SCOPING REVIEW

1. STATISTICS AND TRENDS IN SOCIAL ROBOT

UNIVERSITY OF VALENCIA

Almudena Navas Saurin[1]

Míriam Abiétar López[1]

Esperanza Meri Crespo[1]

Elisabet Marco Arocas[1]

Salomé Carvajal Ruiz[1]

Arantxa Grau Muñoz[1]

Dennis Reidsma[2]

Daniel Davison[2]

Edwin Dertien[2]

Bob R. Schadenberg[2]

Cristina Zaga[2]

Lonneke Kolkman[2]

1. Introduction 2
2. Statistical data available 3
3. Research on Social Robotics funded by EU 5
4. Trends on Social Robotics 14
   a. Education 14
   b. Autism Spectrum Condition 16
   c. Pets and Companion Robots for Eldery People 17
   d. Other 18
5. Conclusions 18

[1] University of Valencia (Spain)
[2] University of Twente (The Netherlands)

1. Introduction

This paper is written in order to produce a Scoping Paper on Statistical information and trends in the use of Social Robots in the social professions. It is produced in the context for the EU Erasmus+ PRoSPERo project which specifically addresses the implications of this development for the education of future professionals in the following domains: child care, early childhood education, elderly care, nursing, social education, social work, special needs education, etc.

Following Share and Pender[3] (2018), social robotics refers to robots in the field of caring and social Professions. Care focused robots may be divided in 3 main types:

- ATs, Assistive technologies
- ALTs, Assisted Living Technologies
- Social Robots

Following Belpaeme, Kennedy, Ramachandran, Scassellati and Tanaka4 (2018) Social robots can be used in education as tutors or peer learners. They review in their paper how social robots are used in education, and addressed the issue to those robots that were intended to deliver the learning experience through social interaction with learners, as opposed to robots used as pedagogical tools for science, technology, engineering and math education. In their journal article, recently published (August 2018), Belpaeme's team show a very interesting review of a meta-analysis conducted in order to gather insight on social robots. They use both cognitive and affective outcomes in order to measure the effectiveness of the robots for learning, and they present the following list used in order to develop their meta-analysis:

Table 1. Common measures for determining cognitive and affective outcomes in robots for learning.

Cognitive	Learning gain, measured as difference between pre- and posttest score
	Administer posttest either immediately after exposure to robot or with delay
	Correct for varying initial knowledge, e.g., using normalized learning gain (*77*)
	Difference in completion time of test
	Number of attempts needed for correct response
Affective	Persistence, measured as number of attempts made or time spent with robot
	Number of interactions with the system, such as utterances or responses
	Coding emotional expressions of the learner, can be automated using face analysis software (*47*)
	Godspeed questionnaire, measuring the user's perception of robots (*78*)
	Tripod survey, measuring the learner's perspective on teaching, environment, and engagement (*79*)
	Immediacy, measuring psychological availability of the robot teacher (*3, 10*)
	Evolution of time between answers, e.g., to indicate fatigue (*31*)
	Coding of video recordings of participants responses
	Coding or automated recording of eye gaze behavior (to code attention, for example)
	Subjective rating of the robot's teaching and the learning experience (*15*)
	Foreign language anxiety questionnaire (*80*)
	KindSAR interactivity index, quantitative measure of children's interactions with a robot (*81*)
	Basic empathy scale, self-report of empathy (*82*)
	Free-form feedback or interviews

We divided the content of the paper in several sections. First of all, we will present the statistical data available, then we will proceed to present a list of those projects funded by EU Horizon

[3] Share, P., and Pender, J. Preparing for a robot future? social professions, social robotics and the challenges ahead. *Irish Journal of Applied Social Studies* 18 (2018).
[4] Belpaeme, T., Kennedy, J., Ramachandran, A., Scassellati, B., & Tanaka, F. (2018). Social robots for education: A review. *Science Robotics*, *3*(21), eaat5954.

2020 that specifically addresses PRoSPERo object of study, the social robotics; nevertheless, we will present those projects involved with PRoSPERo goal that do not use social robotics in them. Last section before Ongoing Conclusions presents trends on the field of Social Robotics: this section has been produced in collaboration with the University of Twente team.

2. Statistical data available

Finding statistical data on the use of Social Robotics has been a quite challenging task if one would like not to pay for them. In fact, in Eurostat, our primary source in the European Union for data, there is little data related to the use of robots in social science, even less of social robotics. For instance, data found indicate the percentage of European enterprises using robots; in the figure below, we show the % of enterprises using service robots, but following the definition stated above, it seems not directly connected to our primary goal.

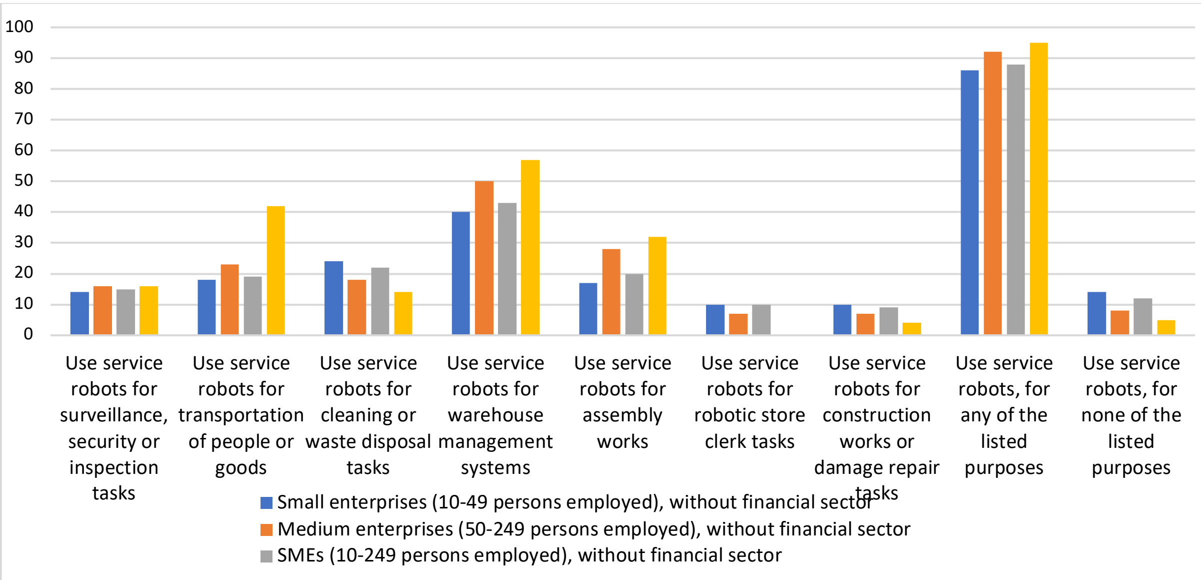

Figure 1: Use of service robots by enterprises in the EU, by purpose (% of enterprises using service robots). Source: Eurostat

On the other hand, a private source of Data, STATISTA, promises to provide much more data on the topic. In this portal there are several entries that may offer statistical data relevant to us; but it is paying site, and the University of Valencia do not have access to their data. The list of possible interesting data we may find in it when searched Social Robotics is:

1) Value of social and entertainment robot market worldwide from 2015 to 2025 (in billion U.S. dollars)*: The statistic shows the estimated value of the social and entertainment robot market from 2015 to 2025. In 2020, social and entertainment robot market is forecast to reach 1.6 billion U.S. dollars.
2) Unit sales of social and entertainment robots worldwide from 2015 to 2025 (in millions)*: The statistic shows the estimated unit sales of social and entertainment robots from 2015 to 2025. In 2020, social and entertainment robot sales are forecast to reach 4.22 million units.
3) Average selling price of social and entertainment robots worldwide from 2015 to 2025 (in U.S. dollars): The statistic shows the estimated average selling price of social

and entertainment robots from 2015 to 2025. In 2020, social and entertainment robots are forecast to sell for 372 U.S. dollars on average.

4) Types of artificial intelligence (AI) applications in development in companies in the United States as of 2018: The statistic shows the types of artificial antelligence applications in development in companies in the United States as of 2018. Around 21 percent of respondents from a group of around 500 companies that were actively involved in developing, piloting, or running AI applications stated that their organization was in the process of developing AI applications for robotics.
5) Share of participants who believe artificial intelligence (AI) applications can address socioeconomic causes in India in 2018, by application: This statistic displays the results of a survey about the share of participants who believe artificial intelligence (AI) applications can address social, economic and environmental causes in India in 2018, by application. During the survey, around 71 percent of respondents believed that artificial intelligence applications will help humans solve complex problems and enrich lives in India.
6) Types of artificial intelligence (AI) applications used in companies in the United States as of 2018: The statistic shows the types of artificial intelligence applications being used in companies in the United States as of 2018. Around 71 percent of respondents from a group of around 500 companies that were actively involved in developing, piloting, or running AI applications stated that their organization used AI applications for data security.
7) Share of participants who believe artificial intelligence (AI) applications will aid gender equality in India in 2018, by likelihood: This statistic displays the results of a survey conducted in 2018 about the share of participants who believe artificial intelligence (AI) applications will aid gender equality in India, by likelihood. During the survey, around 29 percent of respondents in India believed that there was a medium likelihood that businesses and governments will apply artificial intelligence to the cause of gender equality
8) Share of participants who believe artificial intelligence (AI) applications will aid global education in India in 2018, by likelihood: This statistic displays the results of a survey conducted in 2018 about the share of participants who believe artificial intelligence (AI) applications will aid global education in India, by likelihood. During the survey, around 45 percent of respondents in India held a very high belief that artificial intelligence was important for global education.
9) Share of participants who believe artificial intelligence (AI) applications will aid economic growth in India in 2018, by likelihood: This statistic displays the results of a survey conducted in 2018 about the share of participants who believe artificial intelligence (AI) applications will aid economic growth in India, by likelihood. During the survey, around 46 percent of respondents in India held a very high belief that artificial intelligence was important for economic growth.
10) Share of participants who believe artificial intelligence (AI) applications will aid global health and well-being in India in 2018, by likelihood: This statistic displays the results of a survey conducted in 2018 about the share of participants who believe artificial intelligence (AI) applications will aid global health and well-being in India, by likelihood. During the survey, around 40 percent of respondents in India held a very high belief that artificial intelligence was important for global health and well-being.
11) In the context of digitalization: which meaning do the following technology trends have for your company?: This statistic shows the results of a survey among 1,025

companies from 12 countries worldwide on the meaning of technology trends in the context of digitalization as of 2015. At the time of the survey, 15 percent of respondents stated that cloud technologies were of big importance for their company.

After reviewing these sources, one may conclude that the use of social robotics is so innovate in the field of Social professions, main goal of PRoSPERo, that it is quite hard to find any. There is little statistics, especially in the field of social robotics as we define it in this set of scoping papers for the PROSPERO project, but as we will see later, the economic investment by the European Union and the volume of information exchange in congresses it is very high. This may lead to lack of transparency and accountability in the specific field we are dealing with.

3. Research on Social Robotics funded by EU

In order to know the trends in research related to Social Robotics, in this section we focus on the analysis of research projects funded by the European Union Horizon2020 Programme in recent years. In this analysis we have taken into account different criteria presented in the table 1: aims, domain, outcome, budget and countries involved. With these criteria we intend to address not only the purpose of the projects, but also the outcomes in which they materialize their proposal, thus seeing their contribution to society. We also include the budget and the countries involved to see the differential weight that the EU countries have in this domain of research.

In our first search we found 74 projects funded by Horizon2020 that are particularly related to Robotics and its impact to human life. From the revision of this list, we have selected 13 projects that are directly related to the PRosPeRo proposal.

The EU-funded Horizon2020 projects represent a wide variety of research and innovation themes: from healthcare, transportation, industrial and agri-food robotics and inspection to search and rescue robotics. Some deal with complex safety matters on the frontier where robots meet people, to ensure that no one comes to harm. Others will create a sustainable ecosystem in the robotics community, setting up common platforms supporting robotics development. There are also collaborative projects on robotics competitions, while others deal with Ethics, Legal, Societal and Economy as well as benchmarking and standardisation. The research and innovation projects focus on a wide variety of capabilities, such as navigation, human-robot interaction, recognition, cognition and handling. Many of these abilities can be transferable to other fields as well, benefitting Europe's citizens and economy.

All the projects selected are included in the programme: H2020-EU.2.1.1. - INDUSTRIAL LEADERSHIP - Leadership in enabling and industrial technologies - Information and Communication Technologies (ICT). Its specific objective is "to enable Europe to support, develop and exploit the opportunities brought by ICT progress for the benefits of its citizens, businesses and scientific communities".

Table 1: Research projects on Social Robotics funded by the EU

Name	Objective	Domain	Outcome	Budget	Countries
SecondHands H2020-ICT-2014-1, RIA) grant agreement No 643950. **H2020-EU.2.1.1.5. - Advanced interfaces and robots: Robotics and smart spaces** **ICT-23-2014 - Robotics**	To design a robot that can offer help to a maintenance technician in a pro-active manner. this robot as a second pair of hands that can assist the technician when he/she is in need of help. The project revolves around four fundamental concepts: (i) the design of a new robotic assistant; (ii) a knowledge base to facilitate proactive help; (iii) a high degree of human-robot interaction; (iv) advanced perception skills to function in a highly dynamic industrial environment.	Industry	• A robot	Overall budget: 6.930.000€ EU contribution 5.994.000€	Coord.: UK Germany Italy Switzerland UK
CogIMon H2020 ICT-23-2014, grant agreement No 644727 **H2020-EU.2.1.1.5. - Advanced interfaces and robots: Robotics and smart spaces** **ICT-23-2014 - Robotics**	The objectives of the project are: • develop new compliant humanoid robot • investigate human force interaction • transfer human control to full-body robots • design force control movement primitives • develop domain specific software language • create multi-humanoid team-interaction	Information and Communication Technologies	• New compliant humanoid Robot • Full body compliant control methods • Open source tools for robot programming	Overall budget: 6.974.131,7€ EU contribution 5.688.126€	Coord.: Germany Switzerland Italy UK Italy UK Germany Germany UK
CENTAURO H2020-ICT-2014-1 grant agreement No 644839 **H2020-EU.2.1.1.5. - Advanced interfaces and robots: Robotics and smart spaces** **ICT-23-2014 - Robotics**	The CENTAURO project aims at the development of a human-robot symbiotic system where a human operator is whole-body telepresent in a Centaur-like robot, which is capable of robust locomotion and dexterous manipulation in the rough terrain and austere conditions characteristic of disasters. The CENTAURO robot will consist of a four-legged basis and an anthropomorphic upper body and will be driven by lightweight, compliant actuators. It will be able to navigate in affected man-made environments, including the inside of buildings and stairs, which are cluttered with debris and partially collapsed.		• The CENTAURO robot	Overall budget: 4.124.915€ EU contribution 4.124.915€	Coord.: Germany Italy Italy Sweden Sweden Germany Germany Germany
SARAFun H2020-ICT-2014-1 grant agreement No 644938 **H2020-EU.2.1.1.5. - Advanced interfaces and robots: Robotics and smart spaces** **ICT-23-2014 - Robotics**	The SARAFun project has been formed to enable a non-expert user to integrate a new bi-manual assembly task on a FRIDA robot in less than a day. This will be accomplished by augmenting the FRIDA robot with cutting edge sensory and cognitive abilities as well as reasoning abilities required to plan and execute an assembly task. The overall conceptual approach is that the robot should be capable of learning and executing assembly tasks in a human like manner. Studies will be made to understand how human assembly workers learn and perform assembly tasks. The human performance will be modelled and transferred to the	Industrial technologies	• The FRIDA robot	Overall budget: 4.037.266,25€ EU contribution 1.037.265.50€	Coord: Sweden Greece Sweden Sweden Germany Spain

	FRIDA robot as assembly skills. The robot will learn assembly tasks, such as insertion or folding, by observing the task being performed by a human instructor. The robot will then analyze the task and generate an assembly program, including exception handling, and design 3D printable fingers tailored for gripping the parts at hand. Aided by the human instructor, the robot will finally learn to perform the actual assembly task, relying on sensory feedback from vision, force and tactile sensing as well as physical human robot interaction. During this phase the robot will gradually improve its understanding of the assembly at hand until it is capable of performing the assembly in a fast and robust manner.				
BabyRobot H2020-ICT-2015 grant agreement No **687831** **H2020-EU.2.1.1. - INDUSTRIAL LEADERSHIP - Leadership in enabling and industrial technologies - Information and Communication Technologies (ICT)** **ICT-24-2015 - Robotics**	Our main goal is to create robots that analyze and track human behavior over time in the context of their surroundings (situational) using audio-visual monitoring in order to establish common ground and mind-reading capabilities. On BabyRobot we focus on the typically developing and autistic spectrum children user population. Children have unique communication skills, are quick and adaptive learners, eager to embrace new robotic technologies. This is especially relevant for special education where the development of social skills is delayed or never fully develops without intervention or therapy. Thus our second goal is to define, implement and evaluate child-robot interaction application scenarios for developing specific socio-affective, communication and collaboration skills in typically developing and autistic spectrum children. We will support not supplant the therapist or educator, working hand-in-hand to create a low risk environment for learning and cognitive development.	Autistic spectrum children / Special Education	• Robots	Overall budget: € 3.995.741,25 EU contribution € 3.995.741,25	Coord: Greece Greece UK Germany Sweden Denmark France France Sweden
MuMMER H2020-ICT-2015 grant agreement No **688147** **H2020-EU.2.1.1. - INDUSTRIAL LEADERSHIP - Leadership in enabling and industrial technologies - Information and Communication Technologies (ICT)** **ICT-24-2015 - Robotics**	MuMMER is a with the overall goal of developing a humanoid robot (based on Softbank's Pepper platform) that can interact autonomously and naturally in the dynamic environments of a public shopping mall, providing an engaging and entertaining experience to the general public. Using co-design methods, we will work together with stakeholders including customers, retailers, and business managers to develop truly engaging robot behaviours. Crucially, our robot will exhibit behaviour that is socially appropriate: combining speech-based interaction with non-verbal communication and human-aware navigation. To support this behaviour, we will develop and integrate new	Services Tertiary sector	• A humanoid robot	Overall budget: € 5.345.137,50 EU contribution € 4.297.835	Coord: UK UK Switzerland France France Finland Finland

	methods from audiovisual scene processing, social-signal processing, high-level action selection, and human-aware robot navigation.				
An.Dy H2020-ICT-2016-1 grant agreement No **731540** **H2020-EU.2.1.1. - INDUSTRIAL LEADERSHIP - Leadership in enabling and industrial technologies - Information and Communication Technologies (ICT)** **ICT-25-2016-2017 - Advanced robot capabilities research and take-up**	ANDY leverages these technologies and strengthen the European leadership by endowing robots with the ability to control physical collaboration through intentional interaction. These advances necessitate progresses along three main directions: measuring, modeling and helping humans engaged in intentional collaborative physical tasks. First, ANDY will innovate the way of measuring human whole-body motions developing the ANDYSUIT, a wearable force and motion tracking technology. Second, ANDY will develop the ANDYMODEL, a technology to learn cognitive models of human behavior in collaborative tasks. Third, ANDY will propose the ANDYCONTROL, an innovative technology for helping humans through predictive physical collaboration.	Industry / assistance	• Hardware • Exoskeleton	Overall budget: € 3.950.025 EU contribution € 3.950.025	Coord: Italy France Slovenia Germany Netherlands Germany Germany Denmark
MEMMO H2020-ICT-2017-1grant agreement No **780684** **H2020-EU.2.1.1. - INDUSTRIAL LEADERSHIP - Leadership in enabling and industrial technologies - Information and Communication Technologies (ICT)** **ICT-25-2016-2017 - Advanced robot capabilities research and take-up**	What if we could generate complex movements for a robot with any combination of arms and legs interacting with a dynamic environment in real-time? MEMMO has the ambition to create such a motion-generation technology that will revolutionize the motion capabilities of robots and unlock a large range of industrial and service applications. Based on optimal-control theory, we develop a unified yet tractable approach to motion generation for complex robots with arms and legs. The approach relies on three innovative components. 1) a massive amount of pre-computed optimal motions are generated offline and compressed into a ``memory of motion". 2) these trajectories are recovered during execution and adapted to new situations with real-time model predictive control. This allows generalization to dynamically changing environments. 3) available sensor modalities (vision, inertial, haptic) are exploited for feedback control which goes beyond the basic robot state with a focus on robust and adaptive behaviour.	Industry	• A high-performance humanoid robot. • An advanced exoskeleton. • A challenging inspection task in a real construction site will be performed with a quadruped robot.	Overall budget: € 4.157.151,75 EU contribution € 3.96.818,75	Coord: France Switzerland UK Germany UK Spain France France France UK
CROWDBOT H2020-ICT-2017-1	CROWDBOT will enable mobile robots to navigate autonomously and assist humans in crowded areas. Today's robots are programmed to stop when a human, or any obstacle is too close, to avoid coming into contact while	Industry / services	• a semi-autonomous wheelchair • a Pepper robot that navigate in a dense	Overall budget: € 3.997.660 EU contribution € 3.997.660	Coord: France Switzerland Switzerland Germany

grant agreement No **779942** **H2020-EU.2.1.1. - INDUSTRIAL LEADERSHIP - Leadership in enabling and industrial technologies - Information and Communication Technologies (ICT)** **ICT-25-2016-2017 - Advanced robot capabilities research and take-up**	moving. This prevents robots from entering densely frequented areas and performing effectively in these high dynamic environments. CROWDBOT aims to fill in the gap in knowledge on close interactions between robots and humans during navigation tasks. The project considers three realistic scenarios: 1) a semi-autonomous wheelchair that must adapt its trajectory to unexpected movements of people in its vicinity to ensure neither its user nor the pedestrians around it are injured; 2) the commercially available Pepper robot that must navigate in a dense crowd while actively approaching people to assist them; 3) the under development robot cuyBot will adapt to compact crowd, being touched and pushed by people.		crowd while actively approaching people to assist them; • a robot cuyBot that will adapt to compact crowd, being touched and pushed by people.		France UK Germany
MoveCare H2020-ICT-2016-1 grant agreement No **732158** **H2020-EU.2.1.1. - INDUSTRIAL LEADERSHIP - Leadership in enabling and industrial technologies - Information and Communication Technologies (ICT)** **ICT-26-2016 - System abilities, development and pilot installations**	MoveCare develops and field tests an innovative multi-actor platform that supports the independent living of the elder at home by monitoring, assist and promoting activities to counteract decline and social exclusion. It comprises 3 hierarchical layers: 1) A service layer provides monitoring and intervention. It endows objects of everyday use with advanced processing capabilities and integrates them in a distributed pervasive monitoring system to derive degradation indexes linked to decline. 2) A context-aware Virtual Caregiver, embodied into a service robot, is the core layer. It uses artificial intelligence and machine learning to propose to the elder a personalized mix of physical/cognitive/social activities as exergames. It evaluates the elder status, detects risky conditions, sends alerts and assists in critical tasks, in therapy and diet adherence. 3) The users' community strongly promotes socialization acting as a bridge towards the elders' ecosystem: other elders, clinicians, caregivers and family.	Assistance (elders)	• a robotic platform	Overall budget: € 5.933.611,25 EU contribution € 5.933.611,25	Coord: Italy Italy Italy Spain Sweden Cyprus Italy Slovenia Spain Sweden UK Spain UK France Sweden UK
IMAGINE H2020-ICT-2016-1 grant agreement No **731761** **H2020-EU.2.1.1. - INDUSTRIAL LEADERSHIP - Leadership in enabling and industrial technologies - Information and Communication Technologies (ICT)**	IMAGINE seeks to enable robots to understand the structure of their environment and how it is affected by its actions. ""Understanding"" here means the ability of the robot (a) to determine the applicability of an action along with parameters to achieve the desired effect, and (b) to discern to what extent an action succeeded, and to infer possible causes of failure and generate recovery actions.		• a TRL-5 prototype that can autonomously disassemble prototypical classes of devices, generate and execute disassembly actions for unseen instances of similar devices, and recover from certain failures.	Overall budget: € 3.797.050 EU contribution € 3.797.050	Coord: Austria Germany Germany France Spain Turkey Germany

ICT-26-2016 - System abilities, development and pilot installations			• a multi-functional gripper capable of multiple types of manipulation without tool changes.		
SciRoc H2020-ICT-2017-1 grant agreement No **780086** **H2020-EU.2.1.1. - INDUSTRIAL LEADERSHIP - Leadership in enabling and industrial technologies - Information and Communication Technologies (ICT)** **ICT-28-2017 - Robotics Competition, coordination and support**	SciRoc is a project supporting the European Robotics League (ERL), whose aim is to bring ERL tournaments in the context of smart cities. SciRoc will call for leading European robotics developers from European companies and research labs to send teams to demonstrate their technologies and systems in high profile competitive demonstrations in a smart city environment. SciRoc continues to build the European Robotics League; raising interest through public engagement, validating and disseminating new benchmarks, and accelerating development through demonstrating the performance of components and techniques against these benchmarks. Setting competitions based on these benchmarks in the Smart City context drives development towards real societal needs. SciRoc will offer companies as well as researchers a unique opportunity to demonstrate their systems and technology to a wide public audience in a realistic and believable context, and will foster an informed, fact-based communication about robotics and its societal implications with public stakeholders and the media.	Service / industry		Overall budget: € 1.994.442,5 EU contribution € 1.994.442,5	Coord: UK Germany Spain Belgium Belgium Portugal UK Italy Italy Spain
REELER H2020-ICT-2016-1grant agreement No**731726** **H2020-EU.2.1.1. - INDUSTRIAL LEADERSHIP - Leadership in enabling and industrial technologies - Information and Communication Technologies (ICT)** **ICT-35-2016 - Enabling responsible ICT-related research and innovation**	The REELER project aims at aligning the roboticists' visions of a future with robots with empirically-based knowledge of human needs and societal concerns. Based on extensive robotics/SSH-RRI collaboration, REELER will offer proactive steps towards ethical and responsible robots by suggesting radical changes in current robot design procedures. Moreover, REELER will formulate guidelines in the REELER Roadmap for distributed responsibility among roboticists, users/affected stakeholders and policy-makers by closing the current gap between these. At the core of these guidelines is the concept of collaborative learning which permeates all aspects of REELER and will guide future SSH-ICT research.	Ethics	A research-based roadmap presenting a) ethical guidelines for Human Proximity Levels, b) prescriptions for how to include the voice of new types of users and affected stakeholders through Mini-Publics and call forth roboticists' assumptions via sociodrama and c) an agent-based simulation tool for policy-making.	Overall budget: € 1.998.267,50 EU contribution € 1.998.265	Coord: Denmark Italy UK Germany

But even if we find the above list of projects directly related with Social Robotics, the EU has funded over the last year around projects related with Robotics in general for almost 300.000.000€[5] in total. We list here below those indirectly related with PROSPERO aims:

Name Coordinator	Overall Budget	EU Contribution	Country
ECHORD Plus Plus Funded under: FP7-ICT	26.759.556,00 €	19.750.000,00 €	TECHNISCHE UNIVERSITAET MUENCHEN Germany
HORSE Funded under: H2020-EU.2.1.1. H2020-EU.2.1.5.1.	8.851.778,29 €	7.945.601,00 €	EUROPEAN DYNAMICS ADVANCED INFORMATION TECHNOLOGY AND TELECOMMUNICATION SYSTEMS SA Greece
ReconCell Funded under: H2020-EU.2.1.1. H2020-EU.2.1.5.1.	6.306.457,00 €	5.561.569,00 €	INSTITUT JOZEF STEFAN. Slovenia
Flourish Funded under: H2020-EU.2.1.1.5.	4.780.047,50€	3.560.870€	EIDGENOESSISCHE TECHNISCHE HOCHSCHULE ZUERICH Switzerland
SWEEPER Funded under: H2020-EU.2.1.1.5.	4.345.912,49 €	4.028.311,50 €	STICHTING WAGENINGEN RESEARCH Netherlands
AEROARMS Funded under: H2020-EU.2.1.1.5.	5.719.602,50€	4.722.852	UNIVERSIDAD DE SEVILLA Spain
RoMaNS Funded under: H2020-EU.2.1.1.5.	4.345.912,49 €	4.028.311,50 €	THE UNIVERSITY OF BIRMINGHAM United Kingdom
COMANOID Funded under: H2020-EU.2.1.1.5.	4 244 481,25	4.244.481,25	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS France
WiMUST Funded under: H2020-EU.2.1.1.5.	5.719.602,50 €	4.722.852,00 €	UNIVERSITA DEGLI STUDI DI GENOVA Italy
RobDREAM Funded under: H2020-EU.2.1.1.5.	5.401.911€	5.401.911	KUKA DEUTSCHLAND GMBH Germany
EurEyeCase Funded under: H2020-EU.2.1.1.5.	6.377.521,25 €	6.377.521,00 €	KATHOLIEKE UNIVERSITEIT LEUVEN
SoMa Funded under:	7.096.091,25€	6.321.278,75€	TECHNISCHE UNIVERSITAT BERLIN Germany

[5] https://cordis.europa.eu/project/rcn/194119/factsheet/es

H2020-EU.2.1.1.5.			
FLOBOT Funded under: H2020-EU.2.1.1.5.	4.244.481,25 €	4.244.481,25 €	CY.R.I.C CYPRUS RESEARCH AND INNOVATION CENTER LTD Cyprus
RETRAINER Funded under: H2020-EU.2.1.1.5.	3.711.964,11€	2.784.831€	AB.ACUS SRL Italy
AEROWORKS Funded under: H2020-EU.2.1.1.5.	3.970.081,25 €	3.970.081,25 €	LULEA TEKNISKA UNIVERSITET Sweden
SmokeBot Funded under: H2020-EU.2.1.1.5.	3.817.417,70€	3.817.417,50€	OREBRO UNIVERSITY Sweden
ColRobot Funded under: H2020-EU.2.1.1.	5.401.911,00 €	5.401.911,00 €	ECOLE NATIONALE SUPERIEURE D'ARTS ET METIERS France
RAMPup Funded under: H2020-EU.2.1.1.	4.746.967,50€	3.995.511,25€	TEKNOLOGISK INSTITUT Denmark
SafeLog Funded under: H2020-EU.2.1.1.	3.245.811,96 €	2.648.314,00 €	KARLSRUHER INSTITUT FUER TECHNOLOGIE Germany
Bots2ReC Funded under: H2020-EU.2.1.1.	4.768.875€	3.964.162,50€	RHEINISCH-WESTFAELISCHE TECHNISCHE HOCHSCHULE AACHEN Germany
EndoVESPA Funded under: H2020-EU.2.1.1.	7.096.091,25 €	6.321.278,75 €	SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO S ANNA Italy
MURAB Funded under: H2020-EU.2.1.1.	4.343.307,50€	3.982.307,50€	UNIVERSITEIT TWENTE Netherlands
INPUT Funded under: H2020-EU.2.1.1.	4.204.713,75 €	3.186.473,75 €	OTTO BOCK HEALTHCARE PRODUCTS GMBH Austria
SPEXOR Funded under: H2020-EU.2.1.1.	3.989.025€	3.989.025€	INSTITUT JOZEF STEFAN Slovenia
ROBOTT-NET Funded under: H2020-EU.2.1.1.	3.711.964,11 €	2.784.831,00 €	TEKNOLOGISK INSTITUT Denmark
SoftPro Funded under: H2020-EU.2.1.1.	8.675.611,25€	7.440.026,25€	FONDAZIONE ISTITUTO ITALIANO DI TECNOLOGIA Italy
RockEU2 Funded under: H2020-EU.2.1.1.	5.906.642,75 €	3.671.935,00 €	EUROBOTICS AISBL Belgium
TrimBot2020 Funded under: H2020-EU.2.1.1.	6 354 951,25€	5.420.607,50€	THE UNIVERSITY OF EDINBURGH United Kingdom
DeTOP H2020-EU.2.1.1.	3.817.417,70 €	3.817.417,50 €	SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO S ANNA Italy

EDEN2020 Funded under: H2020-EU.2.1.1.	8.361.446,25€	8.361.446,25€	IMPERIAL COLLEGE OF SCIENCE TECHNOLOGY AND MEDICINE United Kingdom
AEROBI Funded under: H2020-EU.2.1.1.	4.338.412,50 €	3.914.493,38 €	AIRBUS DS SAS France
UP-Drive Funded under: H2020-EU.2.1.1.	7 604 893,75	4.671.896,25	VOLKSWAGEN AG Germany
XoSoft Funded under: H2020-EU.2.1.1.	4.746.967,50 €	3.995.511,25 €	FONDAZIONE ISTITUTO ITALIANO DI TECNOLOGIA Italy
AirBorne Funded under: H2020-EU.2.1.1.	2.931.193,75€	2.295.998,13€	ALMA MATER STUDIORUM - UNIVERSITA DI BOLOGNA Italy
BADGER Funded under: H2020-EU.2.1.1.	4.618.462,50 €	4.618.462,50 €	UNIVERSIDAD CARLOS III DE MADRID Spain
micro-ROS Funded under: H2020-EU.2.1.1.	3.877.451,43€	2.940.920€	PROYECTOS Y SISTEMAS DE MANTENIMIENTO SL Spain
PICKPLACE Funded under: H2020-EU.2.1.1.	4.768.875,00 €	3.964.162,50 €	ULMA MANUTENCION S. COOP. Spain
SheaRIOS Funded under: H2020-EU.2.1.1.	3.318.177,50€	2.716.906,63€	TWI LIMITED United Kingdom
MyLeg Funded under: H2020-EU.2.1.1.	3.049.410,71 €	2.735.937,50 €	RIJKSUNIVERSITEIT GRONINGEN Netherlands
HYFLIERS H2020-EU.2.1.1.	3.897.020€	3.897.020€	OULUN YLIOPISTO Finland
HEPHAESTUS H2020-EU.2.1.1.	4.343.307,50 €	3.982.307,50 €	FUNDACION TECNALIA RESEARCH & INNOVATION Spain
VERSATILE Funded under: H2020-EU.2.1.1.	4.301.766,25€	3.479.631,75€	FUNDACION TECNALIA RESEARCH & INNOVATION Spain
ROSIN Funded under: H2020-EU.2.1.1.	3.835.585,00 €	2.706.246,13 €	TECHNISCHE UNIVERSITEIT DELFT Netherlands
ILIAD Funded under: H2020-EU.2.1.1.	6.987.715,36€	6.987.715,36€	OREBRO UNIVERSITY Sweden
MULTIDRONE Funded under: H2020-EU.2.1.1.	3.989.025,00 €	3.989.025,00 €	ARISTOTELIO PANEPISTIMIO THESSALONIKIS Greece
CYBERLEGs Plus Plus Funded under: H2020-EU.2.1.1.	4.621.125€	4.285.200€	SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO S ANNA Italy
Co4Robots Funded under: H2020-EU.2.1.1.	7.692.516,26 €	7.564.337,50 €	KUNGLIGA TEKNISKA HOEGSKOLAN Sweden
ROPOD Funded under: H2020-EU.2.1.1.	3.926.375€	3.494.825€	Hochschule Bonn-Rhein-Sieg

REFILLS Funded under: H2020-EU.2.1.1.	8.675.611,25 €	7.440.026,25 €	C.R.E.A.T.E. CONSORZIO DI RICERCA PER L'ENERGIA L AUTOMAZIONE E LE TECNOLOGIE DELL'ELETTROMAGNETISMO Italy
SMARTsurg Funded under: H2020-EU.2.1.1.	3 990 206,25	3.990.206,25	UNIVERSITY OF THE WEST OF ENGLAND, BRISTOL United Kingdom
RobMoSys H2020-EU.2.1.1.	2.499.463,75 €	2.499.463,75 €	
Dreams4Cars Funded under: H2020-EU.2.1.1.	4.302.865€	4.302.865€	UNIVERSITA DEGLI STUDI DI TRENTO Italy
THING Funded under: H2020-EU.2.1.1.	6.354.951,25 €	5.420.607,50 €	THE UNIVERSITY OF EDINBURGH United Kingdom
FABULOS Funded under: H2020-EU.2.1.1.	7.774.999,50€	6.997.499,56€	FORUM VIRIUM HELSINKI OY Finland
ESMERA Funded under: H2020-EU.2.1.1.	5.165.158,75 €	4.260.521,25 €	PANEPISTIMIO PATRON Greece
RobotUnion Funded under: H2020-EU.2.1.1.	8.074.961,25	7.999.961,25	FUNDINGBOX ACCELERATOR SP ZOO Poland
SARAS Funded under: H2020-EU.2.1.1.	8.361.446,25 €	8.361.446,25 €	UNIVERSITA DEGLI STUDI DI VERONA Italy
EUROBENCH Funded under: H2020-EU.2.1.1.	8.190.691,25€	8.190.691,25€	AGENCIA ESTATAL CONSEJO SUPERIOR DEINVESTIGACIONES CIENTIFICAS Spain
COVR Funded under: H2020-EU.2.1.1.	3.584.850,25 €	3.084.949,25 €	TEKNOLOGISK INSTITUT Denmark
INBOTS Funded under: H2020-EU.2.1.1.	2 982 973,75€	2.982.973,75€	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS Spain
Total	307.946.506,36 €	294.239.424,94 €	

It is important to take into account the budget invested in robotics, essentially if we take into account the accountability policies that govern the European policy. In this regard, it is worth asking about the transfer of these projects to society and to what extent the results obtained imply social improvement.

4. Trends on Social Robotics

a. Education

Social robots are increasingly used as educational tools. Robots in teaching work with a child on a teaching task, such as inquiry learning and stem learning, language learning, but also with younger children for a mixture of play and learning. In these tasks, robots take various roles, such as peer, tutor, tutee, or the object of the learning. Social interaction with the robot occurs on several levels: task related educational interactions (explaining, asking, instructing, ...), collaboration interactions (maintaining common ground, aligning strategies, and coordinating activities), and relational interactions (maintaining a healthy working relationship to be \allies in learning"). The remainder of this section, adapted from, illustrates the various ways a robot can be part of an educational section by looking at examples from related work, which help us to highlight and illustrate possible contributions of such a robot.

Robots in educational settings are often presented Robots in educational settings are often presented to the learner as a \peer" or \tutor". Within these roles the robot may have a different impact on the child's learning and may use a different repertoire of behaviours and techniques to other scaffolding.

Robots presented as facilitator, teaching assistant, or tutor, often take on a role of \more knowledgeable other" to guide one or more learners in the learning task. Operating in this role, a robot may contribute to the learning process through traditional tutoring methods; such as direct instruction, praise, encouragement, or explicit feedback. For example, Kanda et al. used a social robot as a facilitator to other direct instruction and explanations to children working on a collaborative task. Their results suggest that the social nature of the robot contributed to increased motivation in early phases of the learning task. Similarly, Chandra et al. found that a robot who acted as facilitator to two collaborating children, improved their feelings of responsibility. Additionally, Saerbeck et al. have shown that a robotic tutor with social supportive behaviours can have a positive effect on the performance of the learner. However, in certain tutoring situations prone to distractions, too much socially appropriate behaviours seem to have a detrimental effect to learning.

Alternatively, robots can be presented to the child as co-learners or peers. As such, the robot may portray a \differently (or equally) knowledgeable other" and may seek collaboration with the child within the learning task. In this role the robot may other proactive anticipatory helping behaviours to improve the fluency of their collaboration. Such peer-like robots often engage with children over multiple interaction sessions, seeking to build a social relationship. A common approach for promoting learning with a peer-like robot is during playful game-like interactions. For example, the robot might play either an \ally" or an \opponent" of the child, challenging them to achieve a higher performance. To sustain such interactions over extended periods of time, the robot and child can engage in a diverse variety of such activities. Other approaches focus on interactive storytelling with a social robot.

For example, Gordon et al. used such a robot to improve children's second language skills. Thirdly, robots portraying a \less knowledgeable other" tend to evoke caregiving behaviour in the child. Children are naturally inclined to help a \robot in need" when it displays distressed behaviour. However, the extent of helping depends on how the child was introduced to the robot. Tanaka et al. use such a care-receiving robot to promote vocabulary learning. In such cases, the child themselves may act as a tutor, correcting the robot's mistakes (e.g. or explaining concepts to the robot. Through this learning by teaching paradigm, the child gains a deeper understanding of the learning content Finally, as the object of learning, robots are used to teach about topics such as programming, parenthood, or nursing and medical care (in patient simulators).

In conclusion, here are some of the various (social) roles the robot could have: explaining to the learner, be explained to by the learner, encouraging the learner, praising the learner in various ways, giving good or bad examples as a fellow learner, simulating learnable situations, and many more. The effectiveness of these actions depends to a certain extent on the relation between the learner and the robot, and how the robot behaves and presents itself to the learner. This applies to the social professions as well: firstly, because educational robots have a potential place in the education of any kind of domain, including the social professions, and secondly because it could be argued that there is a teaching and coaching angle in working with elderly, people with dementia, and other social domains that are not immediately about teaching.

b. Autism Spectrum Condition

Robots have often been used as a component in teaching and therapy for autistic children26. The robots themselves may be particularly suitable for interaction with autistic individuals for various reasons. Robots can elicit engagement and social behaviour from the children, which others opportunities for developing new interventions for them. Furthermore, they are not so complex in form and behaviour, making them more predictable and easier to interact with. And as interaction technology, they have the capacity to other on-demand personalized learning opportunities.

The applications of robots for autistic children can be divided into three approaches: (1) the use of robots to elicit behaviour, (2) the use of robots to model, teach, and/or practice skills, and (3) the use of robots to provide feedback to an individual (Diehl et al., 2012). Using a robot to elicit certain behaviours, directed either at the robot or the therapist, is a way to create opportunities for the therapist to address the behaviours in the situation they arise and provide alternate, more appropriate, responses. In the other two approaches, the robot takes a more prominent role in the interaction, and additionally also teaches the correct response and/or gives the appropriate feedback. The main task of a robot used in autism therapy is to allow or encourage the children to develop certain social skills that are important for living an independent, meaningful, and socially active life. To this end, research has focussed on key behavioural targets such as imitation (Tapus et al., 2012; Warren et al., 2015), joint attention (Anzalone et al., 2014; Bekele et al., 2014; Warren et al., 2015), collaborative play (Wainer et al., 2014), body awareness (Costa et al., 2015), and emotion recognition and expression. To provide more engaging interaction, incorporating technology into interventions may be particularly beneficial to autistic children. Autistic individuals often have affinity with technology, and generally prefer interacting with media over other play activities. Furthermore, technology does not judge an individual for not being able to meet social demands, which are often challenging for autistic individuals in human-human interactions. Technology can also provide interactions that are specifically designed to cater to the strengths and address the needs of autistic children, potentially creating more understandable and engaging interventions. Autistic children often have relatively strong visual processing skills, and show a strength in understanding the physical world, compared to understanding the human social world. This could be taken into account in the interaction design, for example, by reducing distracting stimuli to increase attention, and by providing visually cued instructions.

In a similar vein, robotic technology has been used to promote engagement of autistic children in interventions. Importantly, the engagement that is observed is often social in nature and is directed not only at the robot, but also at other people near the robot. The latter is significant, because from a pedagogical point of view, it does not always necessarily matter whether the child interacts with the robot or whether the robot elicits interaction between the child and adult, as learning can occur in either case. While incorporating a robot in an intervention for autistic children is often reported to have a positive effect on the child's engagement, developing robot behaviour that can both sustain long-term engagement and facilitate learning remains challenging.)

Regarding a robot's predictability, Autism Spectrum Condition (ASC) is a neurodevelopmental condition, characterised by difficulties in social communication and restricted, repetitive behaviour and interests. Current accounts of ASC place difficulties in generating or using predictions at the core of the condition. One of the manifestations of these difficulties is a de sire for predictability and difficulty in dealing with uncertainty. For educational practices, offering a predictable environment could be beneficial for facilitating learning by providing an environment that puts the child at ease and requires fewer cognitive resources to be processed. This could make it easier for the child to engage with the learning material without having to deal with the discomfort resulting from unpredictability. Indeed, current educational practices emphasize the need for structure at schools (Mesibov2010) The practice, so that autistic children know what to expect. The desire of autistic children for predictability leads to a commonly used argument for why technology, and specifically robots, may be promising tools for autistic children, namely in that they can be programmed to provide a very predictable interaction. Thus, the use of a robot in an intervention could provide autistic children with an object that promotes engagement and delivers learning content in a manner that is easier to process. Engagement is considered to be a necessary prerequisite for learning, where higher engagement results in more opportunities for cognitive and social skill learning. However, the link with the predictability of robots and engagement of autistic children is currently purely theoretical.

For robot learning interventions to actually work, the learned skills must be capable of being generalised. Generalisation - or transferring skills from one context to another - is critical to learning social skills but is often notoriously difficult for autistic children and young people. The goal of social skill training is that the learned behaviours also generalise to humans. In robot-assisted therapy there is a risk that the child will only show the learned behaviour when interacting with a robot and that they do not generalise to humans. Possibly, using a humanoid robot rather than a non-humanoid robot in therapy could benefit the generalisation of the learned skills, as the robot's appearance is more similar to a human (Ricks & Colton, 2010; Scassellati et al., 2012). Rather than relying on this assumption, some researchers have incorporated the generalization of the learned skills into robot-assisted therapy. A triadic interaction between child, robot, and therapist can be used to generalise the learned skills to humans (Colton et al., 2009). The robot is then used to elicit certain social behaviours from the child that are directed at the therapist.

A different approach to generalisation within robot-assisted therapy is by gradually fading the role of the robot in the therapy (Begum et al., 2015; Goodrich et al., 2012). At the beginning of the therapy, there is a triadic interaction between the child, therapist, and robot. Gradually, the interaction becomes dyadic as the robot is removed from the interaction.

Note that, depending on the goal of the use of social robots, a balance must be found in the degree of making the robot human-like. This is important because human-like robots could teach children with ASD social communication skills, but on the other hand, more technical/toy-like robots are appeal more to them and could facilitate in child-caregiver interaction.

c. Pets and Companion Robots for Eldery People

Patients with dementia suffer from a progressive decline in cognitive function. Memory problems occur and the patient loses ability to adapt to the environment. Also, other impairments can occur, such as impairment of abstract thinking, impairment of judgement and language disorders, motor function problems, agnosia, and personality change. Effects that make people with dementia suffer from a generally lower quality of life is the presence of deliriums, illusions, hallucinations, mood shifts, anxiety, agitation, aggressiveness, depression, etcetera. Since there is no cure for dementia, there are therapies that are aimed at improving quality of life, such as music therapy, occupational therapy and pet therapy. Marti et al. researched the effect of Paro social robots on patients with dementia. The choice for Paro has been made because of it looking and acting like a pet, yet it has no similarities with an animal people know as a pet (for instance, cats and dogs) therefore it cannot be compared with the behavior of a real pet and people will likely not notice shortcomings in realness.

The research revealed that Paro distracted the patient from their anxiety. Also, it appeared that Paro facilitated interaction between the therapist and patient. Another type of robot that can be used in dementia care is a telepresence robot. This others family and caregivers the opportunity to be with the patient without physically being there. However, it brings problems such as problems remotely navigating the robots through a (nursing) home. Also, it doesn't help caregivers or family save time, because they spend the time interacting with/through the robot instead of spending time with the patient in real life.

A unique and promising approach is chosen by the makers of Tinybot Tessa (an \embodied voice" type of robot). Tessa is a robot in the form of a pot with a face. Tessa is aimed at people who have memory problems or problems executing their daily tasks. Tessa accompanies a person by giving verbal cues. With these cues, Tessa stimulates the person to get up and execute the task. Also, Tessa can give verbal help in preparing for tasks and appointments. Tessa can be very useful for patients with mild dementia (but is also aimed at people with mild mental retardation, brain damage, autism and other people facing similar difficulties with executing daily tasks). When the dementia is in a more advanced stadium, Tessa will not be as useful anymore, because a certain amount of self-sustainability is required.

d. Other

Besides the few categories mentioned above, research has explored a vast range of applications for social robots in social care. Some other examples are: a social robot leading fitness exercises, as a kind of motivational coach; a social robot acting as a butler to a smart home environment (nowadays also covered by embodied voice type of robots); general play and activational entertainment; and robots for sex and intimacy in therapeutic context (also see the PRoSPERo Ethics scoping review).

5. Conclusions

Although quite aware that there is still room for improving the present scoping paper, we may outline some conclusions on the information gathered here.

As far as domains are concerned, we note that applications focus on industrial issues as well as services. When they focus on the educational or social field, the projects are aimed more at the users or for the purposes of using the robot and not at the training of the workers who use them or at the needs of those who end up using them in the organizations Therefore, we see that the focus on the effects and not on the planification, design or professional development. Finally, we highlight the high economic volume invested by the EU although there are no transparency processes on the effects.