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# Industrial Robots on the Market of Means of Production Automation

**Abstract:** In the automation means segment of the automation market the most dynamic growth in demand is concerned with industrial robots, making up 4% of the global automation market and 17% of the global automation means market. The article presents results of economic and statistical analysis of the automation means market, and in particular of the industrial robots market, from the global, regional and industrial point of view.

**Keywords:** robotisation, automation of production, industrial robots

The development and widespread implementation of various techniques (systems) dedicated to production control as well as of automation means (devices) are the key elements of present production development policy and apply not only to mass and high-volume production, but also to manufacturing performed in small and medium enterprises. Over the past 10 years the average annual growth in the global sales of production automation means amounted to approximately 6%, with the sales value exceeding 152 billion USD in 2012. It is anticipated that in 2014-2020 the average annual rise in production will amount to 8.5% [1].

In the automation means segment of the automation market, the most dynamic growth in demand is concerned with industrial robots, making up 4% of the global automation market and 17% of the global automation means market. The dynamics of the global automation means sales (increase in profit on sales) in the years 2011-2015 is illustrated by data presented in Table 1 [1].

An increase in profit on sales in the robotisation segment is 40% higher than the average profit increase in the segment of automation means and 15% higher than the average increase in profit on sales of all automation means.

Presently, industrial robots are a key element of revolutionary production transformation. For many years, the functions of industrial robots have not been limited to traditional and repeated actions. New generation robots differ to their predecessors by possessing purely “human” features such as intelligence, flexibility, memory, ability to learn and recognition

Table 1. Dynamics of growth in profit of automation means sales in the main product segments in 2011-2015

Profit on sales	2011	2012	2013	2014	2015
<b>Automation means, in total, this includes:</b>	<b>5.9%</b>	<b>4.3%</b>	<b>5.3%</b>	<b>5.3%</b>	<b>5.5%</b>
Robots	6.6%	8.3%	8.6%	7.5%	7.5%
Visual systems	6.6%	3.7%	7.1%	6.2%	6.7%
Sensors	5.6%	3.6%	3.6%	4.2%	4.2%
Relays and switches	5.5%	3.5%	3.6%	4.2%	4.3%
Moving devices	4.9%	1.5%	3.7%	4.3%	4.4%
Others	6.5%	6.0%	6.0%	6.0%	6.0%

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of objects. Size reduction, increase in operation rate, cost reduction and the necessity of improving quality and increasing production efficiency and flexibility are key factors affecting the increase in demand for robotisation means and their implementation expansion. This phenomenon can be observed in all industrial sectors worldwide, irrespective of an enterprise size. The number of globally registered robotisation-related patents rose from 1400 in 2004 to 5094 in 2013. 24% of all patents published have been filed by Japan, 22% by Germany, 17% by the USA, 13% by China and 10% by South Korea.

Companies producing means of robotisation have seen a significant rise in investment spending. According to the US Manufacturing Institute data, in 2011-2013 investments in companies producing means of robotisation rose almost triple, i.e. from 60 to 172 million USD. Significant changes have also affected the sector-related structure of robotic technique implementations. For instance, in 2005, 80% of robots in the USA were concentrated in the automotive industry. In 2013, with a significant increase in general sales of robotisation means, also in the automotive industry, the share of automotive industry in the total sales of robotic technique amounted to 56%. A significant increase in demand for robotic technique

can also be observed in the food production, rubber goods manufacturing, electrical engineering, electronics, pharmaceutical and biochemical industries [2].

After the crisis of 2008-2009, the first significant increase in industrial robot sales took place in 2011, when it grew by 38% worldwide, amounting to 166 028 units, with the sales value rising by 46% to reach 8.5 billion USD. In turn, the global sales of robots and robotic industrial systems including software and tooling increased to 25.5 billion USD. In 2013 the global sales volume of industrial robots reached 179 thousand units, i.e. 12% more than in 2012. It is estimated that in 2014 the global market of robots grew by 15% in comparison with 2013, with the annual number of installed robots reaching 200 thousand items. The number of industrial robots in operation exceeded 1.5 million units and the value of sales exceeded 10 billion USD. Taking into account the value of software and tooling sold alongside robots, the value of the global market of robots and robotic industrial systems exceeded 30 billion USD [3].

Table 2 presents data concerned with the annual sales and the whole stock of industrial robots worldwide and in the main regions of the world in 2011-2013 as well as the forecast for 2016 (according to data provided by the International Federation of Robotics – IFR).

Table 2. Sales volume and number (stock) of all kinds of industrial robots in the main regions of the world in 2011-2013 and the forecast for 2016 (units)

Region	Total sales				Stock			
	2011	2012	2013	2016 forecast	2011	2012	2013	2016 forecast
<b>World in total, this includes:</b>	<b>166 028</b>	<b>159 346</b>	<b>179 000</b>	<b>207 500</b>	<b>1 153 097</b>	<b>1 235 389</b>	<b>1 373 000</b>	<b>1 659 500</b>
<b>America</b>	26 227	28 137	30 800	34 900	192 966	207 017	226 550	281 000
<b>Asia and Australia</b>	88 698	84 645	86 000	107 200	576 545	628 889	733 500	908 500
<b>Europe</b>	43 826	41 218	39 800	45 000	369 965	380 546	388 800	431 700
<b>Africa</b>	323	393	500	700	2 495	2 858	3 300	4 900

In 2013-2014 the greatest demand for industrial robots was observed in China, Japan, South Korea and Germany. In the regional structure, Asia dominates both in terms of annual sales and the number of industrial robots. The share of Asian region countries makes up over a half of worldwide sales and stock of industrial robots. The International Federation of Robotics (IFR) estimates that in 2014 the sales of robotisation means in Asia grew by approximately 21%, with a particularly significant growth taking place in China, Taiwan and South Korea. Since 2008 the annual sales of robots in China have been growing on average by 36%.

China is the leader in the sales of industrial robots. In 2013 the sales of robotic technique in China grew by 60% if compared with 2012, reaching 36 500 units. It is expected that in 2014 China saw an increase in industrial robot sales of 50 thousand items. In terms of the sales of industrial robots Japan comes second, yet its stock of robots is the greatest in the world and amounts to over 300 thousand units. Japan is the world's leader as far as industrial production automation is concerned. More than a half of all robots produced worldwide are manufactured by Japanese companies. In 2013 Japanese companies produced 100 870 industrial robots. In comparison with 2012 the Japan's domestic market demand decreased by 9% amounting to 25 thousand robots, yet the export in 2012 grew by 1.6% amounting to approximately 76 thousand robots.

According to the forecast by the International Federation of Robotics, in 2015-2017 the annual global average increase in robotic technique sales will amount to 16%. In China the annual growth in sales will reach 25% and in 2017 will amount to 100 thousand robots. By 2017 the stock of industrial robots in China will have exceeded 400 thousand units. According to the forecast, in 2017 the amount of robots installed worldwide will reach 2 million items. Positive forecasts concerning the robotic technique

market can be found in reports of many analytical companies. For instance, according to the Allied Market Research company (USA), in 2012 the value of the global robotic technique market amounted to 26.78 billion USD. It is expected that in 2020 the values of this market will exceed 41 billion USD. The annual growth will be 5.4% [4]. According to data by Research and Market (USA), in 2018 the value of the worldwide robotic technique market will amount to 37 billion USD [5].

As regards the worldwide sector-related structure of industrial robot sales, approximately 40% of robots are employed in the automotive industry. In 2010-2013 the sales of robots for the automotive business grew annually on average by 22%. In 2013 the indicator amounted to 5%. The major users of robots in the automotive industry were companies from China, Germany and USA. In 2010-2013 also the machine and metal processing industries saw a considerable annual increase in robot sales of 22%. In 2013, the sales of robots in these industries increased by 17%. A significant rise in robot sales was also visible in electrical engineering and electronics (+9%), rubber goods production (+6.4%) as well as in food and pharmaceutical sectors.

A commonly used industrial production automation indicator is the number of robots per 10 000 workers employed in industry. Presently, it is possible to observe a significant difference

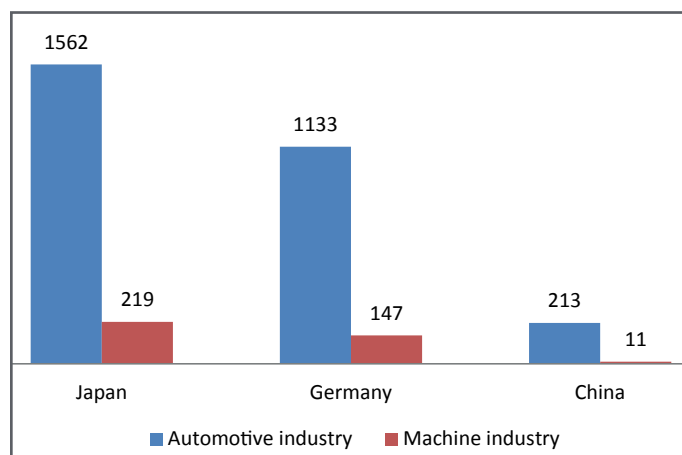


Fig. 1. Industrial robot saturation in automotive and machine industries in Japan, Germany and China (units per 10 thousand workers in a given industry in 2013)

in robotisation level (according to robot saturation indicator) between machine and automotive industries. In developed countries this indicator reaches 7-8, whereas in BRIC (Brazil, Russia, India and China) – 19, which stimulates robotic technique market development both in developed and developing countries. Figure 1 presents robot market saturation indicators (number of robots per 10 000 workers in a given sector) in the automotive and machine industries in Japan, Germany and China [3]. Industrial robot market leaders are the companies FANUC (Japan), KUKA (Germany), ABB Robotics (USA) and YASKAWA (Japan). In 2013 the total sales of these companies made up approximately 70% of the worldwide robot market [6].

In 2013, on the basis of data provided by the International Federation of Robotics, specialists from the KUKA company analysed the level of robotisation in machine industry sectors of 10 countries/regions, where machine industry constitutes 80% of the global production. The results of the analysis conducted are presented

Country/region	Sector						
	Food production	Electronics	Plastics	Foundry	Tanks and containers	Arc welding	Others
China	■	■	■	■	■	■	■
Germany	■	■	■	■	■	■	■
USA	■	■	■	■	■	■	■
Italy	■	■	■	■	■	■	■
South-East Asia	■	■	■	■	■	■	■
Taiwan	■	■	■	■	■	■	■
Central and Eastern Europe	■	■	■	■	■	■	■
Spain	■	■	■	■	■	■	■
Sweden	■	■	■	■	■	■	■
France	■	■	■	■	■	■	■

Fig. 2. Robotisation in various sectors divided into regions, on the basis of data concerning annual robot sales

in Figure 2 [6]. As can be seen, most industrial sectors, both in developed and developing countries, have potential for further growth in industrial robot sales.

On a global scale, the greatest demand for robots is observed in the material processing sector. The stock of material processing robots constitutes 38% of the total global number of industrial robots, including those used in foundry engineering, thermal processing and press forming/forging.

Robots used in assembly operations make up approximately 10%, those for making surface layers – 4% and robots used in special processes (laser and plasma cutting, waterjet cutting etc.) – 2% of the global stock of industrial robots.

Robots used in welding industry make up approximately 30% of the global stock of industrial robots and include mainly arc welding and spot welding robots. In the structure of the global welding robot market, both in terms of number and value, the share of arc welding and spot welding robots amounts to approximately 50%. Regionally, the market structure differs significantly with the European and global markets dominated by spot welding robots and Asian markets by arc welding robots. In 2008-2013 the annual global sales of welding robots increased by more than 50% from 33 thousand to over 55 thousand units. The major share (over 70%) in this market is in North America - 25%, China - 19%, Europe – 21% and Japan – 12%. Analysts of the Tech Navio company forecast that in 2013-2018, welding robots sales will increase on average by 5.7% [7-10]. According to the Japan Welding News, in 2013 the global sales of welding robots were worth 2 615 million USD. The Table below presents the value of



sales in the main regions and countries of the world.

The global market of welding robots is on a permanent increase, primarily due to a high growth rate in the automotive industries in China and India. It is also possible to notice considerable demand for industrial robots in

machine-building industry. The global production shift to Asia has favoured the reduction of welding robots prices in short and mid-term perspectives. In addition, it has contributed to the reduction of welding robotisation investment return time and favoured greater welding robot use in small and medium enterprises.

Table 3. Global annual sales from 2013, in units, in the welding robots market

Country	Arc welding robots		Spot welding robots		In total	
	Units	%	Units	%	Units	%
Europe	3 000	31,1	6 600	68,7	9 600	19,1
Russia and CIS	290	59,2	200	40,8	490	1,0
China	7 000	69,3	3 100	30,7	10 100	20,0
Korea	2 300	59,0	1 600	41,0	3 900	7,7
Japan	3 060	52,4	2 780	47,6	5 840	11,6
Taiwan	730	77,7	210	22,3	940	1,9
India	700	51,9	650	48,1	1 350	2,7
ASEAN countries	2 400	60,8	1 550	39,2	3 950	7,8
Middle East	210	46,7	240	53,3	450	0,9
Africa	240	54,5	200	45,5	440	0,9
Oceania	250	45,5	300	54,5	550	1,1
North America	4 100	36,3	7 200	63,7	11 300	22,4
Latin and South America	730	50,0	730	50,0	1 460	2,9
<b>In total</b>	<b>25 010</b>	<b>49,6</b>	<b>25 360</b>	<b>50,4</b>	<b>50 370</b>	<b>100,0</b>

Source: The Japan Welding News for the World

Table 4. Global sales of welding robots in 2013 in millions of USD

Country	Arc welding robots		Spot welding robots		In total	
	Units	%	Units	%	Units	%
Europe	167	30,4	383	69,6	550	100,00
Russia and CIS	17	63,0	10	37,0	27	100,00
China	325	65,7	170	34,3	495	100,00
Korea	78	54,9	64	45,1	142	100,00
Japan	195	61,3	123	38,7	318	100,00
Taiwan	35	76,1	11	23,9	46	100,00
India	33	53,2	29	46,8	62	100,00
ASEAN countries	14	48,3	1,5	51,7	29	100,00
Middle East	10	50,0	10	50,0	20	100,00
Africa	11	55,0	9	45,0	20	100,00
Oceania	14	48,3	15	51,7	29	100,00
North America	228	35,3	417	64,7	645	100,00
Latin and South America	41	53,2	36	46,8	77	100,00
<b>In total</b>	<b>1 273</b>	<b>48,7</b>	<b>1 342</b>	<b>51,3</b>	<b>2 615</b>	<b>100,00</b>

Source: The Japan Welding News for the World

Constant monitoring and control of welding parameters throughout the process is now possible as a result of providing modern welding robots with tracking systems. The integration of 3D visual control systems with robotic arc welding systems has become common. The long-term perspective forecast anticipates a significant increase in income related to the arc welding robot sector, resulting from their increasingly common machine industry applications, where manual and mechanised welding is increasingly often replaced by robotic welding.

Maintaining profitability while being confronted with lowered prices of welding robots poses a significant issue for industrial robot manufacturers. For buyers seeking investment cost reduction the price has become the basic criterion when selecting welding robots. Robotic technique manufacturers are in increasingly close collaboration with specialists designing total production automation and production process automation systems developing customised solutions.

In pursuit of an increasingly high compatibility of components participating in a technological welding process, manufacturers of industrial robots try to establish partner relations with producers of power sources and other welding technique components. Presently, it is possible to observe an increasingly high demand for flexible and adaptive robots capable of performing assembly operations in mixed and multitask production lines [11].

## References

- [1] Global Industrial Automation. Credit Suisse. Global Equity Research. 14 August 2012. p. 102
- [2] Stanton-Geddes M., Fravel D.: U.S Manufacturing companies are global leaders in industrial robot consumption. USTITC Executive Briefings on Trade. May 2014. p. 2
- [3] World Robotics 2013 Industrial Robots. International Federation of Robotics. 2014. p. 406
- [4] Growth forecast for robotics market 2020 <http://www.metalworkingworldmagazine.com>
- [5] Lewis C.: Robot stocks outperforming market averages. <http://www.robotenomics.com>
- [6] Mohnen P.: KUKA AG German Corporate Conference Company Presentation. KUKA AG. January 21, 2012, p. 16
- [7] Arc/Spot welding Robots. The Japan Welding News for the World, 2010. V.14, N53. p. 4
- [8] Sales volume of torch for robots and torch for semi-auto welding increases. The Japan Welding News for the World. 2011. V.15, N56. pp. 10-11
- [9] General description for welding robots market. The Japan Welding News for the World. 2013. V.17, N63. pp. 5-6
- [10] General description for welding robots market. The Japan Welding News for the World. 2014. V.18, N67. pp. 5-6.
- [11] Presher A.: An Evolution in Industrial Robots. <http://www.designnews.com>