A Critical Growth Analysis of Industrial and Professional Services Robots Installed and in Operation Worldwide

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Abstract

Robots are essential to modern society, boosting efficiency, quality, and safety while reducing costs. The global robotics market, valued at USD 73.64 billion in 2025, is projected to grow to USD 100.37 billion by 2030, highlighting significant opportunities for industry advancement. This study examines the growth and trends of industrial and professional service robots that are installed and operational worldwide since 2011. The analysis showed a 3.4 times increase (240%) in industrial robot installations and a 3.5 times increase (247%) in the number of operational industrial robots worldwide from 2012 to 2023. Similar to industrial robots, professional services robots have shown significant growth, increasing by approximately 118% (or 2.18 times) from 2021 to 2023. In terms of market share, the segments for transportation and logistics, medical and healthcare, and professional cleaning experienced a decline in their share in 2022 and 2023 compared to 2021. Conversely, the share for hospitality and agriculture has seen an increase in 2023 compared to 2021. The adoption of robots in industries worldwide has been growing rapidly. In terms of robot density, South Korea leads with a density of 631 robots per 10,000 employees, followed by Singapore at 488, Germany at 309, Japan at 303, Sweden at 223, Denmark at 211, Italy at 185, Belgium at 184, and Taiwan at 177.

Keywords: *Industrial robots; Professional services robots; Market share; Robot density*

INTRODUCTION

Robots are becoming increasingly vital to modern society, affecting sectors like manufacturing, healthcare, entertainment, commerce and transportation (Arquam *et al.*, 2023; Filippi *et al.*, 2023; Klaus & Blessing, 2024; Verma, 2024). Their growing presence enhances efficiency, product quality, and safety, coupled with cost effectiveness, and thus transforms traditional operational frameworks across industrial and service sectors. The global robotics market, valued at USD 73.64 billion in 2025, is projected to grow to USD 100.37 billion by 2030. This growth represents a robust compound annual growth rate (CAGR) of 20.28%, indicating a positive trend and significant opportunities for advancement in the industry (MI, 2025).

Robots have been around since ancient times (e.g., human figurines in water clocks) that progressed to the development of mechanical knight of Leonardo Da Vinci in 1495. The modern era of robotics started in the 20th century when autonomous and industrial reprogrammable robots were developed in the 1950s and 60s (e.g., Elmer and Elsie, Unimate, Shakey) (Hockstein *et al.*, 2007). The advancement in computer vision and machine learning led to the development of robotic arms in the 1980s. The integration of artificial intelligence (AI) in robotics in the 21st century made robots more sophisticated, efficient, and integral to modern societal needs (e.g., autonomous mobile robots, humanoid robots, surgical robots, self-driving cars, delivery drones, etc.) (Raj & Kos, 2022).

The present study aims to carry out an in-depth analysis of – growth and trends of industrial and professional services robots installed and in operation worldwide, and also the sector-wise growth of robots in professional services. The personal (consumer) services robots, and machines that are not classified as robots (such as software like voice assistants, remote-controlled drones, self-driving cars, smart washing machines) are not included in this study.

MATERIALS AND METHODS

The International Organization for Standardization (ISO) defines a robot in ISO 8373:2021 as a "programmed actuated mechanism with a degree of autonomy, moving within its environment, to perform intended tasks". This means it is a machine that can move and act on its own, performing specific jobs without constant human input.

Robots are broadly classified as industrial robots (used in factories and industrial environments), service robots (assisting humans in non-industrial settings – daily life/customer service or professional settings/services). Within these broad categories, robots can be further classified on the basis of their physical configuration and control methods.

Industrial Robots

An industrial robot is an automated, reprogrammable machine that performs a variety of tasks in an industrial setting, such as welding, assembly, and packaging. The International Organization for Standardization (ISO) defines an industrial robot as "automatically controlled, reprogrammable multipurpose manipulator, programmable in three or more axes, which can be either fixed in place or fixed to a mobile platform for use in automation applications in an industrial environment" (ISO, 2021). Wherein,

- Reprogrammable means their functions (motions or auxiliary) can be changed through software without altering their mechanical system (physical parts);
- Multipurpose means they can be adapted for different tasks or applications with mechanical changes (physical alterations); and
- Manipulator means they have an arrangement of segments, jointed or sliding relative to one another.

The industrial robots are often classified according to their mechanical structure as – Cartesian, SCARA, Articulated, Parallel or Delta, Cylindrical, and Polar robots (ISO, 2021; Singh & Banga, 2022; IFR, 2025a). A brief description of these industrial robots, along with representative images, has been presented in Table 1, and the image/photo sources have been duly acknowledged and provided alongside in the table.

Professional Service Robots

A service robot is a semi- or fully automated machine that provides beneficial services to humans and equipment in various settings such as offices, households, and public areas, excluding manufacturing operations. The International Organization for Standardization (ISO) defines a service robot as "a robot in personal use or professional use that performs useful tasks for humans or equipment" (ISO, 2021). Tasks for personal use encompass a variety of activities, including handling or serving items, providing physical support, offering guidance or information, transportation, grooming, cooking, and cleaning. In contrast, professional applications of robotics involve functions such as inspection, surveillance, item handling, professional cleaning, personnel transportation, logistics management, and medical surgery.

Table 1: Type of industrial robots – description and image.

Robot Type and Description	Image with Its Source
Cartesian robot (Linear robot) An industrial robot operates with three primary axes of control that are linear, meaning it moves in straight lines rather than rotating. These axes are positioned at right angles to one another, conforming to the principles of the Cartesian coordinate system.	 *TM Robotics*
SCARA The Selective Compliance Assembly Robot Arm (SCARA) features two parallel rotary joints that enable it to provide flexibility and compliance within a designated plane of movement.	 *TM Robotics*
Articulated An articulated robot has three or more rotary joints that have 6 or more degrees of freedom.	 *Qviro*
Parallel (Delta) A robot that consists of a mobile platform linked to a fixed base through a series of identical parallel kinematic chains (or legs), creating a closed-loop structure.	 *MSI Tech*
Cylindrical A robot that incorporates at least one rotary joint and one prismatic joint, with the axes aligned to create a cylindrical coordinate system.	 *Robotech.org*
Polar (Spherical) A robot with two rotary joints and one prismatic joint, where the axes form a polar coordinate system.	 *www.tthk.ee*

In the present study, the personal (consumer) service robots are not included. The professional service robots considered in this study have been categorised based on five top applications, namely agriculture, professional cleaning, transportation and logistics, medical and healthcare, and hospitality. Representative images of these professional services have been presented in Table 2, and the image/photo

Table 2: Professional service robots.

Professional Service Robots	Image with Its Source
Agriculture Robots	 *www.escatec.com*
Professional Cleaning Robots	 *LIONSBOT*
Transportation and Logistics Robots	 *maritimeducation*
Medical and Healthcare Robots	 *Northwestern University*
Hospitality Robots	 *hoteltechnologynews.com*

sources have been duly acknowledged and provided alongside in the table.

The agriculture category encompasses a range of robots designed for various tasks, including ploughing, seeding, harvesting, weeding, fertilising, and pesticide spraying, applicable in both indoor environments, such as greenhouses and outdoor settings like fields and vineyards. Additionally, it includes robots utilised for milking and other livestock management activities, such as feeding and barn cleaning.

The professional cleaning category includes robots designed for cleaning floors, windows, walls, tanks, pipes, and vehicle hulls in professional settings. This category also encompasses disinfection robots and others used for specialised or large-scale cleaning tasks.

The transportation and logistics category encompasses robots that transport goods and manage inventory in various indoor and outdoor settings. These robots are utilised in environments such as warehouses, hospitals, hotels, and public streets, supporting activities such as deliveries, stock counting, and restocking.

The medical and healthcare category comprises robots employed in clinical and care environments for various applications such as diagnostics, surgery, rehabilitation, and non-invasive therapies. This category also encompasses hospital support robots, wearable exoskeletons, and telepresence robots, each specifically designed to enhance healthcare delivery and patient care.

The hospitality category encompasses robots designed to prepare and serve food and beverages, along with those that offer information, guidance, or virtual assistance in customer-facing settings such as hotels, restaurants, and museums. These robots enhance the guest experience by streamlining service and providing support in various interactions.

Data Acquisition

The data used in this study were downloaded from the website “Our World in Data”, and the original data sources have been cited as provided by the said website. The data set used and analysed in the present study includes Annual Industrial Robots Installed, Total Industrial Robots in Operation, and Annual Professional Service Robots Installed.

Annual industrial robots installed

The data of this indicator is based on the International Federation of Robotics (IFR) via AI Index Report 2025 with minor processing by Our World in Data (IFR, 2025b). The AI Index Report tracks, collates, distills, and visualises data related to artificial intelligence (AI). The data range is from 2011 to 2023, and was last updated on April 8, 2025.

Total industrial robots in operation

The industrial robots in operation means the operational stock of robots, which is the total number of robots currently in use. The data of this indicator is based on the International Federation of Robotics (IFR) via AI Index Report 2025 with minor processing by Our World in Data (IFR, 2025c). The data range is from 2012 to 2023, and was last updated on April 8, 2025.

Annual professional services robots installed

The data of this indicator is based on the International Federation of Robotics (IFR) via AI Index Report 2025 with minor processing by Our World in Data (IFR, 2025d). The data range is from 2021 to 2023, and was last updated on April 8, 2025.

RESULTS AND DISCUSSION

Industrial Robots Installed Worldwide

The annual installation of industrial robots worldwide has increased from 159,000 in 2012 to 541,000 in 2023, marking an increase of 3.4 times (more than 240%) in just eleven years. The annual installation of industrial robots, and the annual percentage increase (or decrease) compared to the base year

2012, is presented in Fig. 1.

There has been a continuous uptrend in the numbers of annual installations of robots worldwide since 2012, barring the years 2019, 2020 and 2023 when annual installations decreased or insignificant increase compared to the previous year. Lower installations during 2019 and 2020 can be attributed to a global economic slowdown, particularly affecting the major automotive and electronics sectors, and the trade conflict between the United States and China, which created significant economic uncertainty. The overall economic uncertainty led to hesitation in large capital investments, like the purchasing and implementation of industrial robots. Thereafter, in the following years, the installation of industrial robots increased more than ever before so as to maintain or increase the industrial production levels that had decreased during and post-COVID pandemic due to labour shortage, social distancing, and lockdowns. In 2023, despite a global economic slowdown, annual industrial robot installations have maintained a robust demand, clocking the second-highest figure of 541,302 units in the history of annual installation of industrial robots (IFR, 2024).

Industrial Robots in Operation Worldwide

The annual number of operational industrial robots, and their annual percentage increase compared to the base year 2012, is presented in Fig. 2. The annual number of industrial robots in operation worldwide has steeply increased from 1.24 million in 2012 to 2.28 million in 2023, marking an increase of about 3.5 times (about 247%) in just eleven years. This increase in the number of operational robots, during the period 2012-2023, is in line with the installation of industrial robots worldwide.

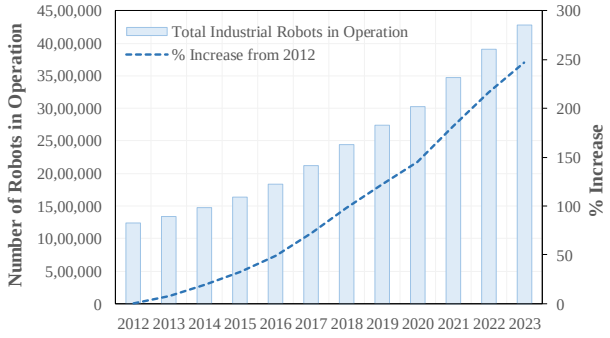

Fig. 2: Annual industrial robots in operation worldwide – numbers and percentage change from base year 2012.

Unlike the decrease in annual installed robots (both in numbers and percentage) during the years 2019, 2020 and 2023 (Fig. 1), the annual number as well as the percentage (compared to the base year 2012) of industrial robots in operation has exhibited a continuous uptrend every succeeding year. The operational industrial robots increased during the COVID-19 pandemic, accelerating the adoption of robots in industry so as to achieve continuity of production and protection of workers. The global annual industrial robots in operation has maintained a robust growth since 2012, clocking higher figures every year – both in numbers as well as percentage increase from the base year 2012 (Fig. 2).

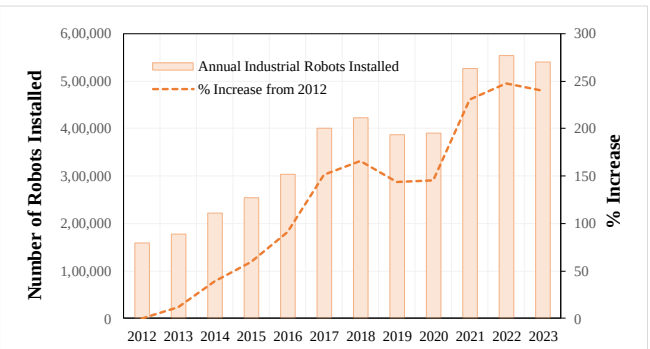

Fig. 1: Annual installation of industrial robots worldwide – numbers and percentage change from base year 2012.

Annual Growth Rate of Industrial Robots Worldwide

The percentage annual growth rate on a year-on-year (YOY) basis means the percentage increase/decrease during a year compared with the preceding year. The percentage annual growth rate on a YOY basis of industrial robots installed and operational worldwide is presented in Fig. 3. The annual growth rate on a YOY basis of installed industrial robots worldwide was 11.95% in 2013, reached 31.58% in 2017 and recorded the lowest growth of -8.51% during the year 2019. Thereafter, the annual growth rate rebounded strongly in the next two years to record the highest annual growth rate of 34.87% in 2021. This sharply increasing trend of the annual growth rate of installed industrial robots reversed after 2021, clocking the second-lowest annual growth rate of -2.17% on a YOY basis in 2023.

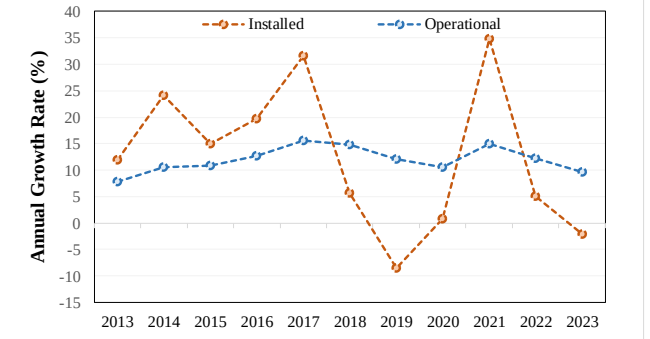

Fig. 3: Annual growth rate of industrial robots installed and operational worldwide year-on-year basis.

Unlike steep ups and downs in the annual growth rate of installed industrial robots, the annual growth rate of industrial robots in operation worldwide on a YOY basis has been more or less steady in the range of 7.85% (2013) to 15.61% (2017), as shown in Fig. 3.

However, despite the increasing annual numbers of industrial robots installed as well as operational worldwide (Figs. 1 & 2), the annual growth rate on a YOY basis has been decreasing post-2021. The possible reasons for the continuing declining annual growth rate on a YOY basis post 2021 could be continuing disruption in machinery production in Asia, particularly China, due to repeated waves of COVID, and economic and trade disruptions and uncertainties due to sanctions, military conflicts and trade policies.

Table 3: Year-wise annual industrial robots installed as a percentage of the global.

Year	Annual Industrial Robots Installed as % of World						
	China	Japan	USA	S. Korea	Germany	India	Rest of World
2012	14.47	18.24	13.84	11.95	11.32		30.19
2013	20.79	14.04	13.48	11.80	10.11	1.08	28.70
2014	25.79	13.12	11.76	11.31	9.05	0.96	28.00
2015	27.17	13.78	11.02	14.96	7.87	0.81	24.38
2016	31.91	12.83	10.20	13.49	6.58	0.86	24.14
2017	39.00	11.50	8.25	10.00	5.25	0.86	25.14
2018	36.64	13.00	9.46	8.98	6.38	1.13	24.40
2019	38.24	12.92	8.53	8.53	5.68	1.10	25.00
2020	45.64	10.00	7.95	7.95	5.64	0.82	22.00
2021	50.95	8.94	6.65	5.89	4.56	0.98	22.03
2022	52.44	9.04	7.23	5.79	4.70	0.97	19.83
2023	51.02	8.50	7.02	5.73	5.18	1.57	20.98
Rank in 2023	***1st***	***2nd***	***3rd***	***4th***	***5th***	***7th***	

Despite fluctuations in the annual growth rate on a YOY basis, the global industrial robots market size, which has been valued at USD 19.89 billion in 2024, is projected to grow from USD 21.94 billion in 2025 to USD 55.55 billion by 2032, exhibiting a compound annual growth rate (CAGR) of 14.2% during the forecast period (FBI, 2025).

Percentage Share and Robot Density of Major Countries

In terms of the percentage of annual industrial robots installed worldwide, the five top countries are China, Japan, the USA, S. Korea, and Germany. Their year-wise percentage share from 2012 to 2023 has been tabulated in Table 3 (IFR, 2025b).

Since 2021, China has accounted for more than 50% of annual installed industrial robots globally. Its share has increased from 14.47% in 2012 to 52.44% in 2022 and accounted for 51.02% in 2023. Apart from China and India, the rest of the top four countries' annual percentage share has been broadly reducing since 2012, possibly due to the substantial increase of China's share, coupled with the increasing installation of industrial robots in other countries, and highly automated industries – e.g. Japan.

Robot adoption in industries around the world has been continuously growing at a rapid pace. The global average robot density (ratio of industrial robots to employees) clocked 162 units per 10,000 employees in 2023 compared to 74 units per 10,000 employees in 2017 (IFR, 2025e). In terms of robot density, South Korea has the highest robot density of 631, followed by Singapore 488, Germany 309, Japan 303, Sweden 223, Denmark 211, USA 189, Italy 185, Belgium 184, and Taiwan 177 per 10,000 employees.

Sector-wise Annual Installation and Growth of Professional Robots Worldwide

Like the industrial robots, the professional robots have also exhibited robust growth in recent years. The total number of professional robots installed globally has increased from 94,000 in 2021 to 205,000 in 2023, clocking an increase of about 118% (2.18 times) in two years. The sector-wise annual installation and percentage share has been presented in Fig. 4.

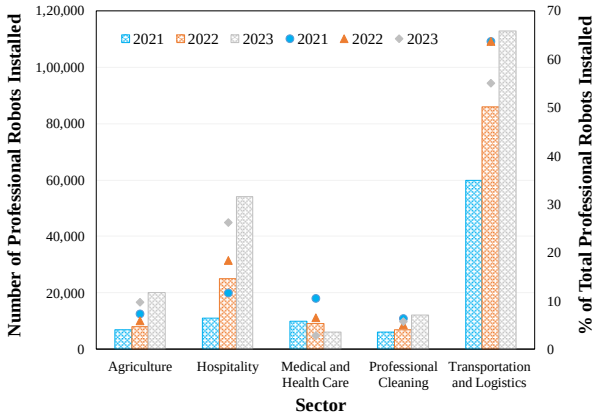

Fig. 4: Sector-wise annual installation and growth of professional robots worldwide.

The transportation and logistics sector dominates the professional robots' installation worldwide, accounting for more than half of the share, followed by hospitality, agriculture, professional cleaning, and medical and health care. The number of professional robot installations in all the sectors has increased on a YOY basis, except in medical and health care during the period 2021-2023. In terms of percentage share, the share of transportation and logistics, medical and health care, and professional cleaning has decreased in 2022 and 2023 in comparison to 2021; whereas, the share of hospitality and agriculture has increased in 2023 compared to 2021. In fact, the hospitality sector has witnessed a robust growth wherein its share of the installed professional robots installed globally has increased from 11.7% in 2021 to 18.52% in 2022 and 26.34% in 2023.

The analysis indicates that the number of installed and operational robots has increased in the Asia-Pacific region in

recent years. A recent market analysis by Mordor Intelligence highlights a shift in regional momentum, demonstrating that while Asia-Pacific continues to lead in volume, the Middle East is experiencing the fastest growth as sovereign funds seek to diversify through technology investments (MI, 2025).

CONCLUSIONS

The following conclusions have been drawn from the data analysis and results of the present study:

- A 3.4-fold increase (240%) in industrial robot installations from 2012 to 2023, and a 3.5-fold increase (247%) in the number of operational industrial robots globally from 2012 to 2023.
- A 2.18-fold increase (118%) in professional services robot installations globally from 2021 to 2023.
- A decline in the market share in the transportation and logistics, medical and healthcare, and professional cleaning segments; whereas, the hospitality and agriculture sectors witnessed an increase in their market share in 2023 relative to 2021.
- China leads in robots installed (more than 50% of annual installed industrial robots globally), and South Korea leads in robot density (631 robots per 10,000 employees).

The adoption of robots in industries is rapidly increasing, projected to reach USD 100 billion by 2030. Asia-Pacific leads in volume, while the Middle East sees the fastest growth.

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Conflict of interest

The author declares that there is not any conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/ or falsification, double publication and/or submission, and redundancy, have been completely observed by the author.

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