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**Market and supplier study on
European robotics, service robotics**

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Executive summary

During the previous years, service robotics statistics has been continuously developed. While the statistical data, published in the World Robotics Yearbook has found increasing interest among media, funding agencies, investors and technology scouts, it was felt that for effective policy making some facets are missing such as data for the categorization of the supply side economics. Since many of these service robotics companies are start-ups it is of particular interest to statistically monitor this innovation driven industry in terms of growth, job creation etc. in order to define measures to effectively fuel sustainable start-up creations and general industrial innovation for economic growth and quality jobs. Currently, Fraunhofer IPA is monitoring more than 600 service robotics companies worldwide. These include about a third categorized as start-up which means the company is not older than five years and technology-driven.

The objective of this continuous activity in RockEU2's task 1.4 "Market Observatory" (started in M7) is to provide a solid basis of data from a European perspective regarding robotics market data, basic business structural data of European robot suppliers, particularly in the fragmented service robotics domain for fuelling the RockEU2 activities particularly in its road-mapping, entrepreneurial and tech-transfer-related aspects. Furthermore, this task is dedicated to providing this information to stakeholder groups and media in regular updates. This extension of service robotics statistics will primarily build on the existing and established work of market observation and surveys, statistics and forecasts provided by the annual World Robotics Report (particularly the service robotics section), but will also be complemented by other public and commercial data sources.

After the elaboration of a revised statistical scheme described in deliverables of the previous RockEU project (e.g. D3.1.2 in RockEU in July 2015 and July 2016) this deliverable D1.7 adds recent developments and data: The result of the data collection between January and June 2016 became available for the first time in Oct 2016 in an executive summary for immediate communication to the European robotics community, the EC, interested media (e.g., as a download). Currently this year's data collection is being completed with the publication of all material expected end of September 2017. The goal of this year's data collection will be providing national surveys for the first time.

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1. Introduction

Coordination of research and development, technology transfer and entrepreneurial activities in robotics should be based on current market developments, reliable forecasts and solid long-term trends. These data should be completed with data characterizing the supply side of service robotics (SR) through structural business statistics.

This will be of particular relevance for the road-mapping process (see WP1 of RockEU2) with respect to the prioritization of measures and policies related to technologies, innovation, public procurement, ELS-issues, and standardization. Furthermore, consistent and comparable statistical material on market data and forecasts, as well as on critical demands and trends is not only valuable for any type of communication (from scientific/technical publications to dissemination and PR), but very much in demand by any stakeholder group and the media in particular.

During the previous years, service robotics statistics has been well developed through the International Federation of Robotics IFR, particularly through its Statistical Department; www.worldrobotics.org, and the continuous development of the statistics base has been an important asset to all strategic planning in euRobotics.

While the statistical data, published in the World Robotics Yearbook, has been well received by media, funding agencies, investors and technology scouts, it was felt that for effective policy making some facets are missing, such as data for the categorization of the supply side, i.e. service robot manufacturers. Since many of these companies are start-ups it is of particular interest to statistically monitor these in terms of growth, job creation etc. to define measures to effectively fuel sustainable start-up creations. Within the last months, Fraunhofer IPA has widened its data basis: currently, the institute is monitoring more than 600 robotics companies worldwide. These include about a third categorized as start-up which means the company is not older than five years and technology-driven.

The objective of "Market Observatory" is to provide a solid basis of data from a European perspective regarding robotics market data (status, forecasts and major trends), basic business structural data of European robot suppliers, particularly in the fragmented service robotics domain (professional and domestic) and overall opportunities and trends for the activities in RockEU2. Furthermore, this task is dedicated to providing this information to stakeholder groups and media in regular updates.

This extension of service robotics statistics will not only build on the existing and established work of market observation and surveys, statistics and forecasts provided by the annual World Robotics Report (particularly the service robotics section), but will also be complemented by other public and commercial data sources (e. g. Eurostat, UNECE, OECD) where appropriate.

After the elaboration and introduction of a revised statistical scheme it is planned to extend the IFR questionnaire by additional items and carry out a structural business survey. The result will be an annual report including an executive summary for immediate communication to the robotics community, interested media or other interested audiences (e.g., as a download).

2. Status regarding “market and society observations”

The service robotics classification scheme had been introduced in previous CSA RockEU-Deliverables D3.1.1 and updated in the follow-up D3.1.2. There it was pointed out how information on past and projected and international sales of service robotics would be extended through a scheme to collect and structure data in what concerns the service robotics supply side.

The data for the previously published World Robotics Report which was published on a press conference in South Korea on Oct. 12, 2016 were collected from January 2016 to June 2016. Again, the categorization scheme which separates service robot applications or application domains was slightly modified to match typical robot types. Also, more than 200 new companies were added to the chart of worldwide robot manufacturers sorted by country and by market field.

2.1. Report on recent service robotics data

A picture of the recent service robotics data is given in Figure 2-1. The whole field shows a strong growth and technology burst. This can also be stated with respect to the more than US\$1 billion venture capital that has been invested in this market. First eco-systems are being formed to facilitate the networks of end-users, suppliers and technology partners and also to offer new services or technology consulting. Strong facilitators for this are mature multi-purpose hardware platforms and more open-source software systems benefiting start-ups.

The total number of professional service robots sold in 2015 rose by a 25% compared to 2014 to 41,060 units up from 32,939 in 2014. The sales value remarkably increased by 14% to US\$4.6 billion. Since 1998, a total of about 220,000 service robots for professional use have been counted in these statistics. Furthermore, about 5.4 million service robots for personal and domestic use were sold in 2015, 16% more than in 2014. The value of sales remained constant at US\$2.2 billion.

The principal area of application for these service robots is the logistics sector, which posted a 50% increase in the number of systems sold to 19,000 units and, with 53% growth between 2016 and 2019, is set to continue along the road to success. A large share of this positive development is attributable to the use of driverless transport systems in production, retail and hospitals. Other high-selling sectors include agriculture, such as robots for milking or cultivation, healthcare, including for operations, diagnostics and rehabilitation, and public safety.

Turning to the general projections for the period 2016-2019, sales forecast indicate an increase to about 333,200 units with a value of US\$23.1 billion. In the case of robots for personal use about 42 million units of service robots for personal use are to be sold worldwide.

It is expected, due to the currently high demand and public visibility of robotics that all indicated sales forecasts will be exceeded.

Europe still strong in the professional service robots domain

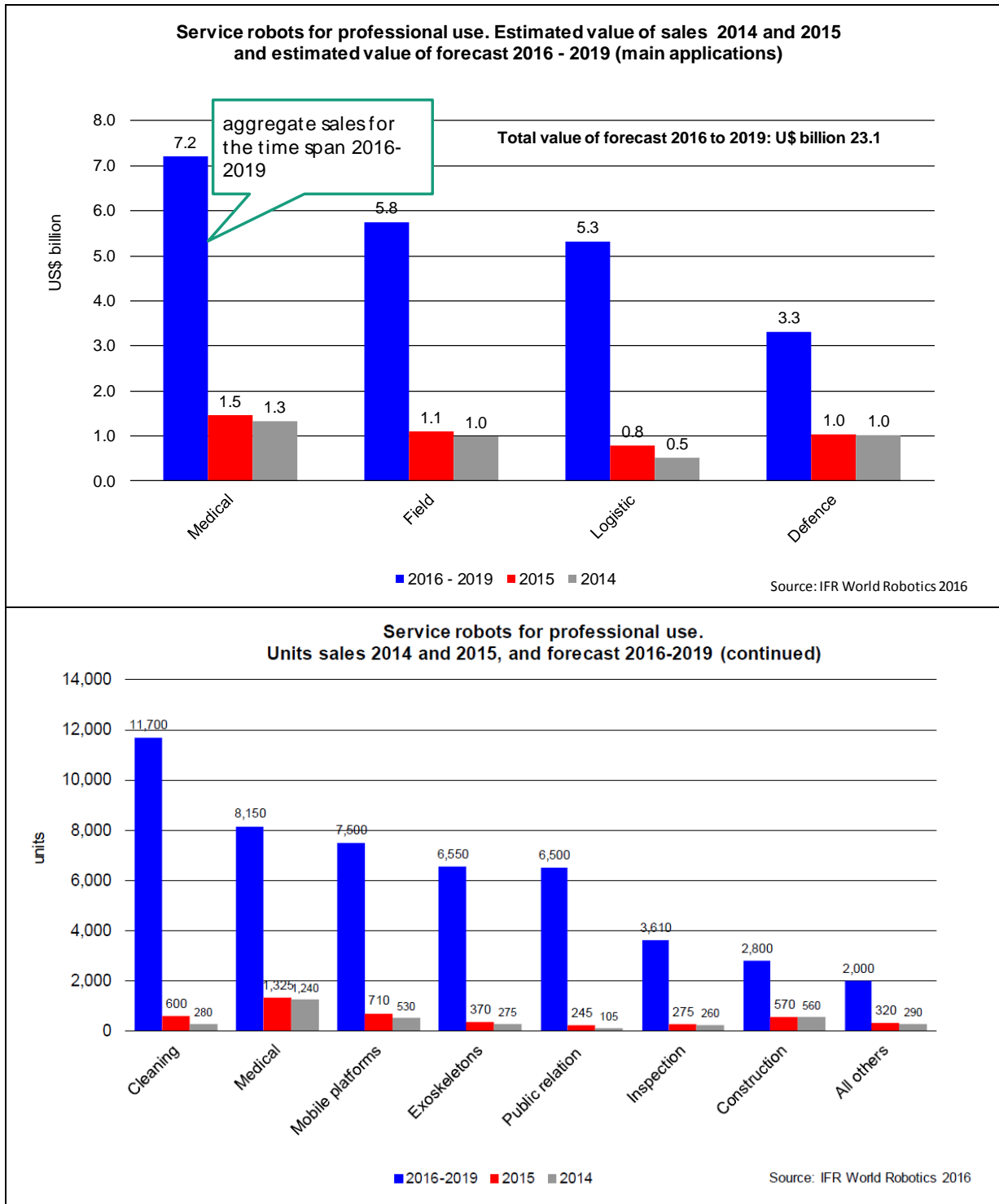
The statistical evaluation reveals that almost 38% of the professional service robots originated from Europe with most field robots produced in Europe (about 91% of the global supply in 2015). Some 55% of all service robots for professional use came from the Americas, most of them being defence-related robots. In the field of medical robotics, Europe (with 48%) and America (with 51%) are almost equal. However, in 2015 most of the inspection and maintenance systems came from Asia, about 62%. Also about 42% of the logistic systems were sold by Asian companies. Sales of professional service robots increased in Europe by 7% and in the Americas by 36%. In Asia sales doubled compared to 2014 counting however for a share of only 7% of the total supply. The high increase was partly due to a better coverage in 2015.

Service robots for private and domestic use: Growth mainly outside of Europe

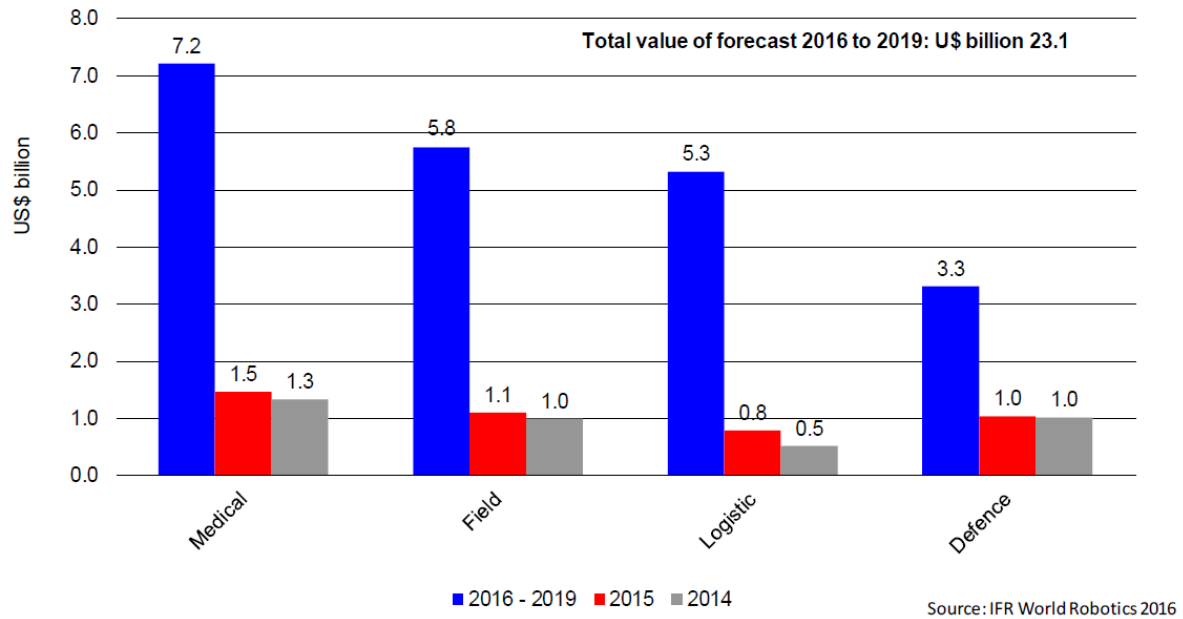
The distribution of personal/domestic robots by region of origin is more different. In 2015, about 44% were sold by American companies with the overwhelming share of robots being vacuum and floor cleaners. In 2015, the number of units of robots for domestic tasks increased by 16% compared to 2014. About 41% of all service robots for personal/domestic use were produced in Asia/Australia in 2015, up from 38% in 2014. The total number of robots units reported by Asia/Australia companies increased by some 55%. This was partly due to a better coverage of data. The major share of 58% of all reported entertainment robots are supplied by Asian/Australian companies. 42% came from

Europe. In total some 16% of the total supply of personal/domestic robots in 2015 was sold by European companies.

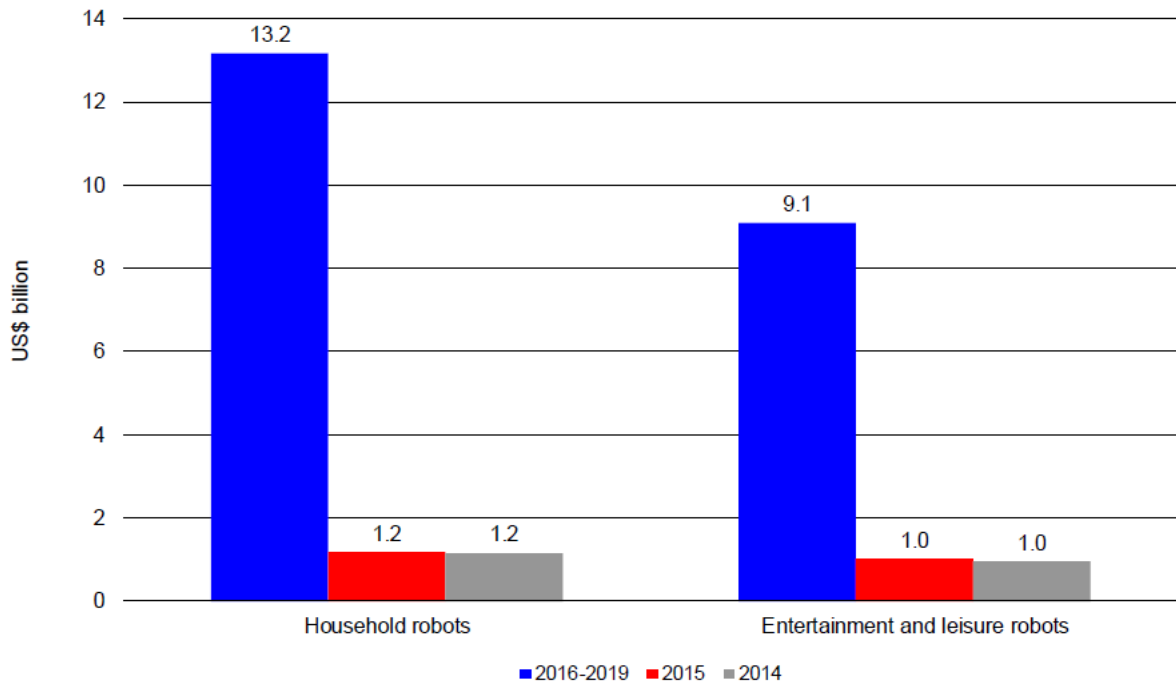
The reported data were communicated among the European Robotics stakeholders through email service and websites (e.g. <https://eu-robotics.net> , <http://www.eu-nited.net/robotics>). An extract of service robotics-related statistical data can be seen in Figure 2-1.



Service robots for professional use. Estimated value of sales 2014 and 2015 and estimated value of forecast 2016 - 2019 (main applications)



Service robots for personal/domestic use. Estimated value of sales 2014 and 2015, forecast 2016-2019



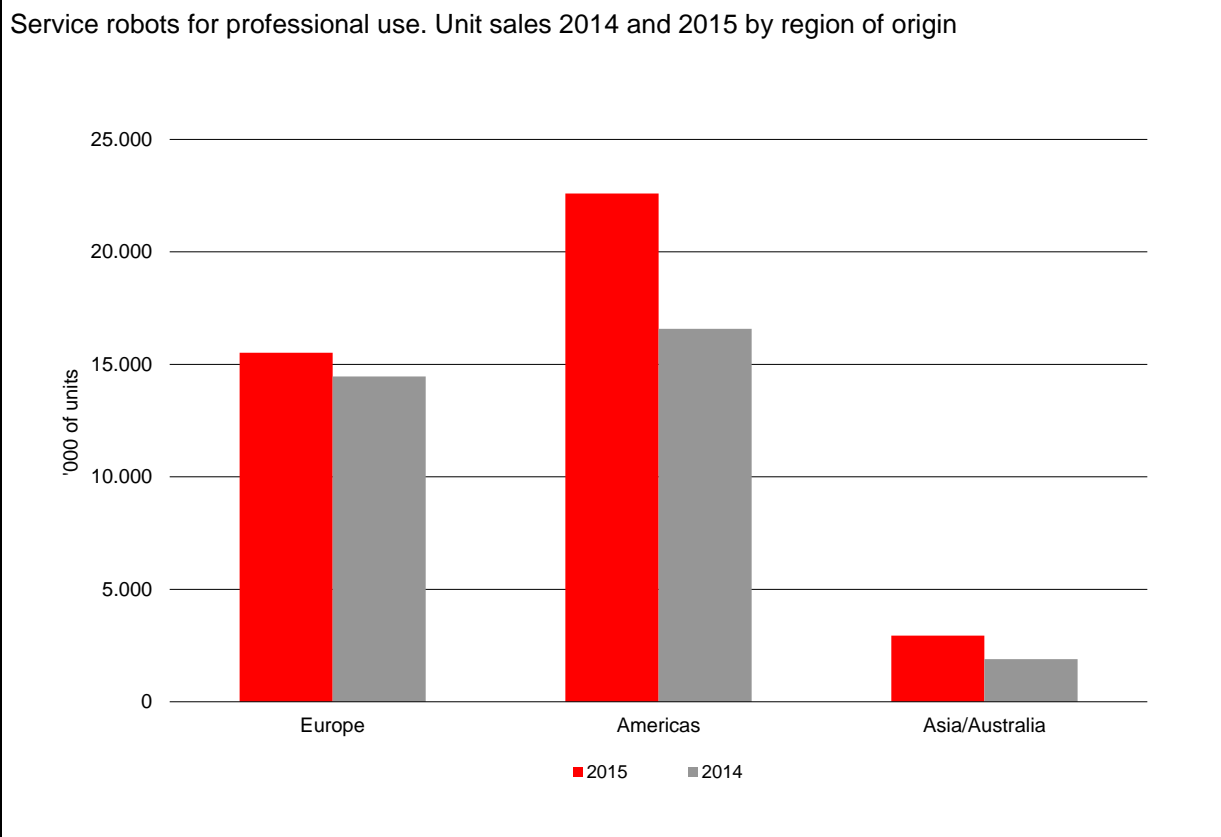
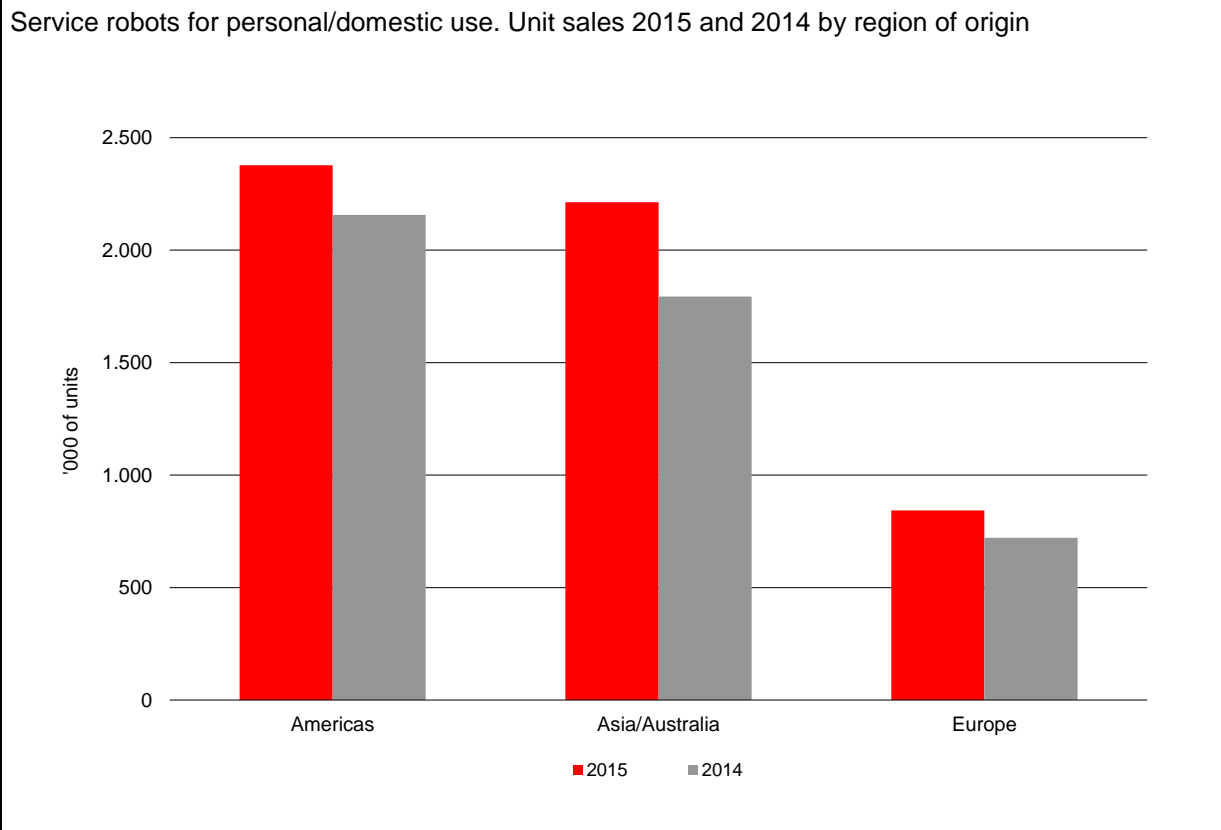


Figure 2-1: Service robot statistics as published and released in October 12, 2016

3. Retrieving Structural Business Statistics

Data currently retrieved by questionnaire among 300+ service robot manufacturers contain the following set of data, see Figure 3-1 and Table 3-1 (to be filled out by service robot suppliers):

Business information (will be treated confidentially)			
Start-up as service robot company/ start-up of service robot activities:			
Start of commercial activities in service robotics:			
Number of employees related to service robotics in 2016:		expected in 2017:	

Your comments on the reported data or on the survey as a whole:

* Compound Annual Growth Rate = average annual growth rate

		Robots sold in 2016					Robots sold in 2016					Projected sales in 2017		Projected sales in 2018-2020	
		number of units					turnover in millions of national currency					Forecast for your company		Forecast for your company	
		Europe	America	Asia/Pacific	others	Total	Europe	America	Asia/Pacific	others	Total	number of units total world	total turnover in millions of national currency	CAGR* units	CAGR* turnover
I	Personal/Domestic Robots	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	0	0,000	0%	0%
1-6	Robots for domestic tasks	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	0	0,000	0%	0%
1	- Robot companions / assistants / humanoids													0%	0%
2	- Vacuuming, floor cleaning													0%	0%
3	- Lawn mowing													0%	0%
4	- Pool cleaning													0%	0%
5	- Window cleaning													0%	0%
6	- Home security & surveillance													0%	0%
7	- Others													0%	0%
8-11	Entertainment robots	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	0	0,000	0%	0%
8	- Toy/hobby robots													0%	0%
9	- Multimedia													0%	0%
10	- Education and research													0%	0%
11	- Others													0%	0%
12-14	Elderly and handicap assistance	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	0	0,000	0%	0%
12	- Robotized wheelchairs													0%	0%
13	- Personal aids and assistive devices													0%	0%
14	- Other assistance functions													0%	0%
16	Other personal/domestic robots													0%	0%
II	Professional service robots	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	0	0,000	0%	0%
17-22	Field robotics	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	0	0,000	0%	0%
17	- Agriculture (broad acre, greenhouse, fruit-growing, vineyard)													0%	0%
18	- Milking robots													0%	0%
19	- other robots for livestock farming													0%	0%
20	- Mining robots													0%	0%
21	- Space robots													0%	0%
22	- Others													0%	0%
23-27	Professional cleaning	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	0	0,000	0%	0%
23	- Floor cleaning													0%	0%
24	- Window and wall cleaning (including wall climbing robots)													0%	0%
25	- Tank, tube and pipe cleaning													0%	0%
26	- Hull cleaning (aircraft, vehicles, etc.)													0%	0%
27	- Other cleaning tasks													0%	0%
28-30	Inspection and maintenance systems	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	0	0,000	0%	0%
28	- Facilities, plants													0%	0%
29	- Tank, tubes, pipes and sewers													0%	0%
30	- Other inspection and maintenance systems													0%	0%
31-34	Construction and demolition	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	0	0,000	0%	0%
31	- Nuclear demolition & dismantling													0%	0%
32	- Building construction													0%	0%
33	- Robots for heavy/civil construction													0%	0%
34	- Other construction and demolition systems													0%	0%
35-39	Logistic systems	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	0	0,000	0%	0%
35	- Autonomous guided (AGV) vehicles in manufacturing environments													0%	0%
36	- AGVs in non-manufacturing environments (indoor)													0%	0%
37	- Cargo handling, outdoor logistics													0%	0%
38	- Personal transportation (AGV for persons)													0%	0%
39	- Other logistics													0%	0%
40-43	Medical robotics	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	0	0,000	0%	0%
40	- Diagnostic systems													0%	0%
41	- Robot assisted surgery or therapy													0%	0%
42	- Rehabilitation systems													0%	0%
43	- Other medical robots													0%	0%
44-46	Rescue and security applications	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
44	- Fire and disaster fighting robots													0%	0%
45	- Surveillance/security robots without UAV													0%	0%
46	- Other rescue and security robots													0%	0%
47-51	Defense applications	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
47	- Demining robots													0%	0%
48	- Unmanned aerial vehicles													0%	0%
49	- Unmanned ground based vehicles (e.g. bomb fighting)													0%	0%
50	- Unmanned underwater vehicles													0%	0%
51	- Other defense applications													0%	0%
52	Underwater systems (civil/general use)													0%	0%
53	Powered Human Exoskeletons													0%	0%
54	Unmanned aerial vehicles (general use)													0%	0%
55	Mobile Platforms (general use)													0%	0%
56-60	Public relation robots and joy rides	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	0	0,000	0%	0%
56	- Hotel and restaurant robots													0%	0%
57	- Mobile guidance, information robots, telepresence robots													0%	0%
58	- Robots in marketing													0%	0%
59	- Robot joy rides													0%	0%
60	- Others (i.e. library robots)													0%	0%
61	Other professional service robots not specified above	0	0	0	0	0	0,000	0,000	0,000	0,000	0,000	0	0,000	0%	0%
-														0%	0%
-														0%	0%

Table 3-1: Template for accessing data according to application/business categories Figure 3-1

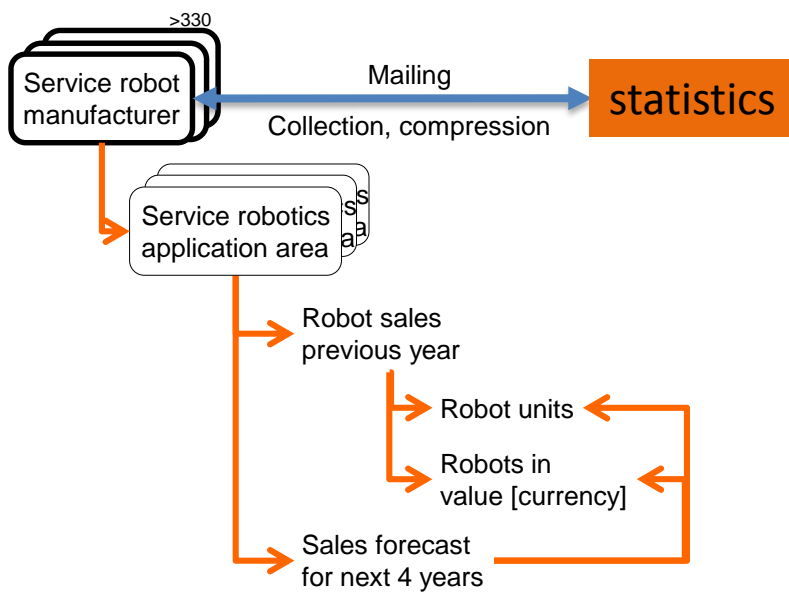


Figure 3-1: Extension of currently retrieved service robotics data (orange) by new data categories regarding industry structure (blue)

4. Service Robotics Manufacturers Overview

Figure 4.1 to Figure 4.5 inform about the distribution of service robot manufacturers worldwide.

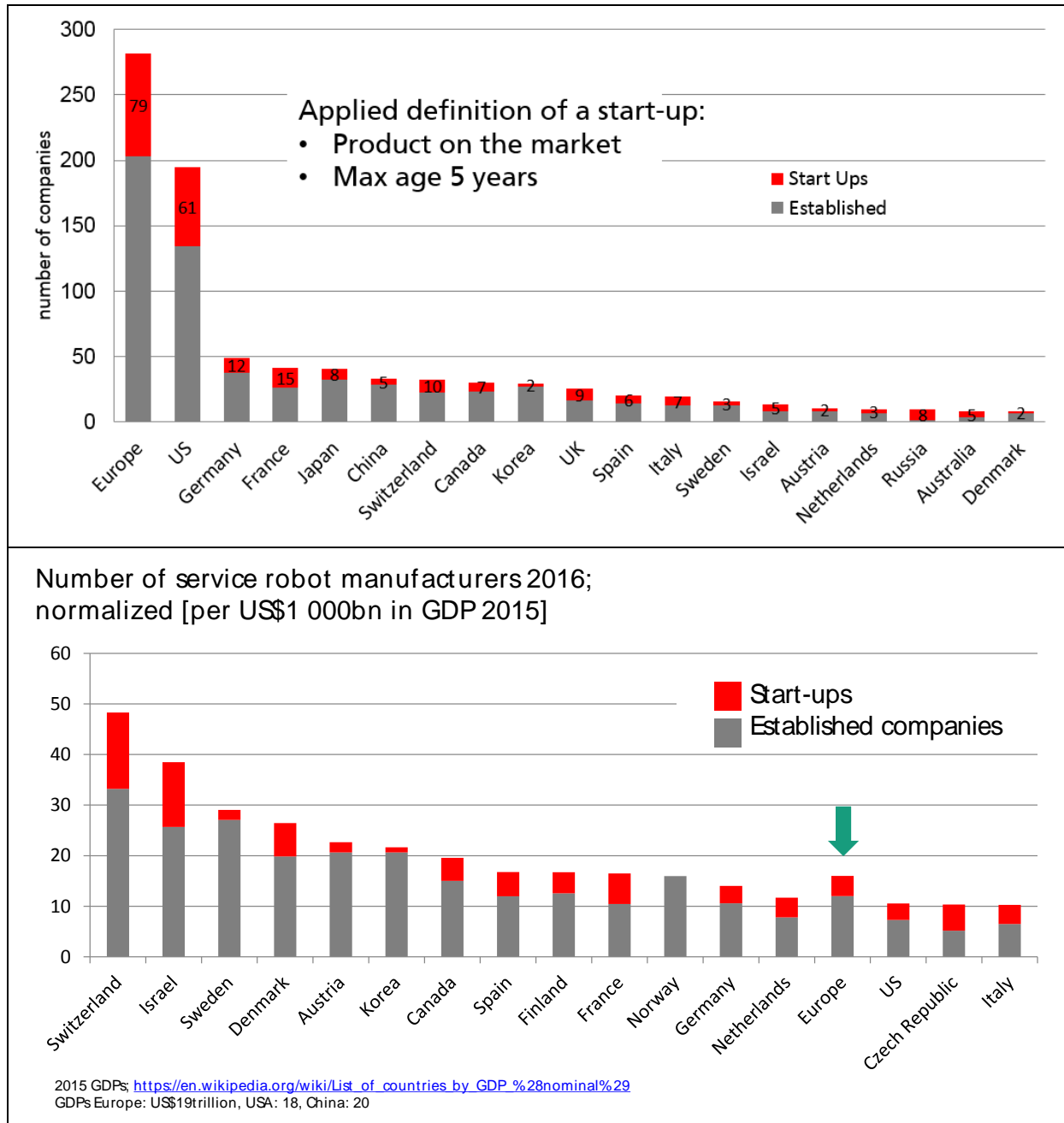


Figure 4.1: Number of service robot manufacturers of all types (Professional and Personal/Domestic Use) by country (worldwide); total is 625; and service robotics start-up density in various countries (density = number of start-up in countries per US\$1,000bn GDP)

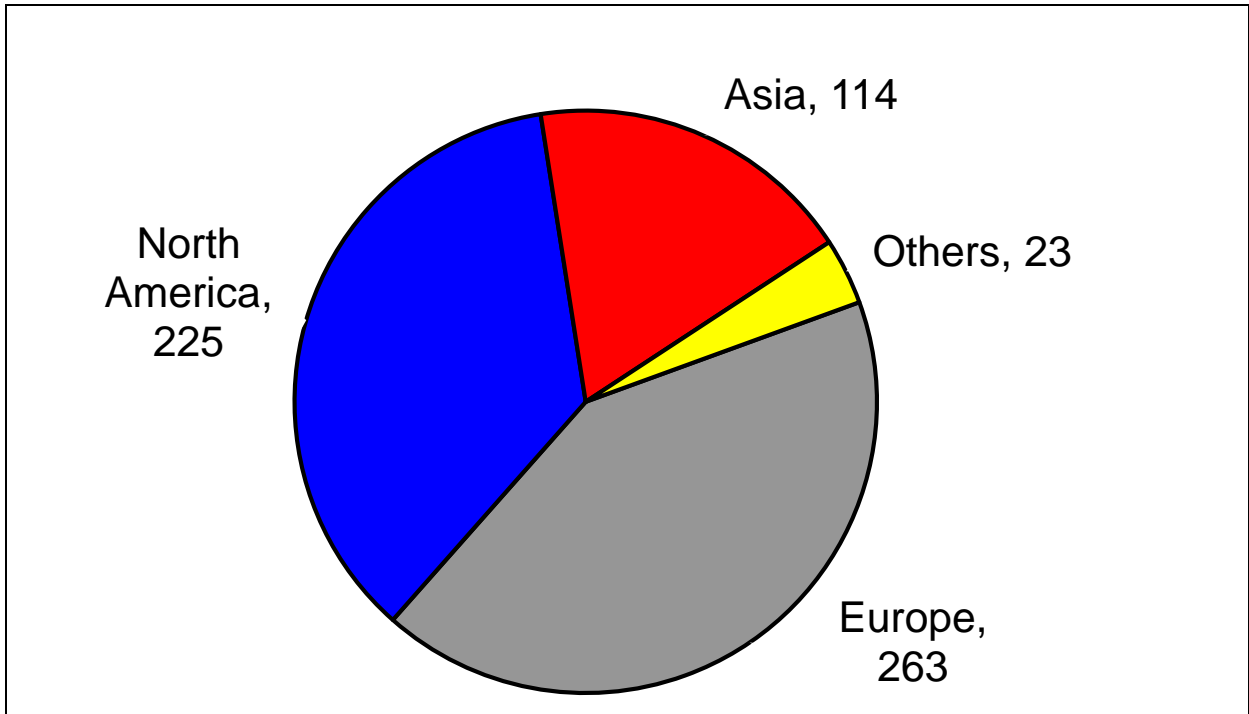


Figure 4.2: Number of service robotics manufacturers of all types by region of origin.

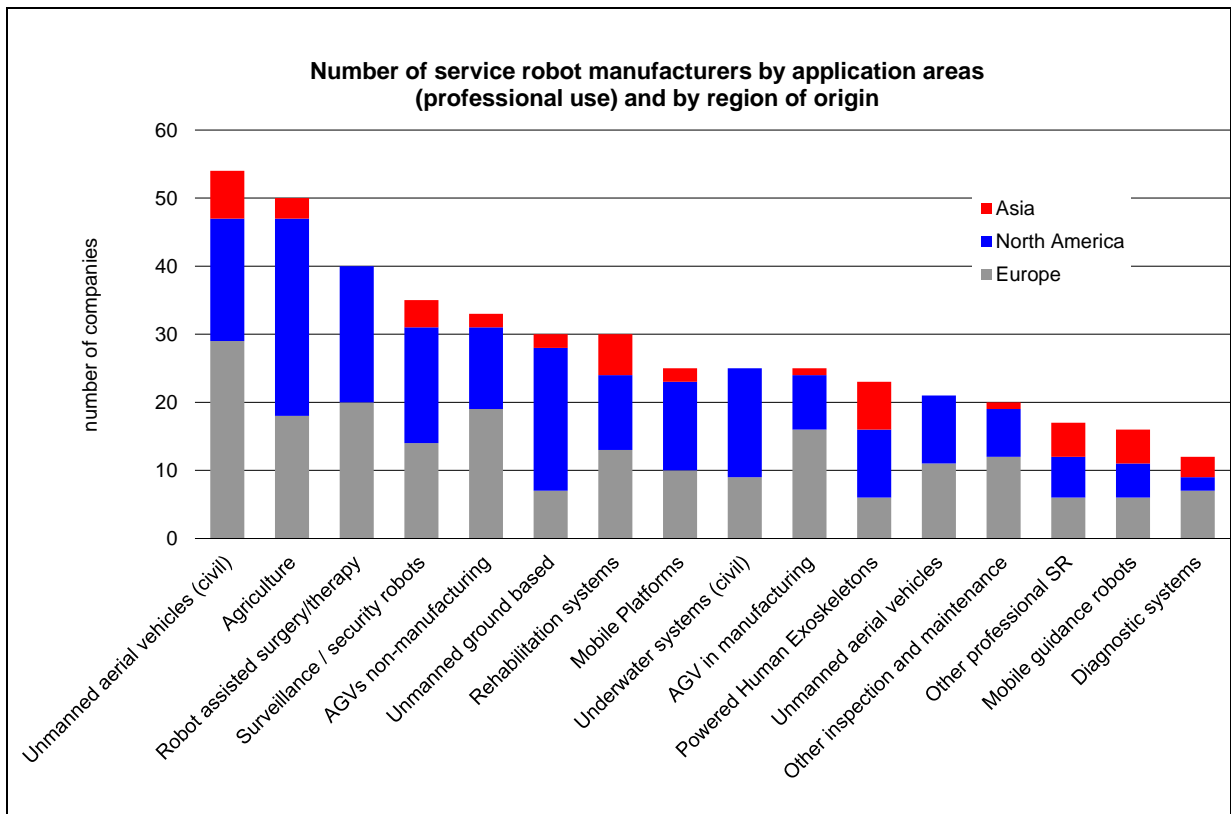


Figure 4.3: Number of service robot manufacturers for professional use (main types) by region of origin.

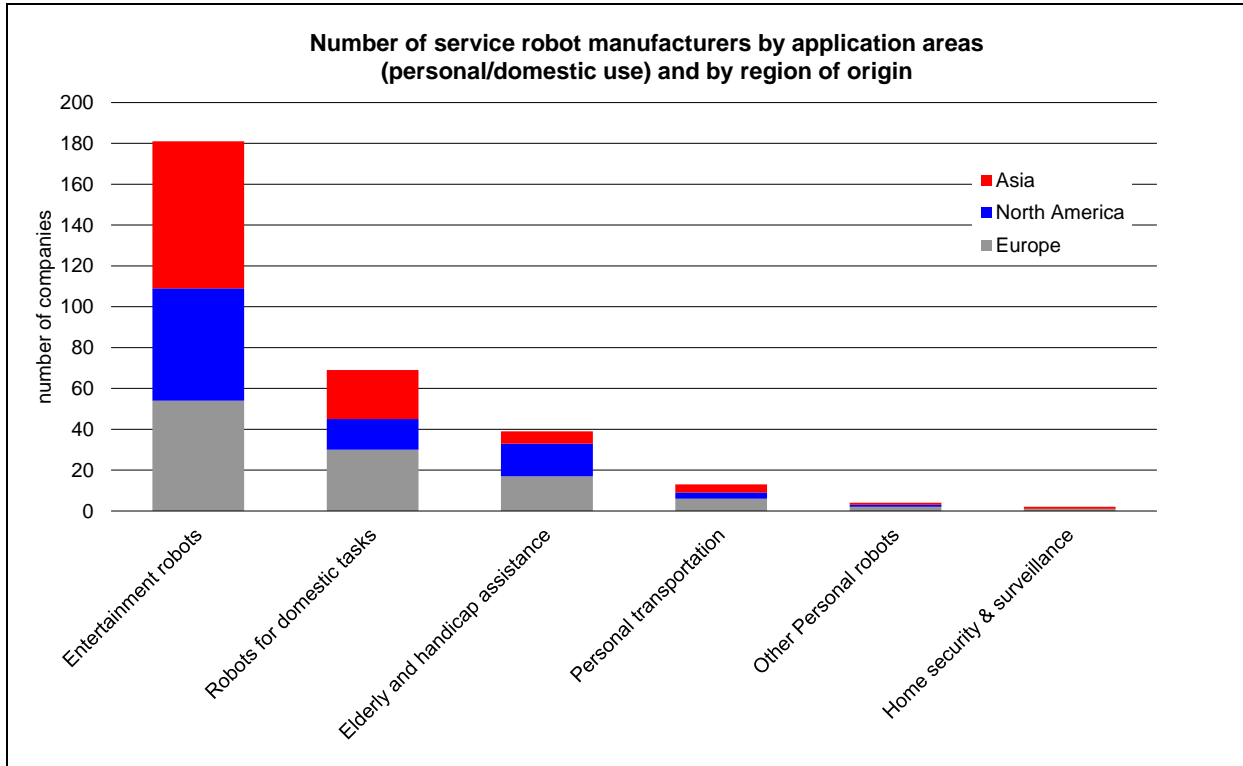


Figure 4.4: Number of service robot manufacturers for (main types for personal/domestic use) by region of origin.

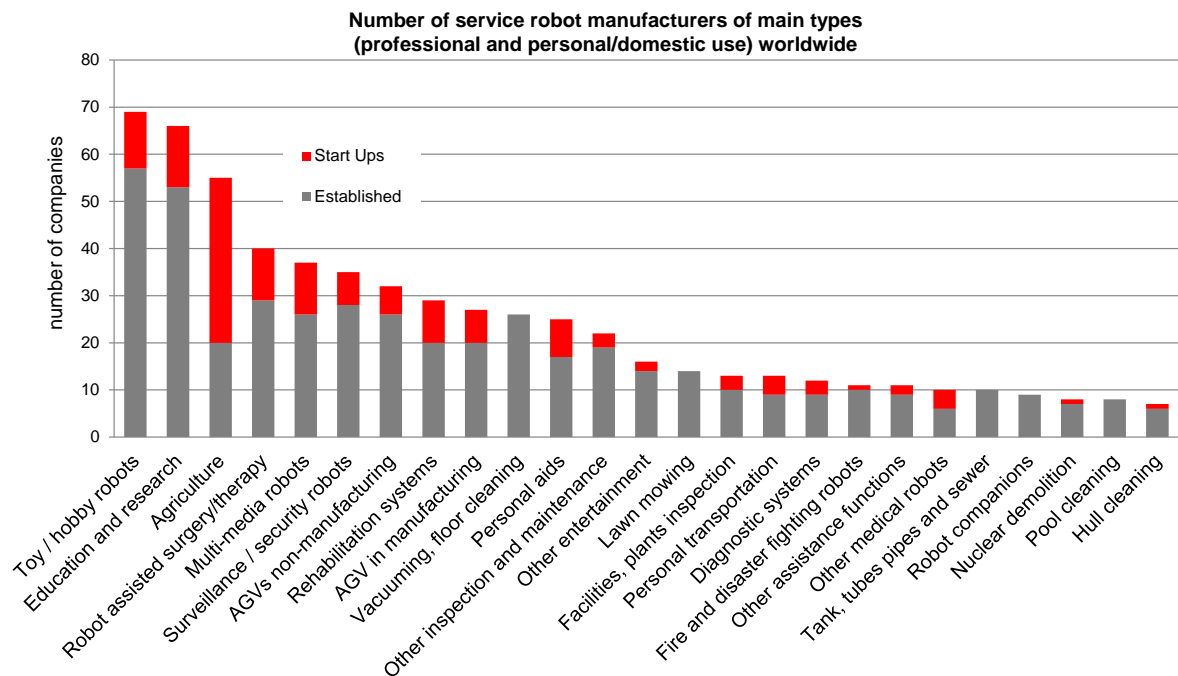


Figure 4.5: Number of service robot manufacturers of all types (professional and personal/domestic use) worldwide categorized as start-up or established company.

5. Some Observations and further outlook

In conclusion we see significant change in the service robotics domain which we anticipate to continue for the long term:

- Service robotics: strong growth and technology burst
- 625+ companies world wide developing/supplying service robots
- Major field of start-up activities (185/625→28+%, >>US\$1bn2015 in VC investment)
- First eco-systems being formed (networks of end-users, suppliers, technology partners, application modules/packages, services, consulting) in the following fields:
 - Mobile robot platforms
 - Unmanned aerial vehicles/multi-copter/drones
 - Strong facilitators for ecosystems are seen to be the combination of mature multi-purpose hardware platforms and open source software-systems, particularly to fuel start-ups
 - European potential for further growth: Logistics, health, but also domestic/personal robotics should be more in the focus.

The procedure of collecting data and producing the new statistics is shown in the Figure 5-1.

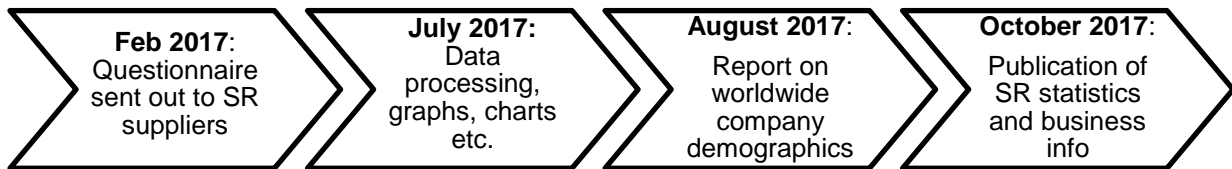


Figure 5-1: Procedure for producing national, EU-wide surveys.

The final goal in collecting, reviewing and disseminating statistics remains unchanged. Our goal is to implement a statistical scheme that will be adopted by national robotics organisations to collect and pre-process data locally and provide these for international survey and benchmarks.

6. References

- [1] „Structural business statistics (sbs); Reference Metadata in Euro SDMX Metadata Structure (ESMS). Compiling agency: Eurostat, the statistical office of the European Union,“ [Online]. Available: http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/DE/sbs_esms.htm. [Zugriff am 1 July 2014].
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