed of product development and delivery.



In high-cost countries where labor and resources are particularly expensive, robots can enable companies to take back parts of their business that have been previously outsourced. In fact, when it comes to employment, the greatest threat is not automation as is sometimes thought, but an inability for companies to thrive and remain competitive.² Instead of displacing workers, robotics and automation can help maximize their potential by creating new opportunities to engage in tasks that have a higher impact on a company's bottom line.

THE IMPACT OF ROBOTICS ON EMPLOYMENT

While robots are often portrayed as rendering humans obsolete, the reality is quite different. Humans will always be needed to do the kind of work that only humans can do. Robots, for all their flash and innovation, are still just machines. And as machines, they're at their best when they're doing physical, rote, mundane tasks that don't require thinking and/or finesse. That's because robots use a pre-defined set of rules and instructions in order to accomplish a task. Truly the best of both worlds occurs when robots and humans work together, doing what each does best, striking a balance of technical tasks that machines can do, along with sophisticated tasks that only human workers can do—such as anything requiring decision making, creativity, or fine hand dexterity.

That's why many of today's robots are more collaborative than ever, often complementing and assisting their human co-workers. These collaborative robots, or co-bots, work side-by-side with humans, helping companies and workers become more productive than ever before.

According to research firm Loup Ventures, today's industrial robot market accounts for the highest potential of all robots sales (61%), however, due to advancements in computers, artificial intelligence, and motion sensing capabilities, collaborative robots will be one of the fastest growing markets in the robotic space—accounting for 34% of all industrial robots sold by 2025.³

Looking ahead, robots and humans will continue to work together in tandem. That's because a very small amount—less than 10 percent—of all jobs are fully automatable. (And about 60 percent of jobs contain at least some tasks that can be fully automated.)⁴ So don't think the machines will be taking over anytime soon. Instead, there will always be a need for human beings to do the types of tasks that only human beings can do.

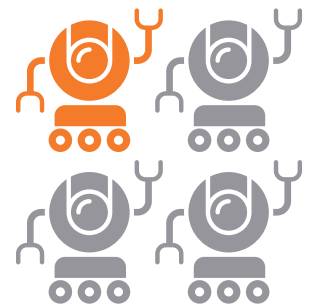
Even as robotics may cause declines in certain occupations, automation will change, as well as create, many more opportunities for future workers. It's predicted that automation will create many new occupations that don't exist today, much like technologies of the past have done—creating new and better opportunities for those who currently do repetitive work. According to research company Million Insights, the use of industrial robots in China, for example, has helped workers become more efficient, reducing costs while slashing idle time by an incredible 80 percent.⁵

These days, many industries are experiencing, or are expected to experience, positive net job growth as a result of robotics.⁶ Of those, manual and service-related careers involving at least some redundant or repetitive tasks stand to benefit most. Rather than force out workers or making their jobs obsolete, automation allows workers to forgo some of their mundane responsibilities and focus instead on higher-skilled, higher-quality, and higher-paid tasks—ones that are not only more interesting and engaging, but that also add more value to their company.

TYPES OF COMMERCIAL ROBOTS

Commercial robots fall into two categories—industrial and service. Industrial robots are programmable robots used for manufacturing and other industrial tasks including welding, painting, or other fabrication processes. Service robots are used for non-manufacturing tasks and can be separated into personal and professional service robots.

AVERAGE GROWTH
RATE OF THE
PROFESSIONAL
SERVICES ROBOT
MARKET 2018-2020
20%-25%



Personal service robots, such as robotic floor vacuums, are consumer-facing robots used for automating tasks within the home. Professional service robots are business-oriented, and are used for a wide variety of commercial purposes controlled by a trained operator. These kinds of service robots automate commercial processes that may or may not be within the industrial sector. Examples include cleaning robots for public places, delivery robots in offices or hospitals, fire-fighting robots, rehabilitation robots and surgery robots in hospitals.

The International Federation of Robotics (IFR) predicts an average growth rate of 20% to 25% between 2018 and 2020 for the professional service robots market, reaching \$27 billion in value. Logistics applications represent the largest portion of the professional service robots market. These robots are typically used for palletizing, product picking, and moving goods within a warehouse to improve uptime and efficiency.

Cleaning robots are a new and quickly growing segment of the robot industry that can engage in a variety of cleaning tasks, depending on the needs of the facility that employs them. Cleaning robots fall under either the autonomous guided vehicle (AGV) or autonomous mobile robot (AMR) category. AGVs possess minimal on-board intelligence and are capable of obeying simple programming instructions only. In contrast, AMRs generally contain more sophisticated, flexible, and cost-effective technology that allow for more sophisticated navigation and movement.

To learn more about the different types of robots and how they're used, read our blog post, [Types of Industrial Robots in Manufacturing and Warehousing](#).

The global industrial robotics market is expected to be worth \$40 billion by 2020



THE GROWTH OF INDUSTRIAL ROBOTS

The International Federation of Robotics has predicted that 1.3 million industrial robots will be in use by 2018, with sales growth reaching record levels year-over-year. According to Million Insights, the global industrial robotics market is expected to be worth \$40 billion by 2020, a rise of more than \$15 billion since 2013.⁷

And things are only picking up speed. According to Loup Ventures research, the industrial robotics market is expected to grow by 175% over the next decade.⁸

Currently, industrial robots only perform about 10 percent of the day-to-day manufacturing tasks that could be potentially automated—things like assembly, packaging, and material handling. Even as advanced robotics technology gains momentum, there's still plenty of room for growth—and along with it, huge potential for companies to become more competitive and productive.

The Boston Consulting Group estimates that by 2025, robots will perform at 25 percent automatable capability, with the largest impact generated in countries that currently invest in advanced production technologies. These include South Korea, China, Japan, Germany, and the United States—five countries that now account for almost 80 percent of global robotics purchases. In the future, global market growth of robotics is expected to be driven by manufacturers' need to reduce operational costs. The McKinsey Global Institute predicts that up to half of the total productivity growth needed to ensure a 2.8% growth in GDP over the next 50 years will be driven by automation.

While robotics technology seems to be the way of the future, it's already widespread in industries as diverse as manufacturing, logistics, retail, healthcare, military, and even agriculture. Even so, the possibilities and potential of robotics is still emerging as companies continue to explore the many ways they can be used.

WHAT CLEANING ROBOTS CAN DO FOR YOUR BUSINESS

While embracing robotics can be a significant undertaking and investment, it's not an all-or-nothing prospect. Robotic cleaning machines can help forward-thinking companies leverage groundbreaking robotics technology in a fairly accessible way. It can also create a competitive advantage through improvements in productivity and employee retention, while also opening up new marketing and public relations opportunities through brand enhancement.

These types of professional service robots offer a broad spectrum of business benefits, depending on a company's needs. For facility managers, the need to work more efficiently and effectively is always important as managers are continuously looking to improve processes, increase sustainable practices, and streamline operations.

The average cleaning company loses up to **55%** of its customer base **EVERY YEAR** due to poor service

For building service contractors (BSCs), robotic cleaning machines can yield a powerful advantage in an industry facing tremendous competition and high turnover. Currently, there are over 54,000 BSCs competing for the global cleaning services market (which is projected to reach \$74 billion dollars by 2022),⁹ and it's estimated that the average cleaning company loses up to 55% of its customer base every year due to poor service.¹⁰ Robotic cleaning machines can address these challenges by increasing cleaning speed and consistency, using performance tracking to optimize resources, reducing employee turnover, and more.

Cleaning robots are ideally suited for many types of industries and environments, including but not limited to big box stores, shopping centers, airports, and grocery stores. And the market for these machines is booming, projected to be worth \$2.5 billion by 2020, according to a study by Markets and Markets. Of these, floor cleaning robots are the largest and fastest growing category.¹¹

However, in spite of the advantages, cleaning robots aren't necessarily the right choice for every business. Since the machines require a certain amount of physical space, a company needs to determine if their environment is conducive to robotics, and also whether or not the technology would serve their particular needs and requirements. In addition, is the company in a position to incorporate robotic cleaning machines into their current operation? Do they have the resources and systems in place to train operators and make a smooth transition to the new technology? Working closely with an experienced, service-oriented consultative partner can help you assess your unique situation and objectives, and determine if cleaning robots make sense for you. To get started learning more, read our blog post: [5 Questions to Ask When Considering Robotic Cleaning Machines](#).

SOME PRACTICAL ADVANTAGES OF ROBOTIC CLEANING MACHINES

Robotic cleaning machines offer many practical advantages to both facility managers and BSCs—everything from increasing productivity, to improving employee retention, to reducing the likelihood of accidents. By nature, robots are built to work whenever and wherever you need them, giving operators a large amount of options and flexibility.

Having a robot cleaning in the background is like adding more consistent, reliable workers to your team. By taking on some of the repetitive, redundant tasks that machines can easily do (such as sweeping and mopping), robotic cleaning machines free up workers to put more of their effort and attention on tasks that can create a larger impact—tasks that only humans can do—and that have a more direct affect on a company's bottom line. This "co-boting" practice might include more specialized cleaning tasks, or other kinds of tasks entirely.

Employing robotic cleaning machines can also enable cleaning crews to work faster and more efficiently, allowing them to service more facilities faster, upgrade their level of service, and keep customers happier. And because workers have more time for tasks that can deliver a higher bottom-line impact, their time and labor ends up being more valuable to the company.

Robots can also play a role in making work environments safer by reducing accidents and mistakes due to human error. Overnight cleaning crews, for example, can get tired and make mistakes in judgment or lose focus. This can lead to accidents and damaged equipment, structures, or products. Some of these mistakes can be costly. Robotic cleaning machines, on the other hand, are programmed to be reliable and consistent. Many have built-in safety features that protect against accidents, whether they're used independently of, or collaboratively with, human workers. Through the use of sensors, lasers, and cameras, robots limit exposure to damage.

Many of today's robotic cleaning machines offer the latest in sustainable cleaning solutions, technologies, and equipment—just like their non-robotic counterparts. And so in addition to other advantages, they can help companies reduce their environmental impact and create a cleaner, healthier workplace. Tennant's machines, for example, minimize environmental impact in seven key categories including energy, CO2 emissions, ozone, smog, acid, eutrophication, and particulates.¹² Not only is this great for the environment, but it's cost effective, too. Today's environmentally friendly machines require less water and fewer chemicals—saving money on supplies while reducing downtime, thereby making cleaning crews more productive. This can help companies increase their bottom line and help BCSs in particular gain a competitive advantage in the market.

HOW DATA AND PERFORMANCE TRACKING CAN IMPROVE OPERATIONS

Data tracking is increasingly important and widespread across business, technology, and life in general—from sales data, to financial data, to GPS data, to health data, and much more. The way to optimize your process for best results is to know where you are, measure it against where you want to be, and then use the data to make adjustments.

For BSCs and facility managers looking to maximize their performance with minimal investment, data tracking is an excellent solution. Choosing robotic cleaning machines with data reporting technology gives fleet managers greater insight into cleaning performance, enabling them to optimize their cleaning performance and track key performance indicators. This can help companies increase efficiency, reduce expenses, maximize operation time and fleet size, ensure health and safety, make fewer errors, and identify areas for improvement.

A survey by Cleaning Maintenance & Management of nearly 400 facilities around the U.S. compared cleaning performance between fleets using traditional, non-performance-based standards and those using data-driven standards. Not only did the data-driven fleets achieve nearly 23 percent greater daytime productivity, in terms of cleanliness and appearance, they scored more than 20 points higher on a 100-point scale. Not surprisingly, the data-driven fleets also achieved consistently higher customer satisfaction thanks to their more efficient and effective cleaning performance.¹³

Another way to leverage performance data is by generating a weekly proof of service report. The report gives BSCs or cleaning teams the ability to give their clients the concrete statistics to prove that they cleaned the contracted space (or spaces) for the contracted amount of time. This valuable information can be shared with clients as proof that would otherwise fall to the BSC's word over true factual data.

+23%
using data-driven
standards

Traditional
standards
of daytime
productivity
for cleanliness
and appearance

For both facility managers and BSCs, adopting a robotic cleaning program can go a long way toward enhancing a company's brand image by positioning it as a forward thinking, innovative leader.

For BSCs, the proof of service report and other powerful asset management solutions can be compelling differentiators to provide extra value for their existing customers and win new business. For facility managers, it empowers them to optimize their resources and operate more efficiently, maximizing budgets as well as performance results.

While usage data provides an instant snapshot of fleet performance, the true potential of the technology lies in the many ways operators can leverage the data to develop new insights, identify opportunities, and improve their results.

ROBOTIC CLEANING MACHINES CAN HELP RETAIN AND ATTRACT WORKERS

The cleaning industry is known for high turnover. The jobs aren't very glamorous and workers sometimes do it on a temporary basis in between other jobs. This can make it a struggle to keep staff. What's more, the current labor market is very tight. Unemployment is at the lowest levels in decades and employers are struggling to fill positions. To remedy these current challenges, robotics offers several benefits that could help retain and attract employees.

First, robotics can aid employee retention by improving job satisfaction, performance, and overall work quality. The high-tech equipment training involved enhances workers' skills, which can make them feel more valued and help them become more desirable employees (while expanding their career opportunities).

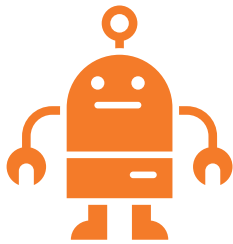
Robotic cleaning machines can also help companies repurpose existing workers. With less of their time spent doing rote, repetitive tasks, employees have more time to focus on other cleaning tasks like cleaning windows, bathrooms, stocking, emptying trash, etc.—ones that require a human to perform. Freeing workers up also creates the potential for them to interact with customers, upsell products, or get trained to do tasks that have a more direct impact on a company's earnings.

Providing workers with more satisfying, less mundane work can make them happier and more motivated. It can also increase their level of engagement because they don't have to spend as much of their time doing mundane, repetitive tasks. For an employer, having happier, more engaged workers leads to lower turnover, higher retention, and lower costs since fewer resources need to be devoted to hiring, interviewing, and recruiting.

For companies having trouble filling positions, robotic cleaning machines can help by enabling current employees to accomplish more in less time, allowing fewer workers to accomplish the work of a larger crew. And when it comes to attracting prospective employees, robotics brings with it a certain coolness factor that's attractive to those interested in working for a forward-thinking company. Embracing robotics creates the perception that a company is a better place to work, and one that values innovation. This can give a company a leg-up on the competition when it comes to attracting workers.

ROBOTIC CLEANING MACHINES CAN ENHANCE YOUR COMPANY BRAND

For both facility managers and BSCs, adopting a robotic cleaning program can go a long way toward enhancing a company's brand image by positioning it as a forward thinking, innovative leader. Adopting a robotics program is public relations fodder that can help companies garner attention, stand out from the competition, and boost internal morale. Company innovation is always a source of pride that motivates and excites employees, especially when it's combined with tangible benefits that improve their day-to-day lives. As a marketing tool, robotic cleaning machines provide the opportunity for all kinds of new marketing initiatives—ways to get the word out to current customers and prospects about how the company is embracing robotic technology.



Robotic machines create the perception of higher quality, better performance, health, sustainability, safety, and reliability—all of which can deepen current business relationships and help sell to prospects

For BSCs, robotic cleaning machines provide a stronger way to help stand out in the competitive commercial cleaning market. In addition to some of the other benefits previously mentioned—such as increased consistency, reliability, and proof of service reports—robotic machines create the perception of higher quality, better performance, health, sustainability, safety, and reliability—all of which can deepen current business relationships and help sell to prospects. They can also lead to better performance results that can create happier, more loyal, longer-lasting customers.

Studies show that clean facilities create measurable health and safety benefits—reducing employee absenteeism by as much as 46 percent.¹⁴ And in public spaces like shopping centers and grocery stores, cleanliness—and spotless floors in particular—are essential for customer satisfaction. In this way, the improved performance robotic cleaning machines offer can help a company create a better customer experience and deliver higher standards that enhance their overall brand—and keep customers coming back.

Robotic cleaning machines can also boost a company's brand status by their mere physical presence. While they offer the flexibility to operate any time, day or night, in all kinds of conditions, robotic cleaning machines can be a strong visible presence that causes people to stop and take notice. A self-driving cleaning robot makes an impression in an airport, shopping mall, or big box store. In a way, it's a kind of a moving billboard—an intangible benefit that can pay dividends through higher brand perception, customer affinity, and recall. It's a visual representation of a company's commitment to innovation that reflects positively on the brand. Which is why it's so important to choose a manufacturing partner who supports not just the machine itself, but through its expertise, guidance, and insight, the larger brand as a whole.

HOW TO CHOOSE A ROBOTIC CLEANING MACHINE PARTNER

Buying a robotic cleaning machine is a start. But learning to use it and maximize its full value is the real key to reaping the benefits. When it comes to purchasing, it's important to do sufficient research and choose a manufacturer who not only builds high quality, durable equipment, but who also offers the technical support and service, as well as the logistics and business expertise, to help companies effectively incorporate their new equipment into their operation, no matter the scale of their business.

Remember, first and foremost, a cleaning machine is still just that—a cleaning machine. While robotic technology offers many advantages, the bottom line is that cleaning machines need to do an excellent job of cleaning—and to do so sustainably and cost-effectively. When considering a robotics partner, it's beneficial to choose one with a strong reputation for building reliable cleaning machines—and with a mechanical and technical support network for when things go wrong.

The recent growth in the cleaning robot industry has meant many new entries into the cleaning machine market. Many of these companies come without much of a history or reputation. To get the most from your robotic cleaning machines, it can be valuable to select a manufacturing partner with a proven track record and reputation for quality, service, support, and training—one that knows what it takes to design industry-leading cleaning machines and integrate them smoothly into one's business operation. To find the partner that best aligns with your business and goals, it can be helpful to research several manufacturers before making a decision.

Besides choosing a quality machine, another thing to consider is choosing a manufacturer who will be more than just a manufacturer. Companies interested in robotics are looking for partners that can work with their people to help with the business process change and change management. They want to purchase their fleets from a company known for outstanding customer service, training, and technical support—a manufacturer with the network in place to implement, train, and deploy scalable robotics solutions for any size business operation—from a warehouse, to an airport, to an international retail chain.

ARE ROBOTIC CLEANING MACHINES RIGHT FOR YOU?

The rapid evolution of robotics has created many new opportunities for companies to stay competitive and increase productivity while also improving the job quality and employment outlook for workers. These days, collaborative co-bots are taking on a range of repetitive job tasks, enabling their human co-workers to spend more time on higher value work. This is good for both employees and employers, who can repurpose their workers to have a greater impact on the bottom line.

Cleaning robots in particular have seen tremendous growth in recent years as they've become more sophisticated and more practical—able to work seamlessly with existing operations of almost any size. For facility managers and BSCs, robotic cleaning machines offer powerful benefits—everything from greater speed and consistency, to detailed performance tracking and brand enhancement. But even though they're being adopted in record numbers, robotic cleaning machines aren't necessarily right for every company. Which is why it's important to speak with an experienced partner with the business savvy to help you evaluate your situation and decide what's best for your organization.

For more information or to find out if robotic cleaning machines may be right for you, visit us at [Tennantco.com](https://www.tennantco.com) or call us at 800.540.1399.

NOTES:

¹International Federation of Robotics (April 2017). The Impact of Robots on Productivity, Employment and Jobs. https://ifr.org/img/office/IFR_The_Impact_of_Robots_on_Employment.pdf

²International Federation of Robotics (April 2017). The Impact of Robots on Productivity, Employment and Jobs. https://ifr.org/img/office/IFR_The_Impact_of_Robots_on_Employment.pdf

³Matthews, Kayla (May 2018). Robotiq. 10 Key Robotics Statistics You Need to Know. <https://blog.robotiq.com/10-key-statistics-about-robotics-you-need-to-know>

⁴McKinsey Global Institute (December 2017). Jobs Lost, Jobs Gained: Workforce Transitions in a Time of Automation.

⁵Saran, Cliff (March 2018). Industrial Robots Set to Cut Out Human Workforce. <https://www.computerweekly.com/news/252436737/Industrial-robots-set-to-cut-out-human-workforce>

⁶McKinsey Global Institute (December 2017). Jobs Lost, Jobs Gained: Workforce Transitions in a Time of Automation.

⁷Saran, Cliff (March 2018). Industrial Robots Set to Cut Out Human Workforce. <https://www.computerweekly.com/news/252436737/Industrial-robots-set-to-cut-out-human-workforce>

⁸Matthews, Kayla (May 2018). 10 Key Robotics Statistics You Need to Know. <https://blog.robotiq.com/10-key-statistics-about-robotics-you-need-to-know>

⁹Marshall, Nick (April 2018). The Economic Challenges Facing Commercial Cleaning. <https://blog.ammex.com/the-economic-challenges-facing-commercial-cleaning/#.Xlp2nBNKjOS>

¹⁰Franchise Help. Cleaning Industry Analysis 2018—Cost & Trends. <https://www.franchisehelp.com/industry-reports/cleaning-industry-analysis-2018-cost-trends/>

¹¹Beecher, Stephanie S. Commercial Cleaning and Technology Collide. <https://www.cleanlink.com/cp/article/Commercial-Cleaning-And-Technology-Collide---20742>

¹²https://www.tennantco.com/en_us/solutions/ec-h2O-technology.html

¹³Tennant (2015) Leveraging Data to Drive BSC Performance: A Practical Introduction to Asset and Cleaning Operations Management for Building Service Contractors.

¹⁴Tennant (2015) Leveraging Data to Drive BSC Performance: A Practical Introduction to Asset and Cleaning Operations Management for Building Service Contractors.

SOURCES:

Beecher, Stephanie S. Commercial Cleaning and Technology Collide. <https://www.cleanlink.com/cp/article/Commercial-Cleaning-And-Technology-Collide---20742>

Benevides, Chris (November 2016). 7 Cost-Saving Benefits of Automated Guided Vehicles (AGVs). <https://www.conveyco.com/7-cost-saving-benefits-automated-guided-vehicles-agvs/>

Benevides, Chris (November 2016). The Advantages and Disadvantages of Automated Guided Vehicles (AGVs). <https://www.conveyco.com/advantages-disadvantages-automated-guided-vehicles-agvs/>

Elliot, Vince. Comparison of Key Industry Performance Metrics: An Abbreviated View of some of our findings, Cleaning & Maintenance Management. <https://www.cmmonline.com/articles/comparison-of-key-industry-performance-metrics>

Franchise Help. Cleaning Industry Analysis 2018—Cost & Trends. <https://www.franchisehelp.com/industry-reports/cleaning-industry-analysis-2018-cost-trends/>

International Federation of Robotics (April 2017). The Impact of Robots on Productivity, Employment and Jobs. https://ifr.org/img/office/IFR_The_Impact_of_Robots_on_Employment.pdf

Marshall, Nick (April 2018). The Economic Challenges Facing Commercial Cleaning. <https://blog.ammex.com/the-economic-challenges-facing-commercial-cleaning/#.Xlp2nBNKjOS>

Matthews, Kayla (May 2018). 10 Key Robotics Statistics You Need to Know. <https://blog.robotiq.com/10-key-statistics-about-robotics-you-need-to-know>

McKinsey Global Institute (December 2017). Jobs Lost, Jobs Gained: Workforce Transitions in a Time of Automation.

McSweeney, Kelly (March 2017). Industrial Robots Are Good for the Economy, Study Suggests. <https://www.zdnet.com/article/industrial-robots-are-good-for-the-economy/>

Murphy, Andrew (June 2017). Industrial: Robotics Outlook 2025. <https://loupventures.com/industrial-robotics-outlook-2025/>

Otto Motors (October 2017). How Industrial Robotics Create a More Productive Work Environment for Employees. <https://ottomotors.com/blog/industrial-robotics-and-employees>

Reports n Reports (July 2017). Industrial Robotics Market by Type (Articulated, Cartesian, SCARA, Parallel, Collaborative Robots), Industry (Automotive, Electrical & Electronics, Metals & Machinery, Pharmaceuticals & Cosmetics), and Geography—Global Forecast to 2023. <https://www.reportsnreports.com/reports/166950-industrial-robotics-market-global-forecast-analysis-by-applications-functions-product-geography-2012-2017.html>

Saran, Cliff (March 2018). Industrial Robots Set to Cut Out Human Workforce. <https://www.computerweekly.com/news/252436737/Industrial-robots-set-to-cut-out-human-workforce>

Soergel, Andrew (February 2015). Robots Could Cut Labor Costs 16 Percent by 2025. <https://www.usnews.com/news/articles/2015/02/10/robots-could-cut-international-labor-costs-16-percent-by-2025-consulting-group-says>

Tennant (October 2018). 5 Questions to Ask When Considering Robotic Cleaning Machines. https://www.tennantco.com/en_us/blog/2018/10/robotic-cleaning-machine-considerations.html?icid=robotic-cleaning-machines

Tennant (2015) Leveraging Data to Drive BSC Performance: A Practical Introduction to Asset and Cleaning Operations Management for Building Service Contractors.

Tennant (January 2019). Types of Industrial Robots in Manufacturing and Warehousing. https://www.tennantco.com/en_us/blog/2019/01/industrial-robots-2019.html