

INDUSTRIAL ROBOT APPLICATIONS IN MANUFACTURING PROCESSES IN ASIA AND AUSTRALIA

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Subject review

In order to see the role of industrial robot in a manufacturing process and to see which manufacturing processes have the highest industrial robot application, industrial robot application in Asia/Australia has been analysed. Automation and modernization of a manufacturing process in any industrial branch is impossible without industrial robot application. In Asia, it has been known for years, and this paper will prove it. Annual and total industrial robot application has been analysed in the following manufacturing processes: handling material operations, welding, assembly, processing, dispensing and the other/ undefined, where robots could not be classified in the manufacturing process. Industrial robot application of the leading Asian countries has been analysed, those with the developed industry and others with industry in the developing stages, where the automation and modernization of the manufacturing process is performed. This paper provides a comparative analysis of the industrial robot application in the last three years, at the annual level and the total number (operational stock) of the industrial robot applications. The percentage reference is given of the industrial robot applications in different industrial branches in 2010. It also provides the prediction analysis of the industrial robot applications in the following period till 2014.

Keywords: automation, industry, industrial robot, manufacturing process

Primjena industrijskih robota u proizvodnim procesima Azija/Australija

Pregledni članak

Da bi smo vidjeli ulogu industrijskog robota u proizvodnom procesu, u kojim proizvodnim procesima je najveća primjena industrijskih robota, analizirali smo primjenu industrijskih robota u Aziji/Australiji. Automatizaciju i modernizaciju proizvodnog procesa u bilo kojoj industrijskoj grani nije moguće zamisliti bez upotrebe industrijskih robota, što su shvatili prije toliko godina u Aziji, a što će pokazati i ova analiza. Godišnja i ukupna primjena industrijskih robota analizirana je u sljedećim proizvodnim procesima: operacije rukovanja materijalima, zavarivanje, montaža, obrade, pakovanje i ostalo/neodređeno gdje nismo robote mogli svrstati u proizvodni proces. Analizirana je primjena industrijskih robota u vodećim zemljama Azije, u kojima je razvijena industrija ili se razvija industrija te gdje se vrši automatizacija i modernizacija proizvodnih procesa. U radu je data komparativna analiza u zadnje tri godine primjene industrijskih robota kako na godišnjoj razini tako i ukupni broj primjenjenih industrijskih robota. Dan je postotni omjer primjene industrijskih robota u raznim industrijskim granama u 2010. U analizu su uzeta predviđanja primjene industrijskih robota u narednom razdoblju do 2014 godine.

Ključne riječi: automatizacija, industrija, industrijski robot, proizvodni proces

1 Introduction

With constant modernization and automation of the manufacturing process in all branches of industry, with its flexibility and demands for a permanent change in manufacturing lines of industrial robot functions, it becomes more demanding and complicated due to the increasing trend of industrial robot application. With the development of new technologies and usage of new materials, different industries demand new manufacturing lines, and an increasing demand for alternative energy sources (solar cells manufacturing) will increase industrial robot applications.

The diversity of industrial robot applications is in constant increase, which demands flexible automation in food, pharmaceutical and electro/electronic industry and time decrease of product manufacturing, with continual high quality. There is a continual technological improvement in flexibility, accuracy, security and simplification of industrial robot applications. The medium-sized and small businesses will start using the flexible automation in order to be competitive on a market. Their application is still maximal in the automobile industry, but the other branches of industry are also increasing the number of installed robots.

With the development of the information technology there are permanent changes in industrial robotics, leading to new functional solutions and higher possibilities of the industrial robots applications.

Considering that Asia/Australia is a continent with the highest number of applied industrial robots, this paper

provides an analysis of industrial robot applications. The analysis has been performed in four Asian countries: Japan, Republic of Korea, Republic of China and Taiwan, considering that these are the countries with the highest number of applied industrial robots.

There has been analysed the trend of industrial robot applications and parallel application analysis in different branches of industry and in different application areas. It has been carried out in order to see the highest industrial robot abundance, i.e. to reveal which manufacturing processes are automatized, which branches of industry in Asia are developed and in which countries, and which are being modernized and developed by industrial robot utilization [1, 2, 3, 4, 5, 6].

2 Industrial robot application in Asia/Australia

When analysing the industrial robot application shown from Fig. 1 to Fig. 4, the statistical data has been taken from International Federation of Robotics, the Economic Committee data from UN for Europe (UNECE) and Organization for Economic Cooperation and Development [6, 7, 8, 9, 10, 13].

According to Figs. 2, 3 and 4, it is obvious that Asia/Australia takes the first place in industrial robot applications in the world, at annual and at total level. In 2010, in Asia were applied 69 833 of industrial robot units, and the total number of industrial robot applications amounts to 498 933 units. When considering the percentage reference at the annual level it amounts to 59 % in Asia, but at the total level the percentage is smaller

and amounts to 49 %, in relation to the total industrial robot applications in the World. In Asia/Australia, the industrial robot application trend from 1998 ÷ 2010 was in constant increase at the total level from 2002 ÷ 2008.

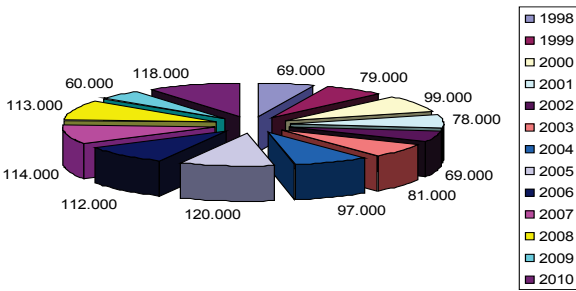


Figure 1 Annual supply of industrial robots in the World from 1998 – 2010

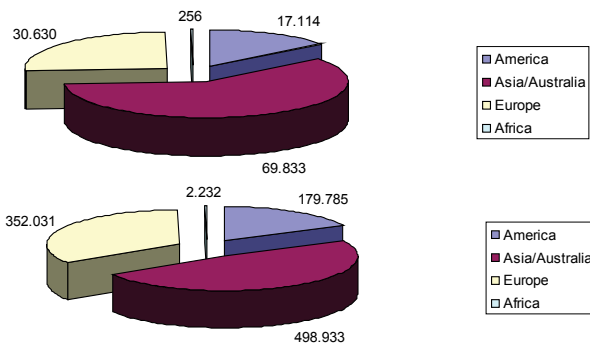


Figure 2 Annual supply and operational stock of industrial robots in the World in 2010 by continent

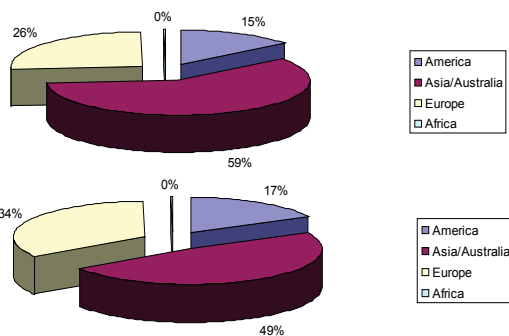


Figure 3 Percentage of industrial robot annual installation and operational stock in World in 2010 by continents

In the last three years there has been a slight fall at the total level, and the annual level of robot applications is different, and the least was in 2001, 2002 and 2009, where the minimal robot application was recorded in the

last twelve years with 31 117 units. It happened due to the financial industrial crisis [11, 12, 14, 15].

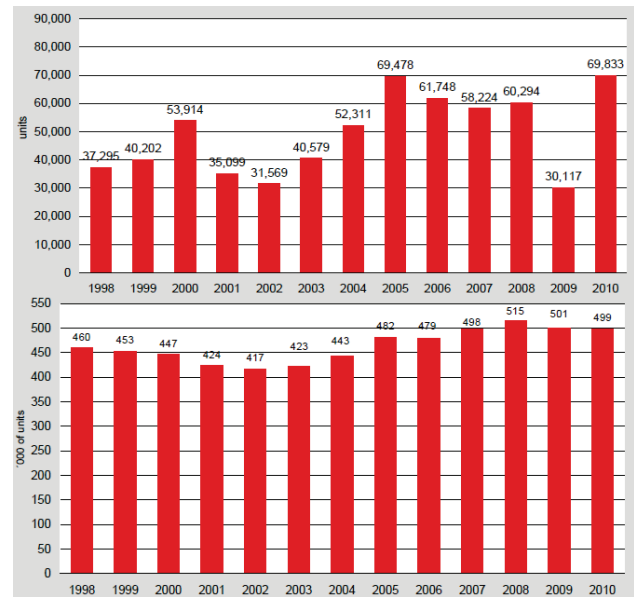


Figure 4 Annual supply and operational stock of industrial robots in Asia/Australia in 1998 ÷ 2010 [6]

3 Industrial robot application in different manufacturing processes in Asia/Australia from 2008 ÷ 2010

Through this analysis the following manufacturing processes have been considered: handling operations, welding, assembly, dispensing, processing and the other processes not classified in a given manufacturing process like: agriculture, forestry, fishery, mining, food manufacturing, and also tobacco and textile manufacturing, paper industry, wood industry, leather, metal industry, plastic and chemical industry, electro/electronic industry, automobile industry, building industry, etc.

The analysis of industrial robot applications in different manufacturing processes is shown in Tab. 1 and Figs. 5 and 6. It is also shown in Tab. 2 and Figs. 7 and 8. They show the analysis of industrial robot applications in Asia by different industries. According to the table and the graph, industrial robot applications in 2010 increased in all branches of industry with regard to the year 2009, due to the financial industrial crisis in 2009.

Table 1 Annual supply and operational stock of industrial robots in various application areas in Asia/Australia in 2008 ÷ 2010 [6, 7, 16]

Continent	Annual supply of industrial robots in Asia/Australia			Operational stock of industrial robots in Asia/Australia		
	2008	2009	2010	2008	2009	2010
Application						
Handling	19 529	10 657	25 282	161 890	160 411	161 143
Welding	19 672	8514	18 215	135 377	134 137	140 825
Assembly	2183	1560	2324	84 768	75 458	64 566
Dispensing	7690	4120	9910	17 334	18 017	18 948
Processing	658	232	647	7317	6929	5579
Others/Unsp.*	10 562	5024	13 455	108 228	106 470	107 852
Total:	60 294	30 117	69 833	514 914	501 422	498 933

*included cleanrooms and unspecified

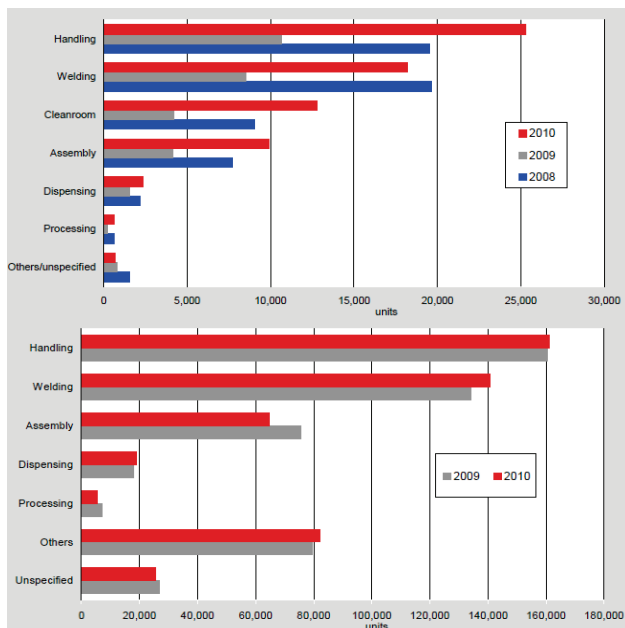


Figure 5 Annual supply and operational stock of industrial robots by application areas in Asia/Australia in 2008 ÷ 2010

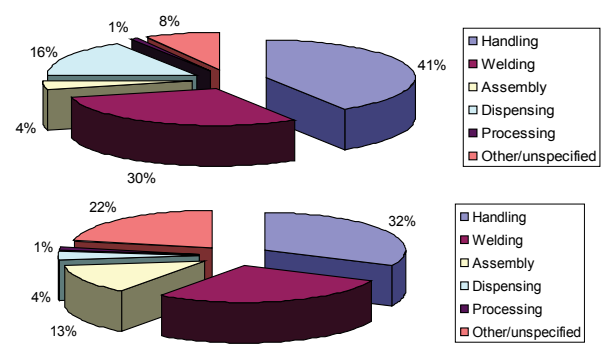


Figure 6 Percentage of industrial robot annual supply and operational stock by application areas in Asia/Australia in 2010

According to the shown tables and figures we come to the following conclusion: In Asia/Australia in 2010 69 833 units of the new industrial robots were applied, which is by 130 % higher than in 2009.

The handling jobs amount to 41 % and welding to 30 % at the annual level. Also automobile industry amounts to 21 %, electro industry to 37 % and chemical industry to 8 % of more applied industrial robots.

Table 2 Annual supply and operational stock of industrial robots by industrial branches in 2008 ÷ 2010 [6, 7]

Application	Annual supply of industrial robots			Operational stock of industrial robots		
	2008	2009	2010	2008	2009	2010
Industry/Year						
Plastics and chemical	6216	3266	5386	56 849	55 028	50 387
Metal product	4971	1362	2378	40 967	39 034	36 012
Electrical/electronics	13 167	8594	25 882	121 982	117 799	116 129
Automotive	20 728	8342	14 644	159 838	158 826	158 089
Unspecified *	15 212	8554	21 543	135 277	130 735	138 316
Total:	60 294	30 117	69 833	514 914	501 422	498 933

*included: agriculture, mining, gas, construction, education, research and development, other

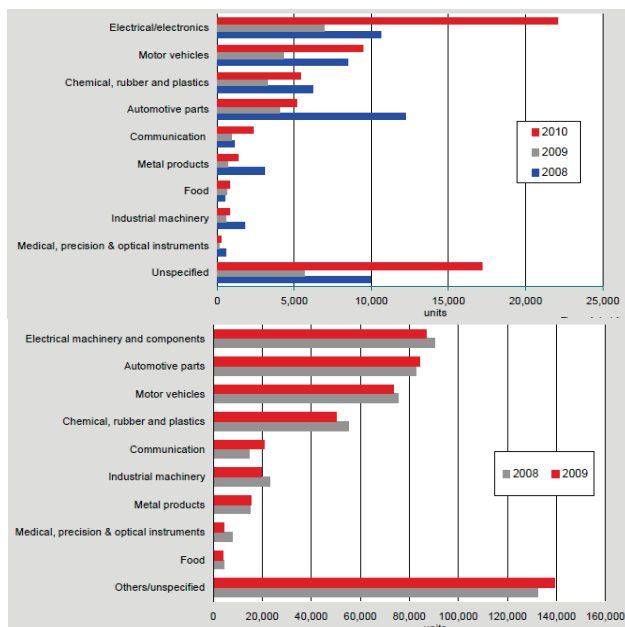


Figure 7 Annual supply and operational stock of industrial robots by industrial branches in Asia/Australia in 2008 ÷ 2010 [6]

automobile industry takes 32 %, electro/electronic 23 % and chemical industry 10 % of industrial robots.

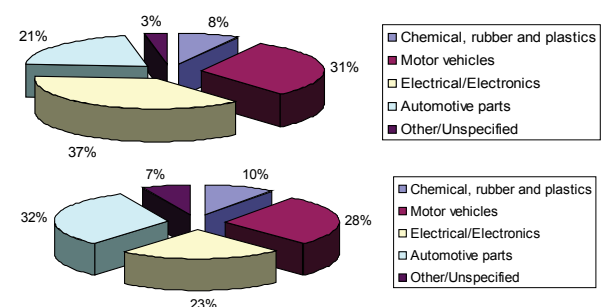


Figure 8 Percentage of industrial robot annual supply and operational stock by industrial branches in Asia/Australia in 2010

The industrial robot application trend at annual level in the last three years is the following: in 2008 with 60 294 units, in 2009 with 30 117 units and in 2010 with 69 833 units. The sudden fall of application in 2009 is caused by the financial industrial crisis. When considering total industrial robot application in the last three years in Asia, the trend has been slightly decreasing.

4 Industrial robot application analysis in countries of Asia/Australia in different manufacturing processes

In Tab. 3, the annual and total industrial robot application in Asia/Australia is shown, from 2008 ÷ 2010.

When considering the total application in 2010, in Asia /Australia the number of industrial robots is slightly higher regarding the year 2009, the difference is negligible. In handling jobs 32 %, welding 28 %, but when analysing the application by industrial branches, the

The countries are ranked by the highest total industrial robot number in 2010, so the first place is taken by the Republic of Korea, although the highest number of industrial robots was applied in Japan.

Tab. 3 shows that the first place in industrial robot applications is taken by the Republic of Korea in 2010 with 23 508 units, then comes Japan with 21 903 units, and the Republic of China takes the third place with

14 978 robot units. After them come the following countries: Taiwan with 3290 units, Thailand with 2450 units, Singapore with 777 units, India with 776 units, Malaysia with 677 units, Indonesia with 357 units. The other countries not mentioned here but belonging to the Asian continent take 401 units of robot applications in 2010. Australia also applied 716 units of the industrial robots in 2010.

Table 3 Annual supply and operational stock of industrial robots in Europe in 2008 ÷ 2010 [6, 7]

Country/Year	Annual supply of industrial robots			Operational stock of industrial robots		
	2008	2009	2010	2008	2009	2010
Republic of Korea	11 572	7839	23 508	76 923	79 003	101 080
Japan	33 138	12 767	21 903	356 000	333 000	286 000
China	7879	5525	14 978	31 787	37 312	52 290
Taiwan	3359	1474	3290	23 640	24 365	26 896
Thailand	1585	774	2450	6340	7832	9746
Singapore	198	398	777	3690	3824	4738
India	883	363	776	3716	4079	4855
Malaysia	370	209	677	2850	2984	3245
Indonesia	176	130	357	1242	1641	2213
Other Countries	299	129	401	2098	2343	2867
Australia	837	509	716	6714	6697	7660
Total:	60 294	30 117	69 833	515 000	501 000	499 000

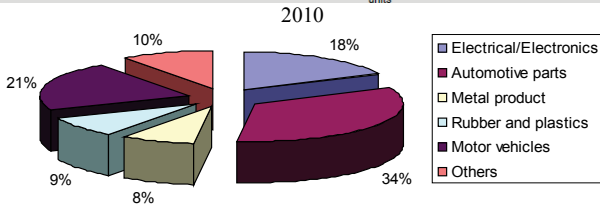
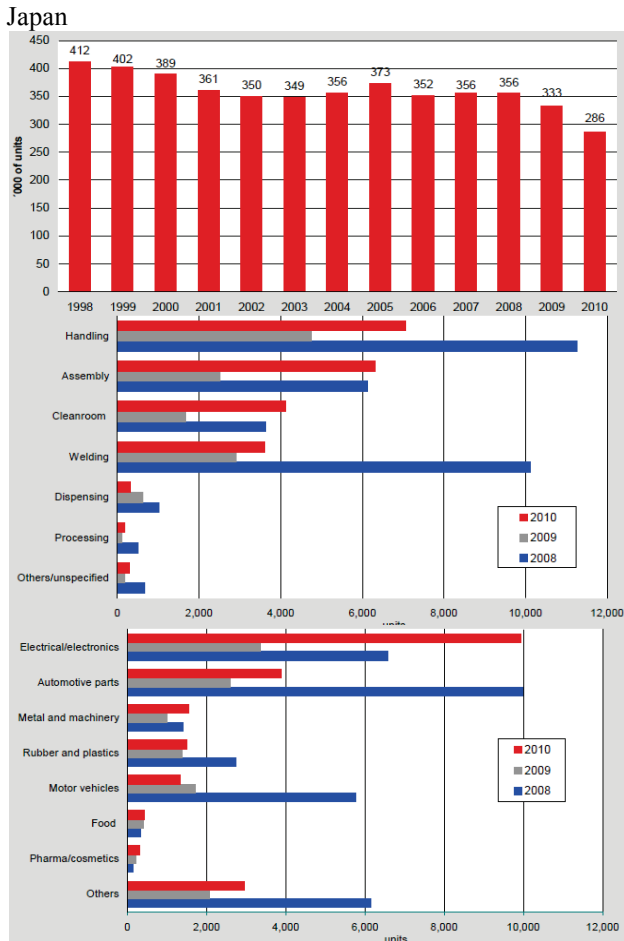


Figure 9 Estimated annual supply of industrial robots by application areas and industrial branches in Japan [6]

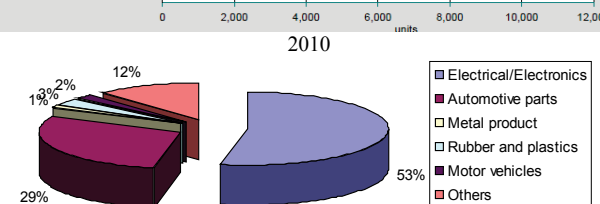
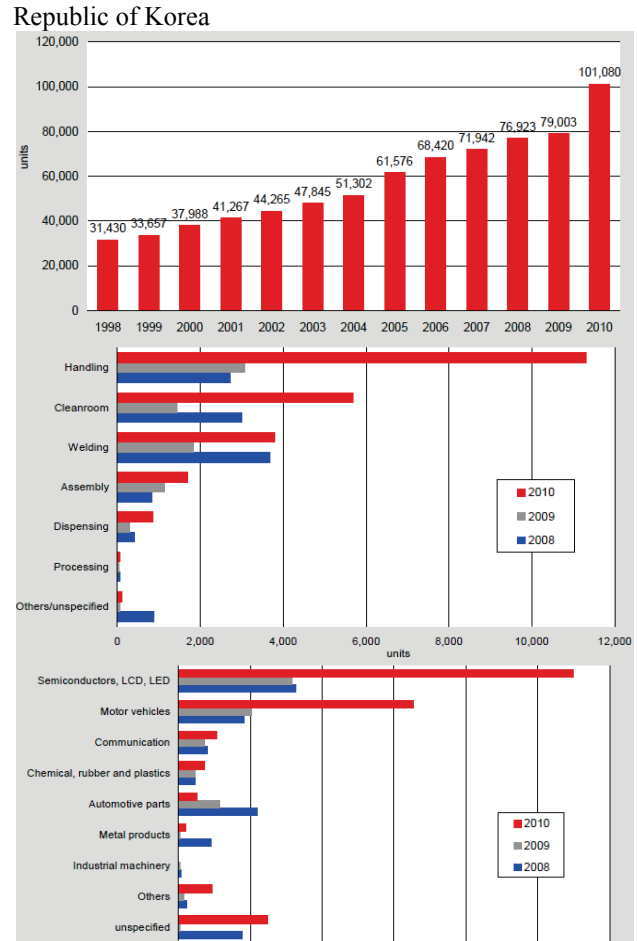


Figure 10 Estimated annual supply of industrial robots by application areas and industrial branches in the Republic of Korea

When it comes to the total robot applications in Asia, Japan takes the first place with 286 000 units, then comes the Republic of Korea with 101 080 units, China is the third with 52 290 units, and the fourth place is taken by Taiwan with 26 896 units.

Then the other countries: India, Singapore, Malaysia, Indonesia and the other countries not mentioned here but belonging to the Asian continent. The total number of the applied industrial robots in Australia is 7660 units. It is obvious here that China is one of the countries that triplicated their application of industrial robots in 2010 in relation to 2009, and doubled it in relation to 2008. It can be said that China is performing automation and modernization of its manufacturing process, and as the highest process of application in automobile and electro/electronic industry is in Asia, China is already developing those industries in order to be competitive on the market.

Republic of China

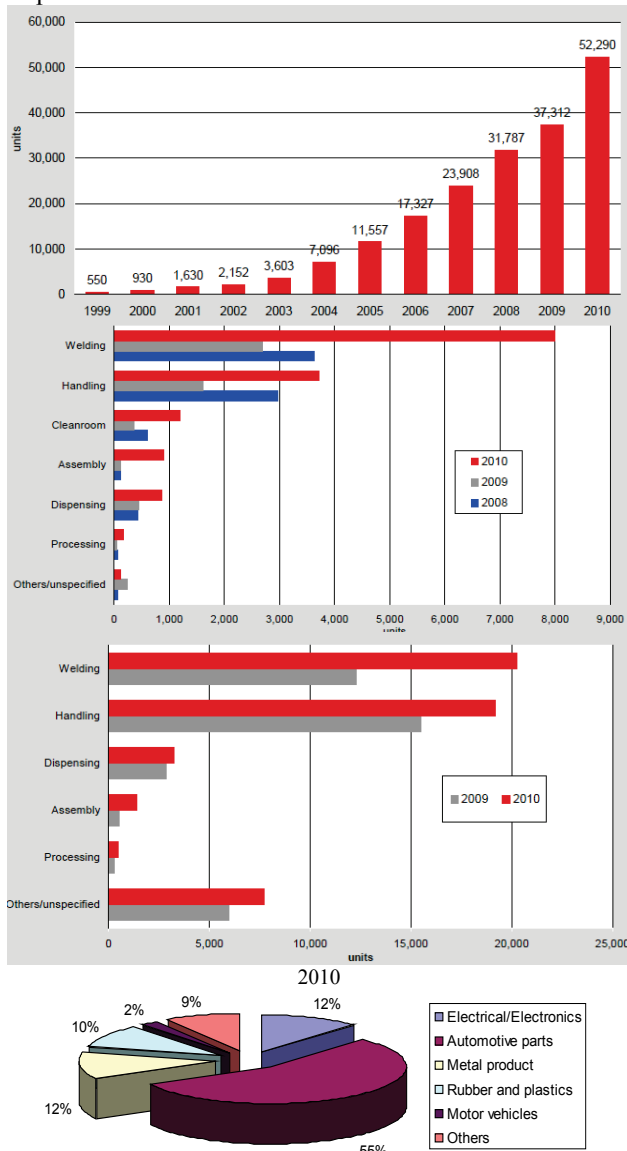


Figure 11 Estimated annual supply of industrial robots by application areas and industrial branches in the Republic of China [6]

In Figs. 9 ÷ 12 the industrial robot application trend for these four Asian countries is shown. According to Fig. 9, total number of industrial robots in the last three years

in Japan has the decreasing trend. In 2010, most of industrial robots were used for handling, assembly, dispensing and welding.

Taiwan

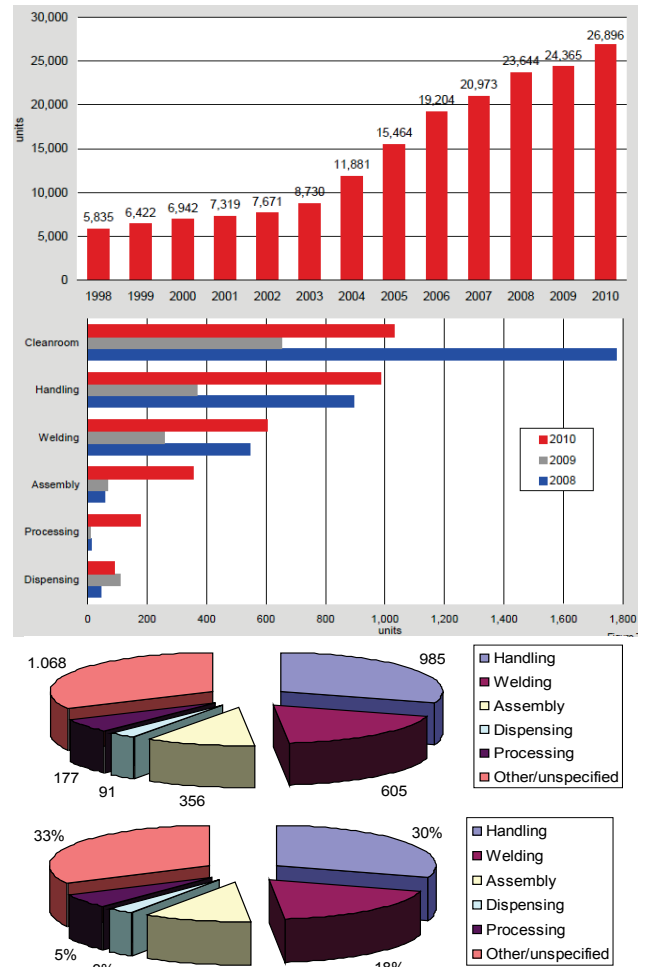


Figure 12 Estimated annual supply of industrial robots by application areas in Taiwan [6]

When considering the robot application in different industries, first comes the automobile industry with 34 %, then motor industry with 21 % and electro/ electronic industry with 18 % of total robot applications in 2010. Fig. 10 shows that the total number of industrial robots in the last three years in the Republic of Korea has an increasing trend. In 2010, the highest number of industrial robots was applied in electro industry with 53 %, then in automobile industry with 29 % of total robot applications.

Fig. 11 shows that the total number of industrial robots in the last three years in China has an increasing trend. When analysing the industrial robot applications, the automobile industry takes the first place with 55 %, metal industry follows with 12 %, rubber and plastic with 10 % of the total robot applications in 2010. When it comes to Taiwan, in the last three years the industrial robot application increased, in the welding process by 18 %, handling process by 30 %, assembly process by 11 % and processing process by 5 % of the total applied robots in 2010.

5 Conclusion

According to the performed analysis it is obvious that Asia/Australia takes the first place by the number of industrial robot applications in the world, at the annual and total level. In Asia/Australia the industrial robot application trend from 1998 ÷ 2010 is in constant increase at the total level from 2002 ÷ 2008. In the last three years there was a slight fall at the total level, and the annual level of robot application was different, and the least was in 2001, 2002 and 2009, where the minimal robot application was recorded in the last twelve years with 31 117 units. It happened due to the financial industrial crisis. In 2010 were applied 69 833 units of the new industrial robots, which is by 130 % higher than in 2009.

The handling jobs amount to 41 % and welding to 30 % at the annual level, also in automobile industry 21 %, then in electro industry 37 % and in chemical industry 8 % of more applied industrial robots. The Republic of Korea takes the first place in industrial robot applications in 2010 with 23 508 units, then comes Japan with 21 903 units, and the Republic of China takes the third place with 14 978 robot units. After them come the following countries: Taiwan with 3290 units, Thailand with 2450 units, Singapore with 777 units, India with 776 units, Malaysia with 677 units, Indonesia with 357 units.

The other countries not mentioned here but belonging to the Asian continent take 401 units of robot applications in 2010. It is obvious here that China is one of the countries that triplicated its application of industrial robots in 2010 in relation to 2009, and doubled in relation to 2008. It can be said that China is performing automation and modernization of its manufacturing process, and as the highest process of application in automobile and electro/electronic industry is in Asia, China is already developing those industries in order to be competitive on the market. A complete analysis is given of the industrial robot applications in four countries: Japan, the Republic of Korea, China and Taiwan, which are leading countries in automation and modernization of the manufacturing process in Asia.

6 References

- [1] Bakšys, B.; Fedaravičius, A. Robotu Technika, Kaunas Technologija, Kaunas, 2004.
- [2] Rogić, M. Industrijski roboti, Mašinski fakultet Banjaluka, Banjaluka, 2001.
- [3] Doleček, V.; Karabegović, I. Roboti u industriji, Tehnički fakultet Bihać, Bihać, 2008.
- [4] Doleček, V.; Karabegović, I. Robotika, Tehnički fakultet Bihać, Bihać, 2002.
- [5] Nikolić, G.; Rogale, D.; Jerbić, B.; et al. Roboti, TTF Zagreb, Zagreb, 2008.
- [6] World Robotics 2010, United Nations, New York and Geneva, 2010.
- [7] World Robotics 2008, United Nations, New York and Geneva, 2008.
- [8] World Robotics 2006, United Nations, New York and Geneva, 2006.
- [9] Wolka, D. W. Roboter sisteme, Technische Universität des Saarlandes im Stadtwald, 1992.
- [10] Freund, E.; Stern, O. Robotertechnologie I, Institut für Roboterforschung, Dortmund, 1999.

- [11] Karabegović, I.; Karabegović, E.; Husak, E. Comparative analysis of the industrial robot application in Europe and Asia. // International Journal of Engineering & Technology IJET-IJENS, 11, 01(2011).
- [12] Tsai, L. W. Robot Analysis: The Mechanics of Serial and Parallel Manipulators, John Wiley & Sons, Inc, 1999.
- [13] Karabegović, I.; Jurković, M.; Doleček, V. Primjena industrijskih robota u Evropi i Svijetu.// 30. savetovanje proizvodnog mašinstva, Vrnjačka Banja, SCG, 2005, pp. 29-45.
- [14] Shimon Y. Nof, Handbook of Industrial Robotics, 2nd Edition, 1999.
- [15] Karabegović, I.; Doleček, V.; Jurković, M. Application of Industrial robots in small and medium sized enterprises. // 1st International Scientific Conference on Engineering MAT 2010, Mostar 18-20. November, pp. 1-7.
- [16] Doleček, V.; Karabegović, I. Diseminacija robota, uvodni referat. // 5th International Scientific Conference on production Engineering Development and Modernization of Production RIM 2005, Bihać, 2005, pp. 3-20.

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