PROJECT FINAL REPORT

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1 Final publishable summary report

For over five years, ECHORD++ has worked to bridge the gap between academia and industry to the lasting benefit of European robotics. With its clear mission of bringing robotics technology from the lab to the market, ECHORD++ turned out to be most probably the most application-oriented EU-funded robotics research project ever attempted, and this happened already during its runtime.

There were two different calls for proposals during the runtime of ECHORD^{++}: A first one in 2014 and a second one in 2015. In both calls more than 250 proposals applied for funding, and 32 experiments could be supported after evaluation in terms of quality, innovation aspects and pathway to the market. Analyzing the innovation triggered by the experiments, we conclude that the development of new products was the most prominent method of innovation in ECHORD^{++} (with 58% of the experiments), followed by improving already existing products (16%), the implementation of new processes (also 16%) and the improvement of existing processes, which happened in 10% of the experiments. Surveys conducted among the beneficiaries suggest that more than 50 % of them have already started to commercialize and generate income or are expected to do that within the next 1-3 years. A commercialization strategy, which is very prominent in ECHORD^{++} is to start with the commercial exploitation of component of the planned prototype to generate the funds to finance the development of the full-fledged technology within a second step.

The Digital Innovation Hubs emerged actually from ECHORD^{++}'s three Robotics Innovation Facilities (RIFs) located at Paris-Sarclay (France), Bristol (Great Britain) and Pontedera (Italy). ECHORD^{++} piloted with the RIFs the transition from academic institutions into service-oriented hubs (which is the path a lot of DIHs listed in the catalogue now have to take) as well as the transition onto self-sustainable hubs, which can then form a self-sustainable network. All these experiences will be highly relevant for the DIH networks currently funded. The RIFs started as facilities with initial public funding into a self-sustainable collaborative network. In order to support the RIFs to get through this period, ECHORD^{++} has started a RIF Booster Program using professional business and organizational development consultants with expertise in robotics to work with the RIFs. Besides outlining a development plan for the three RIFs the consultants provided a deep analysis of the status quo at each of the RIFs and the RIF network as a whole including analysis of hitherto existing RIF collaborations. After this analysis, all three RIFs have taken major steps forward since they now all have viable continuation strategies in place. All RIFs offer free access to high-tech robotic equipment and expertise for SMEs within the European Union. The RIFs will continue to exist, as the inflow of small enterprises is enormous and so is their economic success. Furthermore, they acquired a deeper knowledge of the dynamics of tech transfer activities, which has been exploited in their subsequent operations. The RIF instrument has resulted in an improved regional and national visibility. All three RIFs will therefore continue to use the brand "RIF". The key improvements to the RIFs in the continued operations are a more efficient interaction with potential customers, improved internal processes to deliver results, and improved internal and external communication processes.

Public bodies often have specific requirements for the products they use. ECHORD^{++} offered to both the technology developers and the public authorities the chance to closely interact and interface with each other during the conception and development of the solution. This is to make sure that the product meets the requirements of the target group, technically and price-wise. The Public end-user Driven Technological Innovation (PDTI) scheme offered R&D consortia the possibility to develop

robotics technology according to the needs of public bodies. Two application areas have been identified: Robotics for Comprehensive Geriatric Assessment (CGA) in the Healthcare scenario and Robots for the Inspection and Clearance of the Sewer Network in Cities in the Urban Robotics Scenario. All four development teams worked on improving their prototypes in quality and reliability. As a result, three out of the four teams would need about two additional years to fully commercialize their solutions (the gap and the route to market being different for all three of them). The fourth team has a longer route to market as their hardware still requires more improvement but has generated scientific knowledge, which is very valuable for the community in terms of education and research. Additional third party funding already secured will ensure continuity of work on the prototype. All four teams will have to adopt different commercialization strategies, but these have been clearly identified and underpinned with business plans. All four teams benefited from the competitive product development process in PDTI, with clearly identified synergies, which – by co-creation – can now be exploited and will facilitate the route to market for all four teams. Coaching provided by one technical expert from the ECHORD^{++} core team in conjunction with a member with a track record in business development and commercialization was appreciated by all four teams.

While the activities of all four teams as well as their monitoring by members of the ECHORD^{++} core consortium mainly concentrated on the technical side during the first two phases of PDTI, the focus in Phase III shifted from technology to commercialization and business development. This was also reflected by the expertise of the coaches assigned to all four teams for monitoring: in this last phase, experts of the ECHORD++ core consortium who had both a technical as well as a commercial background did the coaching.

Outreach and dissemination efforts resulted in high recognition of the ECHORD^{++} project among the relevant target audiences, paving the way to market for the research and development teams and their products. A very notable item here is the so-called success booklet “ECHORD: the secret of our success”, which was finalized with the help of a professional writer. The success booklet is a high-level publication presenting stories about the research areas of ECHORD^{++}, the prototypes developed, and their possible application in a low-threshold manner, making the topics accessible for a broad audience. During the whole runtime, ECHORD^{++} presented the project at many major fairs and events, displaying not only the products developed under the umbrella of ECHORD^{++} but also the project’s methodology. Again, many partners exhibiting showed commitment even beyond the runtime of their respective experiments, highlighting the benefit of the strong common brand ECHORD^{++}. Regarding scientific publications, ECHORD^{++} published a 267-page scientific book.

1.1 Executive summary

ECHORD introduced a novel instrument to the landscape of European funding: The “experiments” – flexible joint academia-industry projects allowing to tackle the industry’s burning technology needs in a non-bureaucratic way. Based on the heritage of ECHORD, on top of the experiments, ECHORD^{++} even introduced two additional instruments, PDTI (Public end-user Driven Technological Innovation) and RIFs (Robotics Innovation Facilities), with the clear mission of bringing robotics technology from the lab to the market.

Probably the most application-oriented EU-funded robotics research project ever attempted, ECHORD^{++} overcame some of the major barriers preventing the boost of robotics technology. This resulted not only in outstanding technology development but also in products that have already reached the market, leading to economic growth and job creation in Europe. In order to be successful, ECHORD^{++} had to go beyond what in the past could usually be expected from EU-funded research projects. Flexible, agile management structures had to be put in place, being able to quickly overcome challenges the project has encountered on its way. Outreach and dissemination efforts, probably unparalleled for a project of this size, resulted in a high recognition of the project among the relevant target audiences, paving the route to market for the research and development teams and their products. In addition, with its two booster programs, the Experiment booster and the RIF booster, ECHORD^{++} provided exceptional support to experiment consortia and the competence centers, which form the RIF network, facilitating reaching economic sustainability even beyond the runtime of ECHORD^{++}.

Apart from its excellence in technology transfer, another major success of the ECHORD^{++} project was its contribution to the emergence of a close-knit community for robotic research in Europe. The ECHORD^{++} network, composed of researchers, engineers, managers and more, having directly participated in the projects as core or extended partners, or taken part in proposal evaluations, Experiment or PDTI reviews, counts several thousands of the best experts in the field in Europe. Actually, the ECHORD^{++} contact list features over four thousand entries. Bringing these people together, lowering the entry barrier into European research for the growth and benefit of the community, providing the substrate over which new, successful, lasting collaborations emerge and grow, arguably constitutes a significant contribution of ECHORD^{++} to robotics research in Europe.

The novel structure of ECHORD^{++} also provided a blueprint for future EU projects – tapping untold potential and application possibilities and defining the future direction of robotics research. In fact, the European Commission has recognized ECHORD^{++}. as the very first Digital Innovation Hub network in robotics

As a whole, ECHORD^{++} has gathered a wealth of experience, developed structures, systems and best practice standards that can be utilized in myriad areas. Thus, while the project's impact is already immense, it is enduring legacy will continue to shape the robotics of the future for many years to come.

1.2 Project context and objectives

During the last 10 years, there were actually two ECHORD projects: ECHORD with a runtime from 2009 to 2013 and ECHORD^{++} from 2013 to 2019. "The ECHORD project, funded by the European Commission, enabled the bringing of robotics technology from the lab to the market in more than 50 cases[2]. Within the project we also successfully tested the funding of sub-projects via open calls," is how Günther Oettinger, former European Commissioner for Digital Economy and Society, described the success of the original ECHORD project (2009 – 2013). In 2009, ECHORD manifested itself as somewhat of an exotic animal in the European robotics research landscape. The fundamental ambition of the project consisted in bringing together robotics academia and industry or, in more general terms, technology providers and technology users, in the pursuit of innovation. At the times, within the European

[2] ECHORD funded 51 experiments. ECHORD++ funded 31 experiments besides 6 PTDI and numerous collaborations in the RIF facilities.

research community, excellence remained the central focal point, innovation a foreign, if not outright base, notion. Placing innovation front and center was a bold initiative. This was by design the underlying intent: promoting a shift in the academic culture. Stranger and more radical yet, none of the core partners (composing the initial consortium) would perform Research and Technological Development (RTD) work. Instead, this work would be undertaken by (and the majority of the funding passed on to) additional, extended partners, integrated within the consortium over the project's runtime, using a funding scheme now being referred to as Funding for Support of Third Party (FSTP), also called cascade funding. In particular, the work conducted within ECHORD was structured around two complementary constructs, the Experiments instrument, and the Structured Dialogue instrument. The former is designed around a set of focused (in time and scope) RTD projects, the Experiments that gave its name to the instrument.

The success of ECHORD was predicated not only upon its achievements in terms of technology transfer and innovation, although these were substantial, but also and probably more importantly upon the successful experimentation with a new way to pursue innovation: The Experiments instrument. Following its success in ECHORD, the format of this instrument was broadly propagated through the European research scene, and has been used in a large number of EC projects ever since. The mechanism has in fact become to be an integral part of the Horizon 2020 Work Programme.

Therefore, it is very natural that the follow-up project ECHORD^{++}, received support to build upon the achievements of the original. Despite Europe's long tradition of outstanding research and manufacturing in robotics, finding common ground between manufacturers and the research community persisted to be challenging. The original ECHORD project was of course able to remedy this fact to a notable extent, however, ample room for further activities remained, especially in defining the future direction of robotics research.

Capitalizing on the original ECHORD's success was the mission of the follow-up project ECHORD^{++} to promote the interaction between robot manufacturers, researchers and users. Following its motto "from lab to market" the project should not only serve as an incubator to drive innovation by facilitating the cooperation between the aforementioned groups, but also focus on the market perspective by supporting the RTD teams involved to create solutions as close to the market as possible in an EU-funded project.

Figure 1 - Robotic Innovation Facilities (RIFs) impression

To achieve these goals in complement to the "Experiments" ECHORD^{++} introduced two additional technological instruments, the Robotics Innovation Facilities (RIFs) and the Public end-user Driven

Technological Innovation (PDTI). The object of these were, at a conceptual level, to explore the efficacy of different setups and formats in pursuing and achieving concrete, substantial impact in robotics innovation. With the Experiments and PDTI, ECHORD^{++} offered research consortia funding to develop robotics technology for real use-cases. The RIFs provided a unique chance to try out new business ideas and make field tests at zero risk. These tools were tailor-made to meet the demand for innovative robotics technologies of the manufacturing industry, mainly Small and Medium Enterprises (SMEs) with small lot sizes and the need for highly flexible solutions, and public bodies, looking for robotics technology at competitive prices for tender processes. A more detailed description of the main instruments of ECHORD^{++} will follow in chapter 1.3.1. The "Structured Dialogue" of the original ECHORD brought together the stakeholders in robotics with a specific goal of analyzing trends, agreeing on goals and establishing co-operations. To pave the route to the market, in ECHORD^{++} the scientific and technical work was accompanied by extensive marketing and outreach activities way surpassing the scope of the "Structured Dialogue", both in effort and impact as will be described later in this document. Formulated in terms of means and ends, ECHORD^{++} strived to:

- create new knowledge through advancing the state of the art in robotics by developing novel technology from which new products may be derived;
- encourage European research institutions, robot manufacturers and end-users to work closely together at an operational level by means of the execution of experiments – with the goal to develop new research excellence and bring technology forward;
- enable different user groups (companies, public institutions, research organisations) to get easy access to state-of the art robotics hardware, software and scientific expertise for know-how transfer by means of providing the infrastructure in the RIFs;
- enable research institutions, robot manufacturers and public bodies to explore new application fields and start research & development-work for markets that would otherwise not be addressed, by means of PDTI activities;
- extract, consolidate and broadcast the actual progress achieved in the different instruments to the community of robot manufacturers and research institutions and beyond by means of continuous monitoring, reporting and public relations.

All these measures served a common purpose: Building up a powerful European community of robot manufacturers and research institutions that does not waste its resources in fragmentation, but that works together on a sound operational basis of common ground, trust and mutual understanding. The advantage of a combined action plan of academia and industry was seen to be a "chain of knowledge flow" that spans from concepts (originating from research institutions) to products developed by robot manufacturer. In this set-up, ECHORD^{++} serves as the scientific authority with the notion to establish contact and bridge the gaps between academia and existing, but also a large number of (potential new) users of robotic technology. In summary, the objectives of ECHORD^{++} were:

- to provide attractive opportunities for coordinated and target-oriented scientific research as well as knowledge transfer in robotics;
- to create a productive collaboration environment for research institutions and robot manufacturers across Europe;
- to advance the key enabling (emerging) technologies in a bi-directional, scientific exchange between research institutions and robot manufacturers;

- to encourage the development of new application domains and to enlarge the community of users;
- to provide the industry with tangible and measurable results in terms of the deployment of new technologies;
- to stimulate the involvement of end users in the research process;
- to promote the participation of SMEs with no experience in European research projects.

By taking advantage of the huge capital and personnel investment in the infrastructure already provided by the EC and partner TUM for ECHORD, all of these objectives could be implemented at the lowest possible cost – providing the best "value for money" with the lowest overhead for administration.

1.3 Main results and foregrounds

1.3.1 Instrument's overview

As introduced above, the three core pillars of ECHORD^{++} were the Experiments, the RIFs, and the PDTI instrument. All three addressed the same objective and thereby gave substance to the project's motto "From Lab to Market:" to extend support to technology providers and technology users with the final goal to provide conditions that facilitate the emergence of robotics innovation. Barriers to successful innovation are numerous and difficult to overcome (for instance the infamous "Valley of Death"[3]), and there exists no pre-made recipe guaranteeing success. Within that context, achievements of the Experiments instrument developed in ECHORD stood out as very positive. That model was extended within ECHORD^{++} to include additional support towards commercialization. The RIF model, which can be thought of as a pilot instrument for the Digital Innovation Hub model within the Digitizing European Industry initiative, explored a different setup and scope for innovation, directly providing technical expertise and access to robotics equipment to innovators. The last technical instrument discussed, PDTI, explored a novel approach to a notoriously challenging innovation process, Pre-Commercial Procurement.

Experiments

The format of the Experiments instrument remained largely comparable to that developed in ECHORD. Core ECHORD^{++} project partners framed the scope of the RTD work to be pursued in the instrument through the definition of targeted application areas. These target areas are referred to as scenarios, six of which were defined:

- Cognitive tools and workers for cognitive factories
- General purpose robotic co-workers
- Cognitive logistics robots
- Medical robotics
- Agricultural and food robotics
- Urban robotics.

In addition, four distinct research foci were defined: Key Issues in Practical Machine Cognition, Advanced Perception and Action Capabilities, Multiple Cooperating Mobile Manipulators, System Architectures, Systems and Software Engineering Processes and Tools

[3] S. K. Markham, S. J. Ward, L. Aiman-Smith, and A. I. Kingon, "The valley of death as context for role theory in product innovation," *Journal of Product Innovation Management*, vol. 27, no. 3, pp. 402-417, 2010.

Two open calls were conducted with a first set of fifteen Experiments joining the project and beginning RTD work in early 2015, and a second group of sixteen in mid-2016. The expected duration of each Experiment was eighteen months, with financial support in the order of € 300,000. The Experiments instrument distinguished itself in a number of key respects. In particular, the emphasis on innovation was pervasive throughout the process, from preferred Experiment consortium composition (including both technology provider and user, with the addition of a system integrator to facilitate technology transfer when relevant) to the development of an exploitation plan by each Experiment consortium.

This has been discussed during Experiments' kickoff events, followed-up through periodic monitoring over the Experiment's lifetime, and evaluated in final Experiments reviews, to the encouraged and facilitated participation to relevant professional fairs. So, visibility was raised for the developed product, up to the implementation of measures for commercialization support, post-Experiment runtime in the form of the Experiment Booster programme, further discussed in a later chapter.

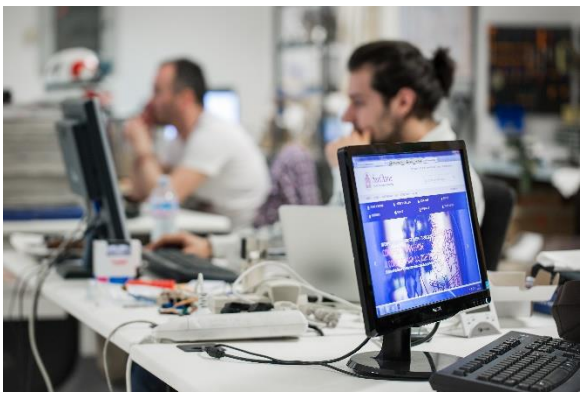

Figure 2 - ECHORD++ impressions

Another distinguishing feature was the nature of the support provided by the core ECHORD++ partners to Experiments partners, in terms of breadth, of frequency of exchanges, but also in terms of the procedural agility necessary to place Experiments in the best position to succeed. In particular, the aforementioned emphasis on innovation implies the delivery of support services extending well beyond the sole provision of financial support. More specifically, services in terms of networking like brokerage days, instrument-specific and project-wide community events, advice on tailor-made Public Relations activities, support for administrative aspects (as a service desk, accessible to all Experiment partners), and support for commercialization, business planning and development. PR included coaching of Experiments partners, definition of PR plan, invitation to high-profile professional fairs, and organisation of instrument- or project-wide PR events.

The structure of the Experiments instrument, as detailed in the project's description of work, called for frequent interactions between Experiment partners, performing RTD work, and core partners, providing support as discussed above, but also monitoring progress of the Experiment. The monitoring process was organized around two-monthly calls, on which Experimenters reported recent progress, setbacks encountered and corresponding possible deviations. The content of these calls was not limited to technical aspects but also included discussion of PR activities and refinement of the business plan for the developed product. Exchanges were supported by a dedicated online infrastructure, centralizing relevant documents, in particular deliverables, and keeping track of deadlines, milestones, status of Key Performance Indicators (KPIs) and of the general progress of the Experiment. This frequency of monitoring calls was high, relative to usual project progress-tracking procedures. In

practice however, monitoring procedures, and more generally the specifics of the support provided, was adjusted for each Experiment, based on particular needs identified. In other words, we observed tremendous heterogeneity, in the different Experiments funded, in terms of the nature of the work being conducted, the maturity of the technologies involved, and the experience and conversely, needs, of the Experiment consortium partners in different aspects like for instance technical expertise, PR or business development. Adjusting the support provided in accordance has proved a key factor to success, although the implied agility in implementation of project procedures required significant efforts from the core consortium partners overseeing the instrument.

RIFs

The ECHORD^{++} Robotic Innovation Facilities (RIFs) form a network of Competence Centres (CCs) in robotics. They offer support in the form of access to equipment and expertise in robotics to interested beneficiaries. The network is composed of three different RIFs, located in Bristol (hosted by the Bristol Robotics Laboratory, BRL), in Paris-Saclay (at the Commissariat à l'Energie Atomique et aux Energies Alternatives, CEA), and in Peccioli (at the Scuola Superiore Sant'Anna, SSSA). The particular form of the support extended to beneficiaries differed greatly depending on the specifics of the considered collaborations. However, the prototypical RIF technical project was conducted over a duration of six weeks, in collaboration between the external beneficiary and RIF personnel. Relative to technical activities in Experiments, the scope here was narrower, and work was generally performed at lower Technology Readiness Levels (TRL). In particular, Experiments were expected to lead to the development of a system beyond laboratory prototype (that is, TRL5 and above). Conversely, the target at the end of the six-week RIF collaboration was a Proof of Concept (PoC, TRL3).

Figure 3 - RIF impression

In contrast to the Experiments instrument, which built upon the strong foundation laid in the original ECHORD, the RIFs were completely new to ECHORD^{++}. To implement this new instrument on a European scale and to attract a wide target-audience for RIF engagements the consortium designed a simple and non-bureaucratic process. In particular, procedures regimenting the work performed in the instrument were designed to bring the barrier of entry as low as possible: potential beneficiaries only needed to identify, which of the three RIFs has the resources (expertise and equipment) to support the desired collaboration. Moreover, almost no paperwork was required (only a few pages describing the technical work foreseen and expected impact), the service was provided free of charge, and Intellectual Property of the foreground developed in the collaboration was left to the beneficiary.

As detailed out later in this report, the RIF concept in ECHORD^{++} provided to be very successful on many levels, not only in terms of technology and business development but also with respect to ecosystem building. As stated by ECHORD^{++} programme officer Cécile Huet the RIFs were “the proof of concept for the idea of developing an ecosystem around competence-centres with testing facilities”[4].

Public end-user Driven Technological Innovation

The Public end-user Driven Technological Innovation (PDTI) instrument explored the active involvement of a public end-user in the robotics innovation process. In practice, the instrument has

[4] youtube.com/watch?v=rEWHBhHKoAI

strong similarities with Pre-Commercial Procurement process widely acknowledged as challenging to enact. However, PDTI allocates a grant to the beneficiaries, following the funding rules of the European Commission and it has a more concentrated focus on co-creation facilitated by very intense coaching of the core consortium partners.

The PDTI process, as implemented in ECHORD^{++}, involved the following steps. Initially, a set of relevant application areas, within which robotics technology could be expected to provide tools for innovation, were identified. Core ECHORD^{++} project members then motivated the definition of innovation challenges corresponding to specific technological needs in these application areas by European public bodies. The core consortium issued an open call to reach out to public bodies to collect those challenges. A panel of experts ranked the proposed challenges, the top two being used as a basis for open calls soliciting proposals for robotic solutions by RTD consortia.

Two of originally six areas[5] identified as application areas in the ECHORD^{++} proposal were selected: the areas of healthcare (specifically, Comprehensive Geriatric Assessment, CGA), and urban robotics (monitoring of sewer networks). For each challenge, three RTD consortia were initially selected. The subsequent steps in the process emulate those involved in a PCP, with three successive and competitive development phases; the first dedicated to solution design, the second to prototype development, the third to the implementation of a pre-commercial solution. The significant differentiating factor of PDTI with respect to typical implementations of PCP consists in the development of involved intermediation processes, between RTD consortia and public bodies, led by core ECHORD^{++} project partners. Moreover, ECHORD^{++} allocated a grant, because there was no risk-sharing or co-funding between the public bodies and the RTD consortia. These processes have taken a form comparable to that of the monitoring procedures developed for the Experiments instrument and present a number of similarities to methods implemented for Public Procurement of Innovation.

1.3.2 Summary of Experiments

Throughout its runtime, ECHORD^{++} implemented 31 Experiments with the main goal of bridging the gap between the laboratories and the market. The Experimenters were given a lot of freedom in shaping the scope of their projects as long as they fit into five general application areas and four technological areas. A strong emphasis was put on involving both academic and industrial partners in each of the experiments, which led to the development of technologies answering the actual needs of the market while also pushing the frontiers of science.

ECHORD^{++} recognized the importance of digitalization of the agrifood sector, which currently is one of the main areas of the "Digitising and transforming European industry and services" focus area[6]. Both, **MARS** and **SAGA** focused on swarm-based solutions for precision agriculture. The first one developed and successfully deployed two cloud-connected ground robots with precise localization technology and integrated seeding units. The second developed a weed detection system, which can be used by a swarm of drones for precise weed removal. The **GRAPE** project also tackled the problem of targeted intervention in agriculture by developing an autonomous robot with pheromone dispenser for precise plague control.

[5]These areas were pre-defined by the core consortium. The challenges specifically submitted by the public bodies are CGA and sewer inspection.

[6] https://ec.europa.eu/programmes/horizon2020/en/sites/horizon2020/files/DT_booklet.pdf

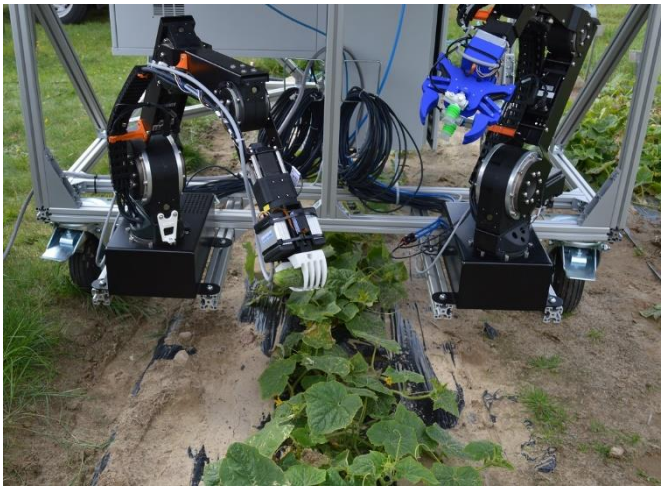

Figure 4 – CATCH prototype

The other projects in the Agrifood area focused on reducing the strain of repetitive and arduous tasks. **3DSSC** developed a robotic solution for peeling of large cheese blocks. Thanks to a precise 3D sensing it achieved accuracy and waste level similar to human workers. The project generated enough commercial interest to tackle the speed of processing in the next stage. A specialized gripper supporting grafting operation was developed within the **INJEROBOTS** project, while **GARotics** and **CATCH** focused on the tedious task of harvesting plants. The first one led to development of sensing system capable of detecting 100% of green asparagus and specialized tool successfully harvesting 95% of them whereas the second resulted in a system robustly detecting over 85% of cucumbers in the test trials.

Cognition in tools, workers and logistics was in the focus of several experiments aiming to deliver robotic solutions capable of perceiving, reasoning and interacting with their environment in several areas, e.g. precise manipulation, waste sorting, logistics. The **DEBUR** project developed an autonomous laser deburring system with integrated visual quality assessment of processed parts. Novel tactile sensors facilitated success of two other projects – **PICKIT** and **WIRES**. The first one managed to reduce the cycle time of bin picking tasks by up to 36%. In the second one, the tactile gripper combined with and advanced vision system and dedicated gripper, was successfully used to automatize routing of wires in switchboards.

Two of the ECHORD^{++} experiments addressed the topic of waste sorting. The system developed within the **AAWSBE1** experiment applied deep-learning-based vision system to improve efficiency of extracting batteries form waste electrical and electronic equipment by 5%. The **RadioRoSo** team developed a robotic system capable of autonomous sorting of radioactive Magnox swarf.

Using improved cognitive capabilities in logistics applications was in the core of three other ECHORD^{++} experiments – **SAFERUN**, **FASTKIT** and **MAX-ES**. The first one developed a new planning algorithm with variable velocity profiles improving both the performance and smoothness of the AGV's movement while adhering to kinematic and safety constraints. The second developed a novel solution combining mobile robots and cable-driven parallel robots. The resulting system facilitates fast picking and kiting tasks in densely planned, high bay rack warehouses. Finally, **MAX-ES** addressed tasks of autonomous navigation, safety and docking of a heavy AGV (22 tons). The developed system conforms to the requirements of the industrial partner and is capable of in- and out-door operation in highly demanding environment of aluminium smelter.

Not all of the projects had such a highly focused application area, and instead developed widely applicable tools benefitting from cognitive technologies. **DUALARMWORKER** developed tools and libraries supporting motion planning, automatic programming and collision avoidance for bi-manual assembly tasks. **FlexSight** developed an integrated and cost-efficient smart 3D sensor supporting bin

picking, assembly and detection tasks. Finally, **CoCoMaps** released the second version of the Psyclone framework supporting verbal and visual communication between robots and humans.

The third focal area of the ECHORD^{++} experiments, being highly coherent with the Human Factor focus area of the Factories of the Future Roadmap[7], revolved around robotic co-workers supporting humans in manufacturing tasks. Programming of the robots still requires considerable expertise, lack of which is often one of the reasons of limited adoption of robotic solutions. In order to tackle this issue, **CoHRoS** developed intuitive assisting teaching tools for highly redundant robots. Intuitive programming of robots was also in focus of **DexBuddy**. The project also demonstrated software successfully combining 3D vision, tactile fingers, and force and torque measuring wrist for online motion and grasp planning and force-controlled motion in industrial applications.

Figure 5 - HyQ-REAL prototype

Two of the ECHORD^{++} experiments dealt with quadrupedal robots using series elastic actuators. Both **MODUL** and **HyQ-REAL** developed robust robotic solutions capable of assisting humans in difficult terrain. A different approach to safe human-robot collaboration was demonstrated within the **SAPARO** experiment. A tactile floor covering the whole work cell was developed in order to allow for a fenceless collaboration between human workers and high payload robots. This sensing device was then complemented with an Augmented Reality system dynamically displaying the safety zones to improve the efficiency of such collaboration even further.

Finally, two of the experiments developed collaborative systems for very targeted and specific applications. An assistant robot supporting human workers in the tire changing process was developed in **TIREBOT**. Test trials showed, that the required effort of workers was reduced by 63%. The **2F** project developed a mobile cobot for the construction yards capable of grout removal and acid cleaning of floors.

The last application area of the ECHORD^{++} experiments, also consistent with the "Digitising and transforming European industry and services", dealt with robotics for healthcare and rehabilitation. Three of the experiments focused on the post-stroke treatment and rehabilitation of the upper limbs. **MOTORE^{++}** developed the first planar rehabilitation robot small enough to be easily carried and used for home exercise. **LINarm^{++}** used variable stiffness actuators to develop a linear movement rehabilitation device. The device included also components for unobtrusive measurement of patients' state, sensor fusion and biofeedback, significantly increasing functionalities of the robot. The low-cost device developed in the **HOMEREHAB** project extends the concept even further and uses 3D manipulator for advanced rehabilitation in home setting. Moreover, it developed a platform for remote monitoring of patients' progress. A similar approach was followed in **KERAAL**, where the

[7] https://www.effra.eu/factories-future-roadmap

humanoid robot is used to guide patients through physical rehabilitations sessions aimed at alleviating lower back pain.

The goal of **LA-ROSES** project was to develop a robotic solution dedicated to laser-assisted keratoplasty -cornea transplantation. A robotic arm is used to position tool responsible for welding of the eye tissue over the patient's eye. The system allows the surgeon to precisely control the trajectory of the tool and supports this task with vision system.

The **EXOTrainer** experiment used available technologies to target a new target group – children affected by Spinal Muscular Atrophy. The prototype gait exoskeleton developed in the project provided walking ability to patients and is currently undergoing clinical trials.

Some of the ECHORD^{++} experiments delivered not only the expected results but also additional, originally unforeseen, highly relevant and exploitable results. Those include the **series elastic actuators** developed as an enabler for the **LINarm^{++}** rehabilitation device and the **navigation and onboard computer module** developed as the control unit in **SAGA**. Such additional, easily marketable solutions will support the experiments in their road to commercialization of the originally planned results.

The Experiments instrument of ECHORD^{++} resulted not only in the technological innovations described above. The process innovation related to organization, implementation as well as monitoring and reviewing of the cascade-funded experiments is not to be overlooked. The Open Call Platform developed in ECHORD & ECHORD^{++} is now used in many European Funded projects. The platform is outstanding with the functionalities it comes with, but also with regard to its excellent documentation: an operational handbook, a virtual testing environment with test protocols to avoid bugs when setting up new calls, a Quality Management handbook with process descriptions and all reference documents.

A methodology for continuous monitoring and regular interactions between the experimenters and moderators assigned by the core consortium was shaped during the first call. Based on the lessons learned, the methodology was further improved during the second call, e.g. by adding a second moderator and clearly separating the roles of the technical and administrative moderators. Moreover, a KPI-based evaluation framework was formulated leading to increased transparency and efficiency of the progress evaluation and final reviews. This methodology has been successfully implemented in many Horizon2020 projects involving the Financial Support to Thirds Parties such as HORSE, RobMoSys, ESMERA and the Human Brain FET Flagship project. Other projects, where TUM is not directly involved (as a partner or is not in charge of the management of the open calls) started to use the platform as beta users as well.

Figure 6 - UnternehmerTUM

Finally, a new instrument, further supporting the experiments in their mission of bridging the gap between lab and market was developed and implemented. The concept for the new instrument was driven by realization, that although many of the experiments developed innovative and relevant technological solutions, they still needed the final push to transform those into successful products. The Experiments Booster Programme (EBP) consisted of two complementary segments – coaching and incubation programme delivered by external institutions (e.g. UnternehmerTUM) and consideration for the third tool, TechFounders, accelerator programme bringing together the participant with potential industrial partners.

Participation in EBP required 5-month relocation of the members of the experiment team to Munich and co-participation in the costs of the programme. The reason behind that was to ensure that only highly motivated teams applied for and participated in the programme. Applications from 7 experiments were received, out of which 4 were selected for funding: SAGA, ExoTrainer, LINarm^{++} and MODUL. Each of the selected projects had different expectations and needs, which were addressed via individualized coaching and incubation approaches.

The EBP allowed **Avular**, member of the original **SAGA** experiment, to redefine the strategy of the company, to acquire new investors and to focus on the development of a new product – the Curiosity Core based on the on-board computer developed within SAGA.

ANYbotics, a spin-off of ETH Zurich funded to commercialize the results of the **MODUL** experiment, used the additional support to reengineer the series of elastic actuators, increase their robustness and reduce production costs. Similarly, the participants of **LINarm^{++}** developed a more advanced and market ready version of their actuator and shaped business strategy to bring it to the market and thus finance further development of the rehabilitation device.

Finally, **Marsi Bionics**, one of the **EXOTrainer** partners, used the additional support to prepare strategy for entering the German healthcare market, which is crucial to ensuring the commercial success of the project.

1.3.3 Summary of RIFs

Introduction to the RIF Booster Programme

The Robotics Innovation Facilities (RIFs) have received funding from the ECHORD^{++} project to serve as collaborative test beds for exploring how academia can successfully interact with small, medium and large enterprises to drive robotic development and economic growth in Europe. After the runtime of ECHORD^{++} the RIFs are expected to be self-sustainable and establish a collaborative network. In order to support the RIFs through this transition period, ECHORD^{++} has engaged professional business and organizational development consultants with expertise in robotics to work with the RIFs[8]. Besides outlining a development plan for the three RIFs (portfolio of services to be offered, business models and business plan), the consultants provided a deep analysis of the status quo at each of the RIFs and the RIF network as a whole including analysis of hitherto existing RIF collaborations. Therefore, the following section of this report combines summarized insights from the ECHORD^{++} core consortium with the consultants' report. It is notable, though, that as stated by the consultants all three RIFs share the same goals as those presented in the RIF project description, but with differing maturity levels and with a focus on different customer types, based on their distinct business ecosystems. This has resulted in variation in terms of how the RIFs have each prioritized their activities to achieve the formulated goals of the RIF Project.

Collaborations at RIF Paris

RIF Paris is operated by CEA List and is integrated within their existing Interactive Robotics Laboratory (IRL), which consists of about 50 researchers. IRL conducts technology research to develop disruptive and radical solutions in the field of robotics.

Figure 7 - ISYBOT

Customers, such as robot developers and qualified end-users, provide fifty percent of the funding for RIF Paris, the majority of them being larger manufacturing companies. Thirty-five percent of the funding comes from public organizations, including the European Commission (EC), national, and regional bodies. The parent company, CEA List, also supports the robotics lab, providing fifteen percent of the funding. The biggest cost drivers are technology and domain experts. CEA List has a long relationship with French industry through their network of spin-offs e.g., ORANO (formerly Areva), as well as through their collaboration with technological organizations that are working to improve the competitiveness of French companies, such as CETIM and SYMOP. Interviews with RIF Paris stakeholders and customers identified the RIF skills and assets that they have found to be of particular value, namely, the RIF Paris research expertise and their ability to assist with fast prototyping, in a time effective and interactive way. Furthermore, when discussing the interview results with RIF Paris, the consultants discovered that the RIF operators have implemented a qualification routine that is conducted before engaging

[8] Namely the Swedish company WIDE Idea Development AB

with customers. This qualification routine has the potential to serve as a model and to provide value for other existing and future innovation hubs, helping them to identify and focus on 'true' customers. These are customers that are ready to implement robotics in their organizations, in terms of having sufficient knowledge and resources, or those that have the capacity to reach this level if they are given reasonable support that can be provided within the available budget.

The outreach activities conducted by RIF Paris rely on personal contacts, through the central marketing function at CEA List and through industry networks, such as CETIM. One of the main benefits of the RIF investment has been the intensification of these outreach activities. A particular challenge for RIF Paris is related to difficulties in reaching out to sectors other than the manufacturing industry, such as healthcare robotics. Another challenge is outreach via digital communication, such as through their webpage and social media. This is because communication channels within CEA List are centrally controlled and are not able to be modified by the RIF itself. During the runtime of the RIF programme within ECHORD^{++}, RIF Paris has executed 21 projects, of which ninety percent were in the field of manufacturing. Eleven large enterprises, seven SMEs (including one robot development company), two Research and Technology Organizations (RTOs)/Academic organizations, and one start-up were supported during the three-year period.

It is important to mention that RIF Paris also works in partnership with system integrators. These collaborations are based on the RIF Paris strategy to work at lower Technology Readiness Levels (TRLs). When projects get closer to reaching higher TRLs, RIF Paris hands them over to system integrator partners, who then support the company in transforming their prototype into a commercial application. Notable collaborations of the RIF Paris in the last years were:

1 **WM88**, which is an SME producing prefabricated kits for kitchen and bathrooms, which are distributed in France and the UK. WE88 has approximately 150 employees and delivers around 70,000 kitchen cabinets and around 1000 bathroom cabinets per year. WM88 encountered RIF Paris through their industrial network, as they needed to automate parts of their production line related to packaging. RIF Paris assisted WM88 in understanding how robotics could be used and helped with the development and benchmarking of the first robotic prototype. RIF Paris subsequently introduced WM88 to a system integrator who implemented the robotics in their organisation. The feedback from WM88 is that RIF Paris helped them to identify and realise a radical solution to their needs and demonstrated the commercial benefits of this kind of automation investment.
2 **Orano (former Areva)** processes nuclear materials. The R&D department at Orano actively contributes to the energy and medical radiological research fields, through a back-end business approach that includes modelling, simulation, electronics development, and technology development for robotics. Orano is a spin-off from CEA List and is now a strategic CEA List collaboration partner. In partnership with RIF Paris, Orano develop products that meet the needs of their customers, with a focus on three main areas: Tele-operation for computer-aided robotics, simulations for train operators, and radiation for tolerant electronics. Solutions in these product areas are both developed and prototyped for implementation by RIF Paris. In conclusion, Orano is of the opinion that RIF Paris has a good understanding of their needs and limitations and is highly responsive in meeting their needs. Of particular value to Orano is the research expertise within RIF Paris.

3 **Isybot** is a spin-off from RIF Paris. The CEO is a former employee of the Interactive Robotics Laboratory. Isybot's collaborative robots, or cobots, leverage an actuator technology developed by the IRL that does not require force sensors, making the robots simple, accurate, lightweight, and safe for the operators they assist. Isybot is an example of a spin-off from RIF Paris that has received support through the structured technology transfer process at CEA List. Currently, Isybot is located at RIF Paris, where the facilities are used to conduct continuous R&D.

The financing of the transformation of RIF Paris into an RCC has been secured by the following five European projects:

- ESMERA – with the aim of supporting SMEs in the realisation, testing and promotion of novel robotic technologies.
- COVR – with the goal of increasing safety for all robots sharing space with humans.
- TERRINET – aimed at creating a network to maintain Europe's leadership in Robotics, by focusing on research.
- RIMA – a project with 23 partners aiming to establish 13 Digital Innovation Hubs (DIH) in robotics, sharing best practices and providing services to facilitate uptake of Inspection and Maintenance technologies.
- DIH-HERO – a network of 16 DIHs, which aims to boost innovation and implementation of robotics in healthcare.

The brand name RIF@Paris-Saclay will be used for the future operation. The RIF processes have been improved to enable better interaction with SMEs and a better understanding of the different needs of each type of SME, for example, end users, technology providers, service providers and system integrators.

RIF Paris have improved their methods and tools for communication with internal and external stakeholders in order to agree upon common values and rules for each project and to ensure that all parties share the same objectives. The internal processes for communication, dissemination of results and marketing within CEA List have been more clearly defined and the cooperation between the different departments has been improved.

Collaborations at RIF Peccioli

RIF Peccioli is operated by the competence centre at Scuola Superiore Sant' Anna (SSSA) in conjunction with TechnoDeal, a spin-off from SSSA. RIF Peccioli consists of the Biorobotics laboratory along with indoor and outdoor areas for on-site testing of robotic solutions, but the RIF also cooperates with the other robotic labs at SSSA. TechnoDeal is the driver at RIF Peccioli for identifying spin-offs and start-ups, as well as for cooperation with existing industry and business development projects. A team of young engineers and project leaders at the SSSA competence centre, who work closely with TechnoDeal, supports and administers these activities. RIF Peccioli has no employed researchers in the organisation. Instead, they collaborate in their projects with PhD students, postdoctoral students and researchers from SSSA.

Figure 8 -RIF Peccioli

35% of the revenue for RIF Peccioli comes from private companies. Regional and national bodies contribute with fifteen percent, while fifty percent is provided by EU funding. The main outreach activities are proactive sales activities and networking activities undertaken by TechnoDeal, and joint activities with SSSA to identify possible spin-offs. SSSA's reputable brand means that many companies, both SMEs and large enterprises, approach the university seeking cooperation in the field of robotics. The discussions with RIF Peccioli customers revealed that the primary value in building international hubs is the international knowledge that they are able to share, rather than providing a direct benefit to the local spin-off or SME.

In summary, RIF Peccioli has hosted around 10 experiments with different consortia, including large enterprises, SMEs and start-ups. Two projects have been executed where single SMEs have approached RIF Peccioli with defined problems to be solved. What stands out at RIF Peccioli is their ability to create spin-offs from their research projects. The spin-offs are not only based on the end results of the research projects, but also on the identification of the potential for commercialization of intelligent problem-solving that occurs during the projects. TechnoDeal, which is mainly financed by the RIF project, has successfully demonstrated the ability to match industry requirements with the research results and competences at SSSA. This has resulted in 10 start-ups since 2015. Notable collaborations of the RIF in Peccioli are listed below:

1 **3DNextech** is a spin-off from SSSA that has developed a device designed to reliably finish objects in ABS and cellulose acetate. This device is a by-product of robotic research at SSSA, where the aim was to develop an underwater robot. During the development process of the robot, the researchers used a 3D printer to develop the prototype and needed to incorporate a process that would provide a smooth and waterproof finish for the 3D printed object. This process does not exist on the market today and so the researchers developed one to meet their needs. They then realised that this newly developed tool, a specific ABS and cellulose acetate process, could be of great value to other industry sectors that use 3D printing in their manufacturing process, such as eyeglass manufacturing companies, as it offers considerable timesaving. At this stage, the SSSA researchers reached out to RIF Peccioli and received support from TechnoDeal with market analysis, business plan development, and IP creation. TechnoDeal further assisted 3DNextech to apply for and secure financing from a business angel, which enabled the creation of the 3DNextech spin-off company. RIF Peccioli and TechnoDeal are continuing to support the company by helping them to find and apply for additional regional funding.

2 **KW** is an SME in Tuscany that supplies appliances, installations, and services for cold-chain and thermo-stations. Their products are used in the biomedical, scientific research, and industrial sectors. KW knows SSSA and TechnoDeal from an earlier collaboration project undertaken in 2013/2014. Given their positive experiences with this project and the good reputation of SSSA, KW approached them again when they encountered difficulties in meeting the EU regulations for their blood plasma storage product. They then received support from TechnoDeal and RIF Peccioli in

developing SMART freezing equipment. The project started in 2015 and the first prototype was ready in 2016. After validation at a hospital in northern Italy, KW have now received certification to use their product to store biological and medical material, i.e. blood plasma. Of primary value for KW was the development of software and electronics to manage the smart device. KW will continue to work with RIF Peccioli on other developmental projects with fast and scientific prototyping requirements.

3 **TURF Europe** is a spin-off from Pisa University, qualifying as a small consultancy and R&D firm specialising in building and maintaining turfed areas of all types. TURF focuses on precision farming, which is a business growth area in Europe and which is of particular value for farming communities in Tuscany. Currently, the technology developed and sold by TURF is targeted at the football stadiums market, where light exposure of the turf is uneven over the course of a day and parts of the turf are in shadow, while other parts are exposed to the sun. The first sales of their product were in 2017 and TURF now works with football clubs in several countries, including Spain, Italy and England. TURF had previously worked with TechnoDeal on a joint application for public funding and, as a former customer, were invited to the launch of RIF Peccioli in 2015. Subsequently, it seemed natural to contact RIF Peccioli when TURF conceived the idea of a portable, automatic and battery-driven weather station. In 2016, through the interaction with RIF Peccioli, TURF met engineers at SSSA who helped them to develop software and electronics, to perform a technical feasibility study and to streamline the selection of suppliers.

4 **Castellani**, a top-ranked medium sized winery in Tuscany, has opened up one of the vineyards close to Pontedera for robot experimentation. The company values an innovative mind-set and wants to be part of developing new solutions, including robots and drones, for a sustainable agricultural future in Tuscany. The principal reason for Castellani working with RIF Peccioli is that SSSA is a reputable brand with which to be associated in Italy. Previous experiences have shown Castellani that it is worthwhile investing in research studies, even if the innovations are currently far from implementation, as this increases the global competitive advantage of their wine on the market. With regard to the implementation of robotics in their business, this will take place as soon as the Return on Investment (ROI) calculations are good.

5 **Geostech** is a small company that, in collaboration with RIF Peccioli, has developed an integrated and intelligent Internet of Things (IoT) solution for the geographical location of objects and people. One application is the transmission of vehicle operating data, which enables, for example, a prediction of maintenance. Another use of the system is in personal security applications. In addition to the technical collaboration with RIF Peccioli, TechnoDeal assisted the company in the development of the business plan. Geostech's rationale for collaborating with RIF. Peccioli became aware of the competence centre through their network. In common with TURF, Geostech also highlighted that the success of their collaboration with RIF Peccioli was based on the fact that they already had a basic idea of what they wanted to do before they approached the competence centre. Geostech are currently planning a further joint collaboration with RIF Peccioli and TechnoDeal.

In Italy, the RIF concept has been used as a model for the national project ARTES 4.0, financed by the Italian Ministry of Economic Development (MISE). The project consists of a network of 13 universities and 115 companies with a total budget of 30 million Euro. Eight of the universities are responsible for

one competence center each, all with a different focus. Robotics is the primary focus of Scuola Superiore Sant'Anna (SSSA).

The ARTES 4.0 project is expected to be self-financing within three to five years. The RIF brand will still be used, but the location will shift from Peccioli to Pontedera, where SSSA is based. The plan for RIF Pontedera is to expand to up to 20 employees within three years.

The RIF Pontedera offering will consist of the following:

- Basic Research, Technology Readiness Level (TRL 1-4). Synergies with the European project TERRINET will be established
- Applied research and product development (TRL 5-9)
- Business Development
- Financial support, through a network of various funding bodies.

One significant advantage provided by ARTES 4.0 is that the offered services can be distributed through the national network of competence centers. As a complement to normal outreach activities, such as fairs, exhibitions, cold calls and personal meetings, a "booking.com" concept will be developed, where companies with a concrete need can be matched with a suitable partner in the ARTES 4.0 network.

Collaborations at RIF Bristol

Figure 9 - RIF Bristol

RIF Bristol is operated by the Bristol Robotics Laboratory (BRL), a well-established laboratory with a large number of existing robotics research projects, financed largely by national funding, but also by some EU Funding. BRL have chosen to allocate a special part of the lab to the RIF project. The RIF can rarely use other BRL resources, as these resources are dedicated for the specific research project for which they have received financing (profit-center approach from the beginning). RIF Bristol has complete control of the resources that are available to support external companies and spin-offs, with the drawback that the lack of flexibility can result in waiting times. In comparison with the other RIFs, RIF Bristol has been 100% financed by ECHORD^{++} and has not benefited from synergistic solutions through other funding sources at BRL. RIF Bristol is located at the University of the West of England, Bristol (UWE).

RIF Bristol is the only of the three RIFs that has a clear and well executed system to support organizations over a six-weeks period in prototyping their ideas and then channeling them out through their connections to continue their business development. This system has resulted in 43 successfully executed projects since 2015, with support provided to 26 SMEs, four large enterprises, five start-ups and seven RTO/Academic organizations during the period. The most important collaborations of the RIF in Bristol can be summarized as follows:

1 **Reach robotics** is a startup selling the gaming robot MEKAMON, an entertainment platform, which is able to engage with others of its kind in "robot battles" via augmented reality. Company founder Silas Adekunle has had the kind of big breaks most startup founders only dream of: a $10 million funding raise, a place on the Forbes 30 Under 30 in Technology list and an exclusive distribution

deal with Apple for his € 300 platform combining robotics, gaming and AR. However, in 2014, when he first stepped into the newly-opened Robotics Innovation Facility (RIF) in Bristol, UK, success was by no means certain. Adekunle credits the RIF with not only introducing him to one of his co-founders, Chris Beck, but also for providing valuable manufacturing contacts, prototyping facilities and software development for their new startup, Reach Robotics. According to Adekunle the facilities, market validation and tailored support provided were key to enabling Reach Robotics to pitch to potential investors and take the company to the next stage.

2 **Walk to Beat** is a student-driven spin-off from UWE that has developed a unique walking stick, aimed at minimizing freezing and gait problems experienced by Parkinson's disease patients. The company approached RIF Bristol for help with design and prototyping. Over a period of six weeks, the team in RIF Bristol and Walk to Beat collaborated to develop a prototype. This prototype was used to obtain feedback for further development from patients suffering from Parkinson's disease, as well as being used in presentations to medical staff at hospitals and to potential funders and financiers. Without the support of RIF Bristol, Walk to Beat would not have been able to build a prototype, as the company had no engineering expertise.

3 **Numatic International** is a large enterprise with 900 employees manufacturing industrial cleaning equipment such as vacuum cleaners and scrubber dryers. RIF Bristol helped them to pilot and embed robotic automation assembly capability and knowledge, which resulted in improved products and processes to sustain their global competitive advantage. A particular focus of the collaboration was the use of cobots. Numatic came to know the RIF by participating in an open day at BRL. Through the interaction and support of the RIF project, Numatic also learned about the KTP (Knowledge Transfer Partnership). Securing KTP funding enabled the company to continue to work with RIF Bristol one day per week over six months, and to hire an automation engineer to develop a proof of concept. This investment resulted in a cost saving of about 25 percent for Numatic International. Numatic will continue to work with RIF Bristol on future projects and also recommend that other companies in their network approach RIF Bristol for expertise and support in automating their production lines through robotics.

4 **Your Socks On** is a start-up company owned and operated by Mike Milligan, who has himself experienced a spinal-cord injury. RIF Bristol helped Milligan to develop and test a prototype of a device to assist people with, for example, a broken back, in coping with their injuries and performing everyday tasks. This idea is based on Milligan's personal post-operative experiences. He realized that there must be a market for a device such as Your Socks On, particularly to help with the task of putting on compression socks used in hospitals. Working to realize his Your Socks On device idea, Milligan was advised to approach RIF Bristol by a contact who had been a previous customer of BRL. RIF Bristol supported Your Socks On in developing and testing the functionality of the product.

5 **Pradeep Devadass** was an architecture student who worked with RIF Bristol to incorporate robots in architecture. The cooperation included two steps: First, for Devadass to learn how robots work and how to use them; and second, to help him develop custom software packages for real-time simulations. The project was focused on how to design using the natural form of trees and how to use robots to construct an architectural structure from them. Devadass was a KTP associate, funded by Innovation UK, with an architectural university and RIF Bristol as partners. The value of RIF Bristol for Devadass was in having different knowledge areas consolidated in one place. The findings of the project have not been commercialized, largely because it was difficult to find a

market and the funding necessary to continue the project. This case highlighted the potential for robotic competence centres to identify high achieving students from different academic fields who show promise as future 'super' entrepreneurs; students who are bringing robots into their research area and making robotics valuable to their fields from both a developmental, research, and business creation point of view.

In October 2018, RIF Bristol secured funding from European Regional Development Fund (ERDF) for three years to assist SMEs. This new program is called SABRE and has circa one million pounds sterling in funds. The aim of SABRE is to support SMEs across Bristol, Bath, North Somerset and South Gloucestershire with the implementation and use of robotics.

In comparison with the RIF Bristol as part of ECHORD^{++}, the time of engagement with customers in SABRE is more flexible, ranging from five days to three months, but the project is more stringent in terms of defining the expected tangible results. This has resulted in a more comprehensive investigative process before choosing companies with which to engage. The new financing instrument enables more engineers to be involved, seven people on a regular basis and up to ten people when needed. The RIF Bristol brand and the special facilities used for RIF activities have been retained (see http://www.rifbristol.com/). Software tools for the estimation of project costs have been established, which make it easier to monitor and follow up on each project.

The basic offering will continue to be robotics hardware development, but the project has a parallel goal to build up a consultancy service that, over the long term, will contribute 30% of the turnover. The main challenges to overcome in achieving this goal are the strict rules governing an ERDF project and the University regulations for commercial activities.

The first customer in the new SABRE project was identified during the RIF project. Three new customers have been added to the list of SABRE clients. The overall pipeline for SABRE currently has three additional clients. The target for the next three years is to assist fifteen companies. It is likely that this target will be met and probably exceeded. A marketing budget of £15,000 has been allocated within the project in order to secure a pipeline of new leads. In addition, visits to identified potential customers have been intensified. The successful RIF engagements with Numatic International and Walk to Beat have increased awareness of the RIF Bristol capabilities. This, in turn, has led to companies in the region initiating contact with SABRE to investigate possible cooperation opportunities. More recently, a local company has awarded RIF Bristol a contract for training in robotics and automation. It is expected that this contract will be repeated a number of times over the next year.

1.3.4 Summary of PDTIs

Public bodies often have specific requirements for the products they use. ECHORD^{++} offers to both the technology developers and the public authorities the chance to closely interact and interface with each other during the conception and development of the solution. This is to make sure that the product meets the requirements of the target group, technically and price-wise.

Even though there is little doubt that activating the public sector would release a tremendous innovation power in Europe, the situation is still as Aneesh Chopra, the first Chief Technology Officer

of the United States, stated back in 2014: „Almost no one likes the procurement process“ and „public purchasing should welcome entrepreneurial ideas“[9].

On a European scale, Pre-Commercial Procurement (PCP) and Public Procurement of Innovation (PPI) are potential answers to this challenge. And: there are many good examples of EU-funded projects geared to software development where this works well. For robotics, though, with sometimes very complex hardware involved, these programmes did not really take off. ECHORD^{++} has identified several factors, which have prevented robotics technology from fully unfolding its disruptive innovation power in the public sector so far:

- Robotics technology requires a lot of explanation and there is often a language barrier between procurers, who think about benefits, and providers, who think about functions.
- A lot of people have psychological hurdles when dealing with robotics as they are afraid of not being able to “master” it properly (hurdle to deal with technology).
- New robotics companies, being entrepreneurial, do not naturally look at the public sector for making technology sales at an early stage.
- There is often a separation in the public bodies as owners of the problems, who can understand where technology may fit, and the procurers of solutions or products.
- Developing robotics solutions for new applications (in both public and private sectors) can take significant development time, whereas public procurers have become used to off the shelf solutions.

Our answer to these challenges – compared to PCP and PPI - is to shift the focus in our collaboration with public stakeholders. Instead of putting the emphasis on the procurement itself (meaning co-funding and risk-sharing between the supplier and the public procurer, with the aim to motivate the procurement of technology by the latter), as done in PCP and PPI, ECHORD^{++} has set up a process which puts a very strong emphasis on co-creation and knowledge transfer.

This is done by transferring the successful concept of the “experiments” invented in the first ECHORD project and further fine-tuned in ECHORD^{++}, to the collaboration with the public sector under the umbrella of ECHORD^{++}’s new instrument: PDTI. Following these lines, our major goal was not to initiate a tender process (with financial risk sharing during technology development), but ECHORD^{++} allocated a grant instead (following the funding rules of FP7). The RTD development teams fully covered the cost of their effort via European Commission cost claims. In addition, the public stakeholders, i.e. the owners of the sewer in Barcelona (for PDTI urban robotics) and the hospital in Barcelona (for PDTI

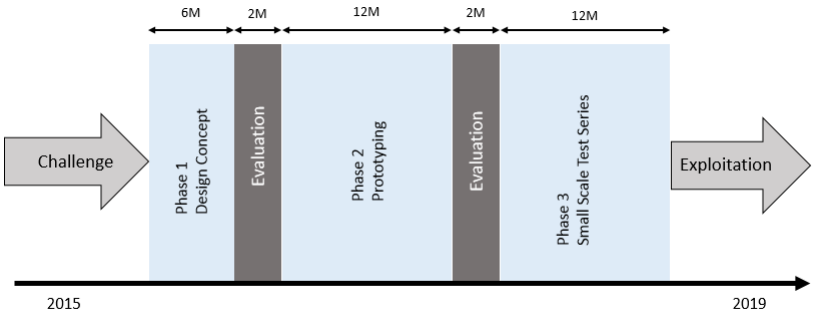

Figure 10 - PDTI Phases

[9] http://www.govtech.com/budget-finance/Bringing-Innovation-to-Procurement.html.

healthcare), voluntarily put additional support effort (effectively an in-kind contribution) as they realized the benefits the new technologies would bring to them.

In terms of co-creation, PDTI again benefited from the knowledge gained with managing the experiments in old ECHORD and ECHORD^{++}, and mainly with the intensive coaching of the RTD development teams by members of the ECHORD^{++} core consortium. This coaching had a dual focus in which core members with a technical background teamed up with members with a commercial background and profound experience in commercialization / technology transfer. The technology development process in PDTI was done in a competitive approach in three sequential development phases. Based on requirements specified by public authorities in the area of urban robotics and healthcare, two concrete challenges were identified for PDTI in ECHORD^{++}.

Sewer inspection was selected as the ECHORD^{++} challenge in the area of urban robotics: Sewers require many humans to work in risky and unhealthy conditions. Introducing a robotics solution in this process aims at reducing the labor risks, improving the precision of sewer inspections and optimizing sewer-cleaning resources of the city, not only in terms of economic expenses but also in terms of water required for the cleaning process and of machinery needed. For ECHORD^{++} the city of Barcelona has provided its sewer network as use-case and test site.

The required robotics solution was required to be able to determine the state of the sewer in order to identify segments where the sewer's functionality has been compromised, either by sediments or by structural defects. Other required functionalities of the technology include sewer monitoring and collecting samples of water, air and sediments.

In the area of healthcare, **Comprehensive Geriatric Assessment (CGA**) was selected as the ECHORD^{++} challenge. CGA is a diagnostic instrument designed to collect data on the medical, psychosocial and functional resources and problems of elderly patients. The information gathered is used to create an overall plan for treatment and follow-up.

Currently, social and clinical professionals involved in the care of elderly people perform CGA: physiotherapists, occupational therapists, nurses, social workers, psychologists, medical doctors, etc. Utilizing robotic technology to conduct geriatric tests will reduce the time medical professionals have to spend with purely mechanistic tasks like documentation. Thus, they will have more time to develop individualized care plans for their patients. The possibility to assess and record the cognitive and physical status of a patient increases transparency and objectivity of the assessment. The interim results of the technology development were to be evaluated in the geriatric hospital itself in the traditional manner.

The sewer network is one of the essential infrastructures of a city. Its characteristics – a very wide underground grid of pipelines and galleries, frequently narrow and worn out – along with the presence of big amounts of waste, yield a hostile working environment. Automated collection of data in an environment of this nature is a complex task: in many points of the sewer network the ground is highly irregular and full of obstacles that, combined with the high levels of wastewater and litter, impedes greatly the operability of terrestrial vehicles.

At the end of ECHORD^{++}, there are two different solutions to address the specific challenge regarding maintenance and inspection of sewers.

ARSI (Aerial Robot for Sewer Inspection)

The specific challenge of this solution: The use of a Micro Aerial Vehicle (MAV) for inspection tasks in the sewer avoids the mobility constraints from which a ground robot would suffer, such as paths with steps, steep drops and even objects in the way. Additionally, a flying platform is able to move faster through the sewer network than the terrestrial alternative and needs simpler logistics in deployment and operation. On the other hand, a MAV solution has to overcome strong constraints of size, weight and energy, as its flying space is bounded by sections less than 100 cm wide. Therefore, its size, and consequently its payload, are limited to minimal dimensions. At the end of ECHORD^{++}, **ARSI** presents a solution, which is extremely strong in terms of software (image processing and has a very high commercialization potential). In fact, with ARSI it takes only half an hour from the moment of data collection to developing the report to the operator. The commercialization of a wearable solution of the sensor package is the low-hanging fruits of ARSI that can easily be used by operators to generate data. The latter would also provide some of the financial resources needed to fund the development of the drone. The next steps in the development process would be to combine their software with off-

Figure 11 - ARSI prototype

the-shelf drones of different sizes and capacities to cover a wide range of use cases in the sewer (and potentially inspection and maintenance tasks beyond this application area). ARSI's business case should definitely go beyond selling a "small" number of drones to a single service provider.

SIAR (Sewer Inspection Autonomous Robot)

The specific challenge of this solution: SIAR was focused on developing a fully autonomous ground robot able to autonomously navigate and inspect the sewage system with a minimal human intervention, and with the possibility of manually controlling the vehicle or the sensor payload when required. To properly address the challenge, the following goals guided the SIAR development: a robust IP67 robot frame designed to work in the hardest environmental conditions; increased power autonomy and flexible inspection capabilities; robust and increased communication capabilities; increased onboard autonomous navigation and inspection capabilities; usability and cost effectiveness of the developed solution. At the end of ECHORD^{++}, SIAR presented an economically very viable solution: the target unitary cost given by the challenge provider (owner of the sewer infrastructure in Barcelona) in the challenge requirements was 0,50 Euro/m on inspection tasks; the SIAR system can reach 0,20 Euro/m. IDMind is willing to commercialize the product. The company is building SIAR's commercialization strategy around a B2B model and they are currently looking for companies that can

provide maintenance and inspection services. The acceptance of robotic technology for maintenance and inspection is changing dramatically. A new market with very interesting opportunities is opening up, and the consortiums are on the edge of taking the right choices to benefit from this situation.

Figure 12 - SIAR prototype

CLARC - Smart Clinic Assistant Robot for CGA

CLARC incorporates a RGB-D sensor, a touch panel, and a shotgun microphone, being able to perform Barthel and GetUp&Go tests without supervision. Additionally, these sensors are supposed to allow the robot to collect additional data automatically during the CGA interactive session using non-invasive procedures. For performing the Barthel test, CLARC offers the interviewee an external device that ease him to answer the questions. The advantage of using a mobile platform is to gain a clinical assistant that – apart from assisting the clinical staff in performing the CGA tests – can accompany the patient and the families to the medical consulting room. During the runtime of ECHORD^{++}, CLARC generated very valuable scientific results. With XXX scientific papers published, CLARC was one of the most performant experiments in terms of generating scientific knowledge. The platform has made significant progress towards integrating user needs into the design process. Careful attention was given to the interface, because older persons may have fears and uncertainties against effective 'engagement' with the robot. The attention given to adjusting the design and appearance of the robot was therefore important. In addition, the data representation and management were rated very positive by the medical experts. Another positive element in the CLARC project is the large number of patients with whom tests have been carried out (more than 400 patients so far). This has helped to better integrate the user perspective in the development. In order to be fully commercial, the platform still needs further development for which the consortium has acquired the funding already. The data representation and management interface certainly are an asset the solution can build on. To this end, strategies for integration into IT-infrastructure should be further developed.

Figure 13 The CLARC prototype works as an assistant.

ASSESSTRONIC

Figure 14 - ASSESSTRONIC prototype

The ASSESSTRONIC solution consists of a tablet for the question-and-answer part of the tests to be performed for the Comprehensive Geriatric Assessment. This tablet can be connected to a kinetic system to take images for the tests which tracking of patients' movements over time (for instance the Get-Up-And-Go test). At a very early stage of the development process, the ASSESSTRONIC team took the decision to not go for an autonomous system, but for a highly modular portable one. The system benefits a lot from its simplicity, scalability and thus does not impair a high risk of failure. The TRL level is rated at TRL 6. The system is on its way to a market-ready solution. From the user perspective, many good elements are demonstrated. ASSESSTRONIC will need an additional two years to commercialize their product. If the last gap in the technology development and the testing with a sufficiently high number of patients is performed, ASSESSTRONIC has a very strong partner on board to bring the product to the market.

1.4 Impact

1.4.1 Impact of experiments

The ECHORD^{++} experiments brought together industrial end users and academic researchers. Thus, from the very beginning of the project, the usual technology push concept has been replaced with clear technology pull. Such an approach led to development of market-oriented solutions, with 74% of experiments reporting either new product (58%) or new service (16%) as the innovative outcome of their projects. Over half of the surveyed experimenters stated, that the results are highly innovative and can be easily appreciated by the customers. What is even more important, only 19% of experiments do not have a clear plan for economic exploitation of the experiments' results. Almost 42% of the experiments is planning to bring the innovative solutions directly to the market, whereas the remaining 39% will deploy the solution within partners' facilities. Even more important is the fact, that **almost half of them have already secured funding for further exploitation**.

The market-oriented mechanism of the experiments resulted in fast implementation of the exploitation plans – **results of almost 27% experiments from the 1st Call are already being commercially exploited**. Majority of the experimenters declared, that the developed innovation will be commercialized either within the next year (6 experiments) or in less than 3 years (12 experiments). This is visible in the activities undertaken by the experiments. The participants of the 1st Call have already shifted towards more advanced stages – certification and securing funding for further development. The experiments from the 2nd call are catching up with most of them having completed the early stages of commercialization process – development of demonstrators, business planning and market studies and moving towards the more advanced steps.

Beside this direct economic impact, the ECHORD^{++} experiments instrument has significantly contributed to development of entrepreneurial spirit of academic researchers. The unique concept of the experiments required a paradigm shift from traditional, academic research projects towards a more business-oriented approach. **The experimenters reported significant development of non-academic skills** – communication (46%), marketing (12 %) and business planning (26%). Moreover, one third of the projects involved media or communication professionals in order to maximize outreach.

What is even more important and **highlights ECHORD^{++} contributions towards shaping entrepreneurial academic culture**, is that the academic partners of the experiments have already established three spin-off companies. Those include ANYbotics AG (MODUL), IDRhA – Innovative devices for Rehabilitation and Assistance (HOMEREHAB), and FlexSight Srl. (FlexSight).

Those results have been achieved without sacrificing the traditional scientific impact of research projects. One of the selection criteria of the ECHORD^{++} experiments was their scientific excellence and indeed, they excelled in delivering top-quality outcomes. The experiments had significant impact on the research community, which was reflected in a number of research publications including high impact journals and conferences (see section A1: List of scientific publication).

The application areas of many ECHORD^{++} experiments reflect the issues and problems currently faced by the European society and industry. The raising costs of workforce and difficulties with recruitment related to both the ageing society and lack of digital skills undermine the competiveness of the European manufacturing sector. The companies are forced to revolutionize their processes in order to decrease the traditional dependence on physical capabilities of workers, to make new technologies more accessible and to support human workers on the shop floor. Only that way it is possible to open the industry to currently underrepresented groups (e.g. women or elderly) and maximize to added value of employees.

The technologies developed in ECHORD^{++} experiments directly support this goal. Starting with the specialized robotic assistant developed in **2F** and **TIREBOT**, through tools supporting easy and intuitive programming of robots being results of **CoHRoS**, **DUALARMWORKER** or **DexBuddy**, to smart AGV-based solutions developed in **SAFERUN**, **FASTKIT** and **MAX-ES** the results of the ECHORD experiments facilitate transition from the traditional worker archetype towards the knowledge worker of the future, as foreseen in the Factories of the Future roadmap.

Similarly, the agrifood sector is marred by difficulties in finding sufficient number of workers. This is caused both by the strenuous tasks in often difficult working conditions and low production margin directly translating into low salaries. Several of ECHORD^{++} developed innovative solutions potentially eliminating the most arduous tasks such as harvesting of vegetables (**GARotics** and **CATCH**) or seedlings grafting (**INJEROBOTS**).

The everyday lives can be affected even stronger by the results of the healthcare robotics experiments. The ageing of society increases demand for long-term healthcare and rehabilitation. At the same time, access to necessary facilities and services is often limited. Results of **LINarm^{++}**, **HOMEREHAB** and **MOTORE^{++}** are already commercially available or close to being put on the market and offer cost-efficient and easily accessible rehabilitation to post-stroke patients. The rehabilitation exoskeleton developed within **EXOTrainer** provides children affected with Spinal Muscular Atrophy with walking capabilities immediately increasing their quality of life and reducing risk of complications caused by immobility and lack of proper rehabilitation. The impact of such solutions is twofold – they improve the quality of life and prevent exclusion of individual patients but also improve the overall efficiency of healthcare systems by removing one of the bottlenecks.

Finally, the ECHORD^{++} experiments had a tremendous impact on the research funding landscape in Europe. The instrument initially proposed within ECHORD and further developed in ECHORD^{++} can be seen as the prototype of the Financial Support to Third Parties widely adopted in many Horizon 2020 project. The processes for selection of the experiments, their monitoring and reviewing have been

developed and continuously polished throughout both calls. This is reflected both in the growing satisfaction of the experimenters in the monitoring process (51% of positive opinions in the 1st call, 74% in the 2nd call) as well as interest in similar initiatives (65% of participants are very interested in participation in similar projects). They have also proliferated beyond ECHORD++, and have been adopted in several other projects (e.g. HORSE, RobMoSys, ESMERA) becoming a widely accepted approach to open call management.

The outcomes of the experiments have been carefully analysed and an additional, originally unforeseen instrument has been developed and piloted – the ECHORD++ Experiment Booster Programme. The purpose of the instrument was to provide individualized, targeted support to experiments needing only slight push to cross the infamous "valley of death" and commercialize their results. After successful implementation, the instrument is ready to be used by other FSTP project to support them in maximizing their impact.

1.4.2 Impact of RIF

Lack of testing facilities has been identified as one of robotics' major handicaps, particularly for small and medium enterprises (SMEs) and startups, like the aforementioned Reach Robotics, who cannot afford to pay to test systems or products. To remedy this, three RIFs were established by ECHORD++, with free access to state-of-the-art robotics technology, hardware and software expertise, legal advice and more. The RIFs served as collaborative test beds for exploring how academia can successfully interact with small, medium and large enterprises to drive robotic development and economic growth in Europe. The real need in European industry addressed by the RIFs is even increasing rapidly, given that automation and digitalization of most industry's operations is key to staying competitive.

The RIFs' success stories in testing out new automation ideas and helping businesses develop innovative technology are numerous, but the main socio-economic impact and the wider societal implications go way beyond the individual RIF collaborations. In fact, the lessons learned from the RIFs as pilot cases for Digital Innovation Hubs are invaluable for maximizing the positive impact DIHs are supposed to have on the European economy and the European job market. Therefore, in this chapter we emphasize the main insights taken from the RIF instrument suggesting to use them to maximize the impact of any other RIF-like structures under the umbrella of European funding.

At the beginning of ECHORD++, the expectation was that the RIFs would field large numbers of solicitations from prospective beneficiaries. Reality proved somewhat different. In particular, if the RIFs did achieve a high volume of activities over the duration of the project in excess of a hundred technical collaborations, the efforts required from the RIFs to motivate participation of beneficiaries proved significant. Value of the service provided did not appear to be self-evident, at least initially. "Built it and they will come" turned out to be an invalid approach for the RIFs. Motivating active participation of the Instrument's core target audience (Small and Medium-sized Enterprises, SMEs) has demanded time, efforts, and pedagogy. In addition, the RIFs initially expected to develop collaborations with beneficiaries from across most of Europe. Instead, the overwhelming majority of successful RIF collaborations were developed with beneficiaries located in relative proximity to the RIFs' facilities. This important finding has already been incorporated in the EC's Digitising European

Industry initiative (DEI) strategy, or to say it in former Commissioner Oettinger's words: "My objective is to have at least one world class digital innovation hub in every region in Europe."[10]

Sales and marketing efforts designed to reach the identified target groups are critical in establishing a sustainable business alongside with dissemination of examples of successful cooperation. These activities require dedicated resources. Given that the time between first contact to delivered service can be long, up to several years, it is necessary to build an extensive pipeline of potential customers. Only a certain percentage of these leads will be interested in robotics, which will reduce the number of leads in the pipeline. The next step is to qualify these remaining leads i.e., to determine if the customer organization has sufficient competence and resources to handle robot implementation. This qualification process will lead to a further reduction of the number of leads.

The experience from the RIF project enables an estimation of the percentage of qualified leads that might result in a project, in relation to the number of first contacts. Based on this figure, the resource and time requirements in relation to the current pipeline can be assessed and the budget adjusted accordingly. A customer relationship management (CRM) tool is recommended for this exercise. In total, from October 2013 to September 2018 the RIF network has managed to:

- **Engage in 128 collaborations**
- **Serve 1225 RIF clients** with RIF offerings
- **Conduct 72%** of all activities with **SMEs**

Global RIF Group
RIF User Type: Breakdown by Activity (RUNNING TOTAL)
Unique clients: 1225

Digital Media	Twitter Followers	LinkedIn Contacts	Facebook Fans	YouTube Views	Email - Organisations	Email - Individuals	TOTAL
Connections	2767	0	0	15659	1963	4058	24447

Interactions	Researcher	Entrepeneur	Start-Up	SME	Large Business	Public Body	Research Centre	HEI	Network	TOTAL	% of Interactions
InfoDays	47	0	0	33	1	3	0	9	0	93	7%
RIFLaunches	51	0	6	101	20	8	5	5	6	202	15%
External Events	0	0	10	217	43	12	23	13	80	398	30%
Collaborations	7	0	19	66	33	0	1	2	0	128	10%
Workshops	42	3	8	213	52	9	4	30	11	372	28%
Market Assessment	0	0	6	2	0	0	0	0	0	8	1%
Internships	33	-	-	-	-	-	-	-	-	33	3%
E++ Experimenters	0	0	0	8	1	0	1	0	0	10	1%
Pipeline	0	0	5	51	15	0	0	1	0	72	5%
	180	3	54	691	165	32	34	60	97	1316	

	Researcher	Entrepeneur	Start-Up	SME	Large Business	Public Body	Research Centre	HEI	Network	TOTAL
Unique Clients	148	4	46	667	174	26	34	50	76	1225
% of Total Clients	12%	0%	4%	54%	14%	2%	3%	4%	6%	

Figure 15 - RIF user statistics

With further regard to marketing, all three RIFs agree that personalized meetings are key, in order to understand the needs of the customers and to identify the individual organization's ability to enhance robotics technology. As a result of this initial analysis, a tailored offering can be made to each customer, establishing trust and leading to a fruitful cooperation. However, the original idea of offering a six-week free trial is only a subset of offerings needed to deliver value to customers, since the customers' needs may vary greatly depending on the size of the organization or the maturity of the aspired technological solution.

Also, during the RIF project, all three RIFs have learned that management and management processes are key components for a successful operation and must be addressed in the future Robotic

[10]http://s3platform.jrc.ec.europa.eu/documents/20182/245218/Cecile+Huet.pdf/5b211f77-186f-4a1e-ab10-702c9b3f516f

Competence Centers (RCC). Running a network of RCCs requires leadership with the ability to create trust and facilitate communication in a distributed organization. The project should identify and position managers that understand group dynamics and can establish a collaborative environment that operates in a so-called "Green Zone"[11]. Summarising our insights on management processes and internal communication we have developed the following five suggestions for future RCC networks:

- Set common values and rules and allocate dedicated resources at each RCC. Expectations need to be defined at the beginning and remain unchanged during the project, unless agile processes are in place and complementary funding is available.
- Strive for collaborative platforms and collaborative projects, by sharing offerings and testbeds. Document each centre's competences and resources. Find common opportunities and make sure that the project delivers meaningful and tangible benefits for European industry.
- Aim for global consistency, but with local activity. Share customer needs, market information and best practices. Establish processes enabling the temporary exchange of experts and other personnel, such as students, in order to improve the collaboration and understanding of each other's operation.
- Establish tools for shared communication (internet, fairs etc.) and coordinate seminars and workshops. Include 'story telling' on marketing strategies as a way to present successful projects. Share marketing material and coordinate the work on social media (LinkedIn,
Twitter etc.) in order to facilitate the creation of a common virtual market place.
- Given these limitations and advantages, it is our assessment that any future RCC project aiming to support the sustainability and market growth of European industry needs to be managed using agile methods and an iterative process as shown in the figure below.

Another learning from the RIF project is, that large enterprises have different needs than SMEs. Large enterprises often invest in developing new disruptive solutions in order to lead the market, while SMEs invest in developing innovative products in order to be competitive on the market. This results in differing time and financial scales. Large enterprises accept a longer time to market and are often prepared to contribute with substantial investments, while SMEs need a quick time-to-market and often have limited financial resources. In many cases, SMEs also require additional services, such as legal work, co-financing and help with insurance and safety issues. The experiences from the RIF operation show that many SMEs chose not to work with RIF Peccioli due to long lead times, as was also the case in RIF Paris.

Regarding financial sustainability of RCCs, innovative collaborative agreements between universities, public actors and private companies must be investigated. The development of such innovative agreements is possible only if each RCC understands the partners with whom they are interacting, and if they are able to co-create local solutions and find suitable financing options. In order to avoid a situation where the funding allocated to the project is based on estimations, we recommend that the funding for further projects is divided up based on the achievement of a number of milestones, which relate to each step in this process and also allow for several reiterations of the process. This reduces the risks for the funding body and increases the likelihood of a successful output from the project. Successful implementation of this method depends on easy application procedures and simplified reporting structures.

[11] Tamm, J W, 2005, Radical Collaboration: Five Essential Skills to Overcome Defensiveness and Build Successful Relationships, Harper Business, pp 336.

All three RIFs have managed to finance a continuation of their operations. During the runtime of ECHORD^{++}, all the RIFs acquired a deeper knowledge of the dynamics of tech transfer activities, which has been exploited in their subsequent operations. Models for alternative "tech-transfer" career paths have been developed, particularly in the university environments.

The RIF project has resulted in an improved regional and national visibility. All three RIFs will therefore continue to use the brand "RIF". The key improvements to the RIF project in the continued operations are more efficient interaction with potential customers, improved internal processes to deliver results, and improved internal and external communication processes.

The numerous wider socio-economic implications of the RIF instrument are accompanied, as mentioned above, by an already significant economic impact achieved by the RIFs. RIF collaborations

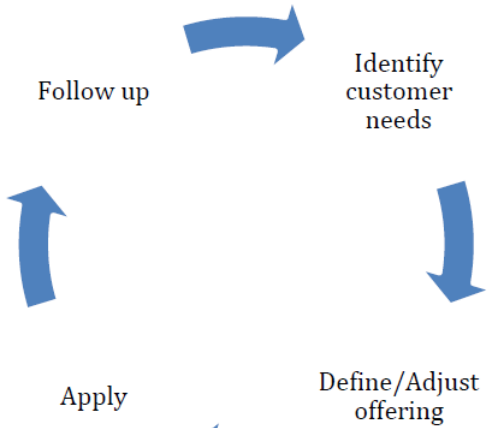

Figure 16 - Iterative Service Design process for continuous improvement of the organisation and its offerings

have directly led to the creation of several startups, some of which have secured financial support from venture capital well in excess of €1 million. In addition, a significant number of the proofs of concept developed in collaboration with industry have led to the development of new products (or improvement to existing ones). Finally, the RIFs proved very successful in experimenting with different additional services in complement to the typical six-week technical collaboration, including: Educational workshops, Intellectual Property (IP) management support, networking support, connecting innovators with venture capital and system integrators, as well as due diligence services for investors in robotics, to name but a few.

1.4.3 Impact of PDTI

PDTI Urban Robotics

Using robots for the Inspection and the Clearance of the Sewer Network in Cities generates impact in a multitude of different areas. The main purpose is to reduce the labour risks, improve the precision of sewer inspections and optimize sewer-cleaning resources of the city. The impact outlined below just reflects the expectations of the public organization, which owns the sewer infrastructure in Barcelona.

Economic Impact: The sewer inspection cost in Barcelona is about 1 million € per year what represents 12.5 % of the total cost of sewers management (about 0.75 €/lineal meter) the new technology developed reduces the cost to 0.50€ /lineal meter, the saving would be about 30%.

Environmental Impact: The new technology would prevent overflows both to the city and to the environment. Through early detection of defects in the sewer, it would be feasible to prevent

wastewater leaks to the underground that could finally get into underground water. And, deeper knowledge of the sewage tendencies would help to tackle and design measures to reduce odours from sewers and environmental policies.

Social and Cultural Impact: The citizens' life quality would improve since a better sewer performance would prevent overflows and odour problems, minimize the affectation to public roads thereby reducing costs. Finally, the new technology should improve sewer workers' health and safety since they will not have to enter into dangerous locations classified as confined spaces.

Innovation Impact: The new technology will really improve the current inspection methodology by reducing the health risks for workers and making it affordable for public administrations.

Ability to Execute: The new technology is really feasible and affordable to implement and include in the current inspection services. The public entity was not looking for a robot but for an innovative operational procedure to inspect and maintain the urban sewer.

ARSI and **SIAR** consortia presented their business plans at the beginning of the research and technological development procedure. Those proposed a market overview, the exploitable results and IP rights management, the business model and exploitation plan as well as the economic viability for every stakeholder involved: the robot manufacturers (Idmind, Simtech Design, Ibak), the inspection services company (FCC) and the public entity (BCASA). During the PDTI RTD phases, the economic viability of the solutions has been adapted. For example, the robot manufacturers looked for a robotic service instead of a robotic product; the public service company became the supplier and the public entity not only boosted the innovation but also reduced the costs of this public service.

At the end of ECHORD^{++}, there are two viable technical solutions – **ARSI** and **SIAR** – with complementary strength points and synergy effects to be exploited. A lot of interesting technology has been developed and/or integrated in both projects. Both projects allow for the commercialization of technological components, such as wireless communications, sensors, data handling and analysis, robotics. Some solutions combined with the current systems used by service providers can already generate cash flow. Each separate value package can help the consortia to further increase the maturity level of the platforms and thus help them to arrive to the market sooner, in an easier and cheaper fashion, but more importantly help the market to understand the potential of the technology ARSI / SIAR are developing and be ready to accept an improved product. Linked to dissemination activities under Echord^{++}, both consortia have received new proposals to replicate their solutions in other scenarios.

An additional two years of technology development will be needed to arrive at fully commercial products. An earlier commercialization of partial solutions is possible.

PDTI healthcare

Due to the demographic change with a growing share of elderly people in society, Comprehensive Geriatric Assessment (CGA) is becoming more and more important. The objective of the standard tests standing behind the geriatric assessment is to develop personalized care plans that adequately address the easing of the physical and mental capabilities of the elderly person while integrating the relatives and their needs and constraints into the care plan. The challenge of Comprehensive Geriatric Assessment as done nowadays is the time investment required by the medical staff to support the patient in performing standard tests. Shortage of qualified personnel as well as a growing demand

reduce more and more the time doctors can allocate to the development of the appropriate care plan. Without the support of electronic tools, the assessment done by humans – for instance when performing the Get-Up-And-Go test with the patient - is very subjective. Using different media in the tests, which are not connected to each other (i.e. data is not integrated or even incompatible with the data management system of the hospital), further impede an efficient allocation of time of the medial staff to the generation of an ideal care plan for the patient. The technology developed under the umbrella of ECHORD^{++} has achieved impact in the following areas:

- improve the diagnostic plan and give right and proportional therapeutic decisions: evaluations from the medical personnel at St. Antoni Abat show that the technology is very promising to create better diagnostics, especially concerning the physical evaluation
- increase patient's functional autonomy at hospital discharge
- select of the most adequate level of care for the patient: with additional data and more precise data on the physical tests, the doctor can choose a more adequate level of care
- manage and store data efficiently: the teams have both worked on a solution that can be integrated into the current data management system, the results from the robotics assessment can easily be copied to the healthcare professional's report
- reduce the stress of patient (who may feel being examined while communicating professionals): both solutions enable the patient to conduct mental tests on their own via a tablet screen
- shorten the total length of the process-using a robotic solution, a reduction of more than 30% of Health Professional's time can be expected and thus reduce current costs: calculations performed during PDTI Phase III show that the systems developed in PDTI healthcare can not only add value to the assessment, but also reduce costs.

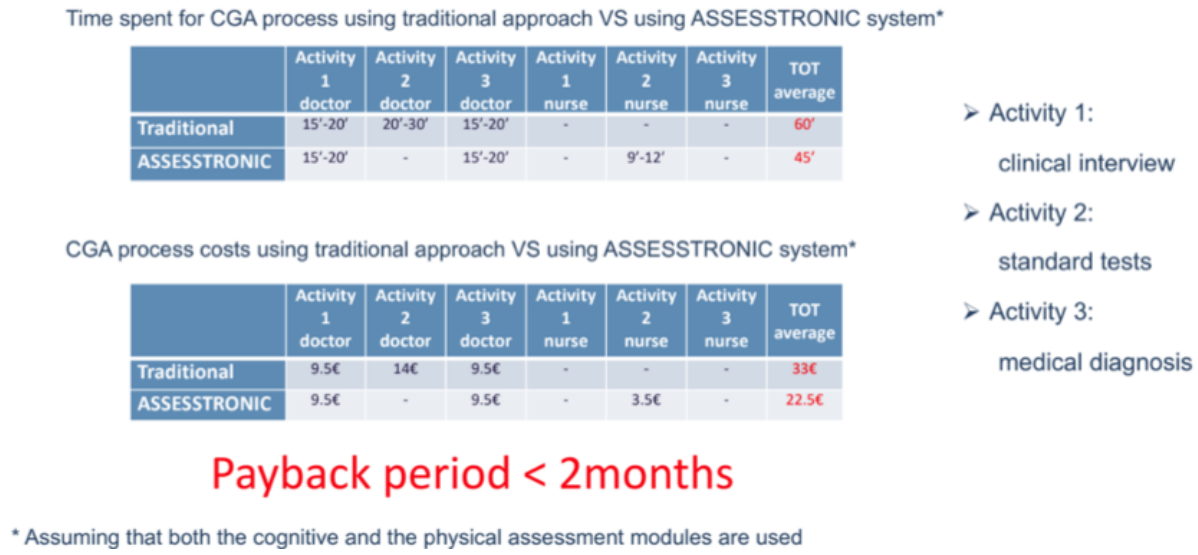

Figure 17 - ASSESSTRONIC business case

Figure 17 states the business case calculated for the ASSESSTRONIC system with a payback period of 2 months based on data from (CatSalut, hosiptals in Catalunya). CLARC plans to offer a full-service model with initial costs of 15 € per CGA with the robot. Based on data from University hospital Jena, the remaining savings for the clinic per day are 262 € (see figure 18). If the clinic initially has to pay 3.500 € setup fee, the payback time for this is less than two months.

Occupational Groups	Salary per occupational group and year (Estimate!)	Hourly rate (€/h) Estimated at 220 working days per year and full time	Savings per day (in min)		Saving hourly date per CGA
Physiotherapists	40.000,00€ €/a	22,73 €	60	Min/Day	22,73 €
Nurses	40.000,00€ €/a	22,73 €	24	Min/Day	9,09 €
Physicians	90.000,00€ €/a	51,14 €	270	Min/Day	230,11 €
Total Savings			354	Min/Day	261,93 €

Assumed savings per CGA of 43,66€:
- per day € 262 €
- per month € 5,800
- per year € 65,500

Figure 18 - CLARC Savings

The solution pursued by CLARC – an interactive mobile service robot combined with a portable device developed for elderly – intends to save about 75% of the time that needs to be invested in each single test. CLARC intends to offer a full-service solution in a subscription model to hospitals. At the end of ECHORD^{++}, CLARC has generated a lot of scientific knowledge. Components of the solution should be further developed. The full-fledged solution still requires work to increase the robustness of the platform. The data representation and management interface certainly is an asset the solution can build on. To this end, strategies for integration into IT-infrastructure should be further developed.

The system presented by ASSESSTRONIC consists of a kinematic system in combination with a tablet PC. The modular approach makes the system extremely scalable in price. The system benefits a lot from its simplicity, scalability and thus does not impair a high risk of failure. The TRL level is rated at TRL 6. The system is on its way to a market-ready solution. From the user perspective, the system includes many good elements. This is the result of some previous technical recommendations of the reviewers having been taken into account carefully. The business plan is solid with regard to market expectations, the market approach, and foreseen sales estimates. The current business plan does not yet properly reflect the fact that a CGA system is a medical product. Therefore, the costs for medical certification need adjustment.

Lessons learned

At the end of ECHORD^{++} the consortium feels that PDTI combines quite successfully the merits of PCP (competitive development approach in clearly defined development phases) with the benefits of the approach on robotics technology development implemented in the “experiments” instrument – first in old ECHORD, now in ECHORD^{++}. Examples are the intensive coaching by members of the core consortium (done in pairs by coaches with a technical and a managerial background) and allocating a grant following FP7 rules (instead of pushing for procurement with risk-sharing between procurer and RTD development teams). The lessons learned of ECHORD^{++} can be summarized as follows:

- If the technology development in a PDTI-like activity is from the beginning restricted to a specific technology (in our case robotics), it is vital to make sure from the beginning that the challenge allows for such a restriction.
- When setting up the teams (both for the technology development as well as for the monitoring resp. coaching) it is important to make sure that all stakeholder groups are identified and actively involved in the process. The level of engagement of the different groups can vary in the different phases of the technology development process, but it is important to have all stakeholders with their interests on the screen.
- When collaborating with the public sector it is important to understand that user and purchaser of the technology are not necessarily the same entity and that the interests of these two can be very different from each other. Therefore, it is necessary at the beginning to clarify the role and decision-taking power of each stakeholder. It is also vital to understand the criteria, which the procurer implements to motivate the purchase decision. This goes in line with the learnings from the RIFs: In projects like ECHORD^{++} the core consortium implements processes, which need to be compatible with the purchase-triggering procedures, which are already in place in the respective organizations.
- When dealing with hardware it is important for the development teams to have a proper mock-up in their labs. SIAR was successful in terms of prototype development because they had a proper mock-up sewer in their lab, which allowed them to perform many tests, while ARSI never achieved to set up such an environment.
- The coaching by the tandems business-technical from the core teams was tremendously important to achieve the results. Coaching needs to include technical as well as business competence. At the end of ECHORD^{++}, there are three prototypes, which will make their way to market within maximum two years if they are able to generate the funds and continue to get the support needed to make this happen. CLARC's way to market is longer, but this team has generated very valuable scientific knowledge and has already managed to acquire additional funds to continue their development. CLARC is probably the team which shifted their mind-set most: They have learned to adopt the agile project management approach, have learned how to integrate user perspective in their healthcare development and have forged a lot of new contacts (including hospitals with patients for testing) which will help them a lot to be successful in the future. Before putting more effort into commercialization, the platform in the CLARC solution needs to be further investigated. Future applications need to be investigated and tested more – CLARC's solution is very future oriented, ASSESSTRONIC's solutions definitely solves today's end-user needs
- Having an additional in-person review meeting between the development teams and the external experts was particularly helpful. Done is sewer inspection, this helped to identify opportunities in commercialization as well as in the collaboration between the two teams, which started as competing organizations, but now benefit a lot from collaborating with each other.
- The monitoring and coaching in PDTI healthcare and PDTI sewer have followed a different approach: While sewer worked with monitoring session alternating between on-site testing and a common set of deliverables, PDTI healthcare developed a common set of KPIs which were applied to teams with a completely different system (modular system instead of a mobile platform). What counts is that the intensive coaching takes place.
- PDTI in ECHORD^{++} has demonstrated that public bodies are highly interested in working in interdisciplinary teams to develop the technology they need. The intensive collaboration is extremely important to lower the entrance barrier for the public body. The collaboration is most beneficial if the

end-user benefitting most is directly involved in the project. In case of sewer inspection, it is the owner of the infrastructure rather than the service provider, in case of healthcare it is the medical doctors and not the procurement agency. PDTI has managed to develop two public bodies who will be ambassadors of the collaboration with roboticists and the implementation of robotics technology. So, innovative procurement in Europe can happen and be very beneficial if the right coaches are in place and are committed to spend the necessary effort. And, PDTI requires a lot of effort. The market, though, is potentially very high then as well.

- The active involvement of the public sector is key to the success of the technology development. Both, public procurers as well as end-users contribute know-how and experiences which are unique. Often the procurement agency is organisationally separated from the end-user of the technology. This separation can be tricky if the weight of the end-user in the purchase decision is not entirely clear. It makes sense to put an emphasis on clarifying the roles prior before setting up joint projects. It also makes sense to implement a methodology on how to assess a public stakeholder in terms of purchase power, organizational structure, engagement, contribution to commercialization etc. The PDTI activities have demonstrated that inspiring the user-centred approach in development teams is a tremendous effort, particularly if the teams have not been exposed to such an approach before. The coordination during all the process by a multidisciplinary team, not only technological one (robotic in our case) is crucial to prevent the development of research-driven technology, which fails to meet market needs.
- Before committing resources in a collaboration with public bodies which is very demanding and time-consuming, it is recommendable to assess the qualification of the public body (resources, track record in commercialization – particularly in EU-funded projects, network etc.). This can be extremely important for the DIH networks in robotics that have just started their activities. The situation has changed now in comparison to the early days of PDTI: Public bodies need less motivation as they start seeing the benefit. Therefore, the EC can be selective.
- Delays need to be avoided by all costs in any technology development project, which is structured in phases. This holds true for PDTI-like activities, but also for huge flagship projects like HBP. Reliability and a sound planning ground are key to success.

1.5 List of all beneficiaries

Core Partners					
Beneficiary Number	**Beneficiary name**	**Beneficiary short name**	**Country**	**Project entry month**	**Project exit month**
1 (coordinator)	TECHNISCHE UNIVERSITAET MUENCHEN	TUM	DE	1	67
3	UNIVERSITY OF THE WEST OF ENGLAND, BRISTOL	UWE	UK	1	67
2	SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA	SSSA	IT	1	67
4	UNIVERSITAT POLITÈCNICA DE CATALUNYA	UPC	ES	1	67
5	COMMISSARIAT `A L'ENERGIE ATOMIQUE ET AUX ENERGES ALTERNATIVES	CEA-LIST	FR	1	67
6	BLUE OCEAN ROBOTICS	Blue Ocean Robotics	DK	1	67
7	R.U.Robots	R.U.Robots	GB	1	67
8	TECHNODEAL SRL	TED	IT	16	67

Experiment Partners Call 1						
Beneficiary Number	**Beneficiary name**	**Beneficiary short name**	**Country**	**Experiment(s)**	**Project entry month**	**Project exit month**
36	IMER INTERNATIONAL SPA	IMER	IT	Flooring Fellow	16	67
41	ROBOTECH SRL	RT	IT	Flooring Fellow, MOTORE^{++}	16	67
29	FLEXIBLE ROBOTIC SOLUTIONS	FRS	BE	3D SMART SENSE AND CONTROL	16	67
38	KATHOLIEKE UNIVERSITEIT LEUVEN	KU Leuven	BE	3D SMART SENSE AND CONTROL	16	67
17	BIELEFELD UNIVERSITY	UNIBI	DE	CoHRoS	16	67
19	CARL CLOOS SCHWEIßTECHNIK GMBH	CLOOS	DE	CoHRoS	16	67
31	FUNDACIÓN TEKNIKER	IK4-TEKNIKER	ES	DEBUR	16	67
34	IDELT, INGENIERÍA DESARROLLO PROTOTIPOS	IDELT	ES	DEBUR	16	67
16	ARTIMINDS ROBOTICS GMBH	AMR	DE	DexBuddy	16	67
13	AEA S.r.l.	LOC	IT	DexBuddy	16	67

45	THE SHADOW ROBOT COMPANY LIMITED	SHADOW	UK	DexBuddy	16	67
37	KARLSRUHER INSTITUT FUER TECHNOLOGIE	KIT	DE	DexBuddy	16	67
15	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	CSIC	ES	EXOTrainer	16	67
39	MARSI BIONICS	MB	ES	EXOTrainer	16	67
32	HOSPITAL SANT JOAN DE DÉU	HSJD	ES	EXOTrainer	16	67
44	STRAUSS-VERPACKUNGSMASCHINEN GMBH	STRAUSS	DE	GARotics	16	67
47	UNIVERSITÄT BREMEN	UNIHB	DE	GARotics	16	67
18	C.WRIGHT & SON GEDNEY LTD	CWS	UK	GARotics	16	67
25	EKYMED SPA	EKY	IT	LA-ROSES	16	67
28	FASTENICA S.R.L.	FAST	IT	LA-ROSES	16	67
21	CONSIGLIO NAZIONALE DELLE RICERCHE	CNR	IT	LA-ROSES, LINarm^{++}	16	67
48	UNIVERZA V LJUBLJANI	UL	SI	LINarm^{++}	16	67
23	ECOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE	EPFL	CH	LINarm^{++}	16	67
35	Idrogenet Srl.	IDROGENET	IT	LINarm^{++}	16	67
14	AGCO GMBH	AGCO	DE	MARS	16	67
27	HOCHSCHULE ULM	HSU	DE	MARS	16	67
24	EINGENOESSISCHE TECHNISCHE HOCHSCHULE ZUERICH	ETHZ	CH	MODUL	16	67
20	CDD MONOPROSOPI ETERIA PERIORISMENIS EFTHINIS YLPIRESION EREYNAS KAI ANAPTIKSIS	CDD M.E.P.E.	GR	MODUL	16	67
33	HUMANWARE S.R.L.	HMW	IT	MOTORE^{++}	16	67
26	FABRICA 136 SRL	F136	IT	MOTORE^{++}	16	67
30	FRAUNHOFER-GESELLSCHAFT ZUR FÖRDERUNG DER ANGEWANDTEN FORSCHUNG E.V.	FRAUNHOFER	DE	pickit, SAPARO	16	67
42	Scape Technologies A/S	STAS	DK	pickit	16	67
40	PILZ GMBH & CO. KG	PILZ	DE	SAPARO	16	67
46	UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA	UNIMORE	IT	TIREBOT	16	67
22	CORGHI S.P.A.	CORGHI	IT	TIREBOT	16	67

PDTI Partners (public bodies)						
Beneficiary Number	**Beneficiary name**	**Beneficiary short name**	**Country**	**PDTI Challenge**	**Project entry month**	**Project exit month**
9	Barcelona Cicle de l'Aigua, S.A. Public Limited Company	BCASA	ES	Urban robotics	16	67
10	Ajuntament de Barcelona City Council (P0801900B, Ajuntament de Barcelona)	Aj BCN	ES	Urban robotics	16	67
11	Agencia de Qualitat i Avaluacions Sanitaries de Catalunya	AQuAS	ES	Healthcare	16	67
12	FUNDACIO PRIVADA SANT ANTONI ABAT	ABAT	ES	Healthcare	16	67
PDTI R&D Partners						
52	ASSISTANCE PUBLIQUE - HÔPITAUX DE PARIS	AP-HP	FR	ARNICA	26	35
51	TEKNOLOGISK INSTITUT	DTI	DK	ARNICA	26	35
50	INLOC ROBOTICS SLU	INLOC	ES	ARNICA	26	35
49	ROBOSOFT Services Robots	ROBO	FR	ARNICA	26	35
53	FUNDACIÓ EURECAT	EUT	ES	ARSI	26	67
54	FOMENTO DE CONSTRUCCIONES Y CONTRATAS SA	FCC	ES	ARSI	26	67
55	SIMTECH DESIGN SL	SD	ES	ARSI	26	67
56	IBAK Helmut Hunger GmbH & Co. KG	IBAK	DE	ARSI	26	67
57	ACCEL	ACCEL	FR	ASSESSTRONIC	26	67
58	Sorbonne Université	SORBONNE	FR	ASSESSTRONIC	26	67
59	SERVICIO ANDALUZ DE SALUD	SAS	ES	CLARC	26	67
61	UNIVERSIDAD DE MALAGA	UMA	ES	CLARC	26	67
62	UNIVERSIDAD CARLOS III DE MADRID	UC3M	ES	CLARC	26	67
63	CYPRUS UNIVERSITY OF TECHNOLOGY	CUT	CY	ROBODILLOS	26	35
64	HELIKAS ROBOTICS LTD	HEL	CY	ROBODILLOS	26	35
65	IDMind-Engenharia de Sistemas, Lda.	IDM	PT	SIAR	26	67
66	Universidad de Sevilla	USE	ES	SIAR	26	67
67	Universidad Pablo de Olavide	UPO	ES	SIAR	26	67

68	METRALABS GMBH NEUE TECHNOLOGIEN UND SYSTEME	MLAB	DE	CLARC	26	67
110	UNIVERSITE DE TECHNOLOGIE DE TROYES	UTT	FR	CLARC	39	67
Experiment Partners Call 2						
69	LEIBNIZ-INSTITUT FUER AGRARTECHNIK POTSDAM-BORNIM EV	ATB	DE	CATCH	32	67
70	COMMUNICATIVE MACHINES LIMITED	CMLabs	UK	CoCoMAPS	32	67
71	ICELANDIC INSTITUTE FOR INTELLIGENT MACHINES	IIIM	ICE	CoCoMAPS	32	67
72	INSTITUT DE RECHERCHE TECHNOLOGIQUE JULES VERNE	IRTJV	FR	FASTKIT	32	67
73	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE	CNRS	FR	DUALARMWORKER FASTKIT	32	67
74	UNIVERSITA DEGLI STUDI DI ROMA LA SAPIENZA	UNIROMA1	IT	FlexSight	32	67
75	IT+ROBOTICS SRL	ITR	IT	FlexSight	32	67
76	ROBOX SPA	ROBOX	IT	FlexSight	32	67
77	Vitirover SAS	VITIROVER	FR	GRAPE	32	67
78	POLITECNICO DI MILANO	POLIMI	IT	GRAPE	32	67
79	UNIVERSIDAD MIGUEL HERNANDEZ DE ELCHE	UMH	ES	HOMEREHAB	32	67
80	ASOCIACION CENTRO TECNOLOGICO CEIT-IK4	CEIT-IK4	ES	HOMEREHAB	32	67
81	INSTEAD TECHNOLOGIES FOR HELPING PEOPLE SL	INSTEAD	ES	HOMEREHAB	32	67
82	FONDAZIONE ISTITUTO ITALIANO DI TECNOLOGIA	IIT	IT	HyQ-REAL	32	67
83	MOOG CONTROLS LIMITED	MOOG	UK	HyQ-REAL	32	67
84	FUNDACION PARA LAS TECNOLOGIAS AUXILIARES DE LA AGRICULTURA	TECNOVA	ES	INJEROBOT	32	67
85	ROBOTNIK AUTOMATION SLL	ROB	ES	INJEROBOT	32	67
86	INGRO MAQUINARIA SL	ING	ES	INJEROBOT	32	67
87	INSTITUT MINES-TELECOM	TELECOM BRETAGNE	FR	KERAAL	32	67
88	GENERATION ROBOTS	GR	FR	KERAAL	32	67

89	CENTRE HOSPITALIER REGIONAL ET UNIVERSITAIRE DE BREST	CHRU Brest	FR	KERAAL	32	67
90	ECA ROBOTICS	ECA	FR	MAX ES	32	67
91	ALUMINIUM PECHINEY	AP	FR	MAX ES	32	67
93	ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS	CERTH	GR	RadioRoSo	32	67
94	ANSALDO NUCLEAR ENGINEERING SERVICES LIMITED	Anslado NES	UK	RadioRoSo	32	67
95	STATNI USTAV RADIACNI OCHRANY v.v.i.	SURO	CZ	RadioRoSo	32	67
96	UNIVERSITA DEGLI STUDI DI GENOVA	UNIGE	IT	RadioRoSo	32	67
97	CESKE VYSOKE UCENI TECHNICKE V PRAZE	CVUT	CZ	RadioRoSo	32	67
98	UNIVERSITA DEGLI STUDI DI PARMA	UNIPR	IT	SAFERUN	32	67
99	Elettric 80 S.p.a.	E80	IT	SAFERUN	32	67
100	PRE GEL SPA	PG	IT	SAFERUN	32	67
101	RFND TECHNOLOGIES AB	REFIND	SE	AAWSBE1	32	67
102	FUNDACION TECNALIA RESEARCH & INNOVATION	TECNALIA	ES	DualArmWorker	32	67
103	AIRBUS OPERATIONS SL	AIRBUS	ES	DualArmWorker	32	67
104	WAGENINGEN UNIVERSITY	WU	NL	SAGA	32	67
105	AVULAR BV	AVU	NL	SAGA	32	67
106	ALMA MATER STUDIORUM - UNIVERSITA DI BOLOGNA	UNIBO	IT	WIRES	32	67
107	UNIVERSITA DEGLI STUDI DELLA CAMPANIA LUIGI VANVITELLI	SUN	IT	WIRES	32	67
108	I.E.M.A. SRL	IEMA	IT	WIRES	32	67
109	STENA RECYCLING AS	STENA	DK	AAWSBE1	32	67

2 Use and dissemination of foreground

Results of the ECORD^{++} dissemination activities are[12]:

- ECHORD^{++} was presented 396 times during the runtime of the project in the press
- The ECHORD^{++} webpage has 73,726 visitors in total
- 26 videos were published on the own YouTube channel with 1297 visitors on average
- The LinkedIn group has now 389 subscribers
- The twitter account has 1318 followers.

The number of press clippings (see Section A3: Press clippings) shows how impressive the project and mainly its scientific achievements were for the press. Only the number of references in the trade press missed the mark. The reason is that an EU project itself is no message for the readers of trade newspapers. Journalists writing for special interest magazines were often highly interested in the prototypes presented on fairs, e.g. the agricultural robots as CATCH or GAROTICS.

The ECHORD^{++} website showed steadily increasing click numbers during the whole period. After the relaunch, it showed a more modern and attractive look, so the number of at least 1000 visitors per month could easily be topped. The content management system was changed from typo3 to WordPress due to the preference of the agency installing the new website.

Videos turned out to be a great success. They also outperformed the EU mark of more than 1000 visitors on average. This success is mainly traced back to the overwhelming visitor number of the GAROTICS video; more than 10,000 visitors had seen it in two and half years. In relation: the Riverwatch video of the old ECHORD, which was highly rated by the reviewers, gained more than 16,000 in five and a half years! It has to be remarked that videos have to have very professional today, and this needs money. Another reason for high click rates are distinct names for the video: e.g. “Multimedia Report” will not win, but “GAROTICS” will.

LinkedIn is an international platform for business contacts, which means, it will not grow quickly, but consequently managed it will show a stable increase. This is the case with the ECHORD^{++} LinkedIn group. The same is true for the twitter account that has more followers due to the easier way of communication. It is also very convenient in an international surrounding.

Dissemination measures took place right from the beginning of the project. Databases, social media channels and power point master slides were set up in the first period and even a PR workshop was organised for all partners. This was quite successful in the first run, but weakened in the end. Surprisingly the survey at the end of the project revealed that two third of the teams felt not well informed about doing PR for their experiment. That means that the workshops itself are helpful but should be repeated every year. Three quarters of the experiment partners have published information about the experiment in another language than English, stressing the importance of communication on local, regional and national level in the respective languages. Journalists are mostly interested in “local” (national in this context) news or in news, which has a direct impact on their own country and economy. The core consortium has only limited possibilities to fulfil this task, therefore the core consortium suggests involving local (meaning: none-core consortium) PR/marketing professionals either in every project team or via being part of a larger organization with a dedicated PR department

[12] Status end of January 2019

or via involving an external agency. As already mentioned videos are not only a “nice to have” but moreover mandatory. To do that professionally a good funding for the whole runtime of a project is needed. More can be done in finding good and exact indexing of the videos uploaded. All other digital channels can be used to announce a new video.

To use the full possible impact of fairs and events they should be in one hand. Usually, the fair companies prefer to have only one contact person who then has full access to all PR possibilities a fair can provide. In this case, it is possible to organize e.g. talks in forums that are a good and cheap possibility to set themes in the target communities and to attract more visitors to the booth.

Some of the lessons learned from the project are probably easy and cheap to organize, but to tap the full potential of future projects’ outreach activities a good and explicit funding is mandatory. Just to give an idea of how much money is needed: the 36-m^2 booth at Medica 2018 cost more than 10,000€ just for the naked place without any booth construction.

As it was stated before, the impressive results that the experiments achieved, have been attained without forgoing the traditional scientific impact of research projects. The experiments had significant impact on the research community, which was reflected in a number of research publications including high impact journals and conferences. On Figure 19 we can see the footprint of the research made by our experimental partners in the scientific society. Averaging more than 20 publications per year for the last three years, the expected results and impact for 2019 can only be prominent.

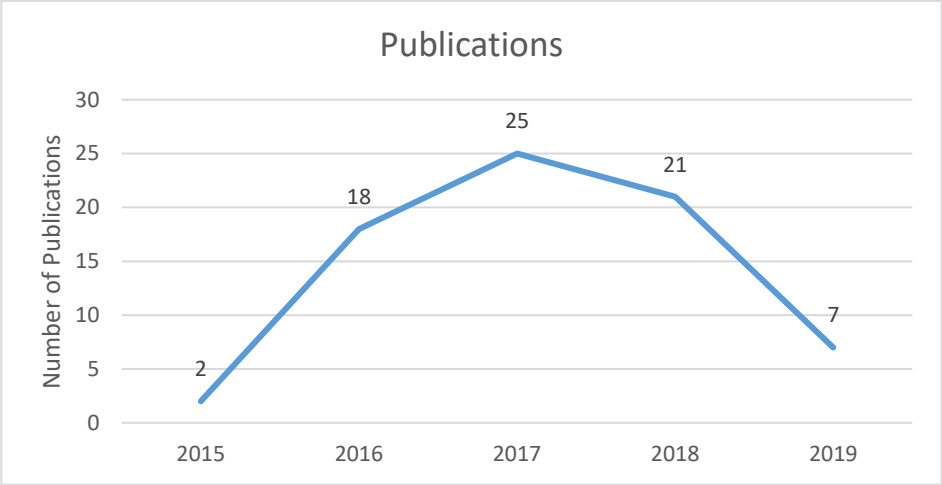

Figure 19 - Publications over the ECHORD++ runtime

Section A1: List of scientific publications

Experiments		Scientific Papers or Journals Submitted												
		No. of paper	**Title**	**Main author**	**Title of the journal or the serie**	**Number, date or frequency**	**Publisher**	**Place and Year of publication**	**Relevant pages**	**Open access (y/n)**	**Did published in open access journal (y/n)**	**Did published in open repositories (y/n)**	**If not open access please explain why.**	**Funding acknowledgement (y/n)**	**If no please explain why.**
	DEBUR	1	Robust 3D Object Model Reconstruction and Matching for Complex Automated Deburring Operations	A. Tellaeche	Journal of Imaging	2(1)	MDPI	2016	8	y	y	y		y	
	EXOTrainer	8	Preliminary Assessment of a Compliant Gait Exoskeleton	M. Cestari, D.Sanz-Merodio, and E. Garcia	Soft Robotics	Vol. 4, No. 2	N/A	2017	*135-146*	n	n	y		y	

			A New and Versatile Adjustable Rigidity Actuator with Add-on Locking Mechanism (ARES-XL)	M. Cestari, D.Sanz-Merodio, and E. Garcia	Actuators	Vol. 7, No. 1	N/A	2018	N/A	y	y	y		y	
			Control architecture of the ATLAS 2020 lower-limb active orthosis	D. Sanz-Merodio, J. Sancho, M. Perez and E. Garcia	Int. Conf. Climbing and Walking Robots and the Support Technologies for Mobile Machines	N/A	N/A	London, UK, 2016	N/A	n	n	y		y	
			Mechanical description of ATLAS 2020, A 10-DOF paediatric exoskeleton	J. Sancho, M. Perez, E. Garcia, D. Sanz-Merodio, A. Plaza and M. Cestari	Int. Conf. Climbing and Walking Robots and the Support Technologies for Mobile Machines	N/A	N/A	London, UK, 2016	N/A	n	n	y		y	

			A wearable gait exoskeleton for the daily life activity of children with SMA	E. Garcia, F. Jorge and M. Prieto	Cure SMA International Conference	N/A	N/A	Los Angeles, USA, 2016	N/A	n	n	y		y	
			Result of clinical trials with children with Spinal Muscular Atrophy using the ATLAS 2020 lower-limb active orthosis	D. Sanz-Merodio, M. Perez, M. Prieto, J. Sancho, and E. Garcia	20th Int. Conf. Climbing and Walking Robots and the Support Technologies for Mobile Machines	N/A	N/A	Porto, Portugal, 2017	N/A	n	n	y		y	
			ATLAS 2020: The paediatric gait exoskeleton project	E. Garcia, J. Sancho, D. Sanz-Merodio, and M. Prieto	20th Int. Conf. Climbing and Walking Robots and the Support Technologies for Mobile Machines	N/A	N/A	Porto, Portugal, 2017	N/A	n	n	y		y	

			Wearable Paediatric Gait Exoskeleton, a Feasibility Study	A. Ganguly, D. Sanz-Merodio, G. Puyuelo, A. Goñi, E. Garcés, and E. Garcia	IEEE/RSJ International Conference on Intelligent Robots and Systems, IROS2018	N/A	N/A	Madrid, Spain, 2018	N/A	n	n	y		y	
	GARotics	2	Robotic green asparagus selective harvesting	A. Leu, M. Razavi, L. Langstädtler, D. Ristić-Durrant, H. Raffel, C. Schenck, A. Gräser, B. Kuhfuss	IEEE/ASME TRANSACTIONS ON MECHATRONICS	Issue 6, Volume 22, Number 6	IEEE	2017	10	y	y	y		y	
			Roboter können Grünsparge lernte günstiger machen	Alexander Mend	Spargel und Erdbeer Profi	3	Rheinischer Landwirtschafts-Verlag GmbH	2017	3	y	y	y		y	Publisher was not a project partne

														r (component supplier)
	LA-ROSES	3	An “All-laser” Endothelial Transplant	Francesca Rossi	Journal of Visualized experiment - JOVE	101		2015	e52939	n	n	n	at the time of publication open access was not mandatory	y	
			A robotic platform for laser welding of corneal tissue	Francesca Rossi	Proc. SPIE 10413, Novel Biophotonics Techniques and Applications IV	10413	SPIE	2017	104130B	n	n	n	publisher's licensing agreement would not permit open access proceedings	y	

			Laser assisted robotic surgery in cornea transplantation	Francesca Rossi	Progress in Biomedical Optics and Imaging - Proceedings of SPIE	10056	SPIE	2017	100560T	n	n	n	publisher's licensing agreement would not permit open access proceedings	y	
	LINarm++	3	Analysis and synthesis of linwwc-vsa, a variable stiffness actuator for linear motion	G. Spagnuolo	Mechanism and Machine Theory	vol. 110	Elsevier	2017	85-99	n	n	n	no funds available to publish in an open	y	
			An affordable, adaptable, and hybrid assistive device for upper-limb neurorehabilitation	M. Malosio	Journal of Rehabilitation and Assistive Technologies Engineering	Vol. 3	SAGE Publishing	2016	1-12	y	y	n		y	

			An unobtrusive measurement method for assessing physiological response in physical human-robot interaction	Blaž Jakopin	*IEEE transactions on human-machine systems*	N/A	IEEE	2017	474 - 485	n	n	y		y	
	MARS	2	Managing a Mobile Agricultural Robot Swarm for a Seeding Task	Timo Blender	IECON 2016 - 42nd Annual Conference of the IEEE Industrial Electronics Society	N/A	IEEE	Florence, Italy, 2016	6879 - 6886	n	n	n	publisher's licensing agreement would not permit publishing in a repository	y	
			Motion Control for Omni-Drive Servicerobots under Kinematic Dynamic	Timo Blender	20th IEEE Conference on Emerging Technologies and Factory	N/A	IEEE	Luxemburg, 2015	1-8	n	n	n	publisher's licensing agreement would not	y	

			and Shape Constraints		Automation (ETFA)							permit publishing in a repository		
	MObile robo T for upper limb neurOrtho Rehabilitation	3	MOTORE++ A Portable Haptic Device for Domestic Rehabilitation	Lucia Saracino	The 42nd Annual Conference of IEEE Industrial Electronics Society, October 24-27, 2016	N/A	IEEE	2016	N/A	y	y	y		y	
			Fusion of wearable sensors and mobile haptic robot for the assessment in upper limb rehabilitation	Lucia Saracino	IEEE International Conference on Multisensor Fusion and Integration for Intelligent Systems (MFI).	N/A	IEEE	2016	N/A	y	y	y		y	

			Upper limb rehabilitation after stroke using a portable haptic robotic device: preliminary results	Stefano mazzoleni	EMBC	N/A	N/A	2016	N/A	y	y	y		y	
	MODUL	2	ANYmal - a highly mobile and dynamic quadruped al robot	M. Hutter	IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)	N/A	IEEE	2016	38-44	y	n	y		y	
			ANYmal - toward legged robots for harsh environments	M. Hutter	Advanced Robotics	vol 31, issue 17	Taylor & Francis	2017	918-931	y	n	y		y	
	pickit	2	Sensor design and model-based tactile	Veit Müller	IEEE Sensors	N/A	IEEE Xplore	Glasgow and 25 December 2017	3	n	n	y		y	

			feature recognition											
			A new Multi-Modal Approach towards reliable Bin-Picking Application	Veit Müller	ISR Conference	N/A	IEEE Xplore, Springer Verlag	München, Nov. 2016	6	n	n	y		y	
	SAPARO	2	Safe Human-Robot Cooperation with high payload robots in industrial applications	Vogel, C.; Fritzsche, M.; Elkmann, N.	Human-Robot Interaction (HRI), 11th International Conference on,	N/A	N/A	New Zealand, 07.-10. March, 2016	N/A	n	n	n	lack of time and resources	y	

			Novel Safety Concept for Safeguarding and Supporting Humans in Human-Robot Shared Workplaces with High-Payload Robots in Industrial Applications	Vogel, C.; Elkmann, N.	Human-Robot Interaction (HRI), 12th International Conference on,	N/A	N/A	Vienna, Austria, 06.-09. March, 2017	N/A	n	n	n	lack of time and resources	y	
	TIREBOT	3	TIREBOT: a Collaborative Robot for the Tire Workshop	Alessio Levratti	Robotics and Computer Integrated Manufactiring	In press	Elsevier	In Press	In Press	y	y	y		y	
			TIREBOT: a Novel Tire Workshop Assistant Robot	Alessio Levratti	Proceedings of the 2016 IEEE International Conference on Advanced Intelligent Mechatronics (AIM)	N/A	IEEE	2016	N/A	y	y	y		y	

			Safe Navigation and Experimental Evaluation of a Novel Tire Workshop Assistant Robot	Alessio Levratti	Proceedings of the IEEE International Conference on Robotics and Automation (ICRA)	N/A	IEEE	2017	N/A	y	y	y		y	
	CATCH	3	Automatic Detection of Field-Grown Cucumbers for Robotic Harvesting	Roemi Fernandez	IEEE ACCESS	6	IEEE	2018	35512-35527	y	y	y		y	
			Cucumber Detection for Precision Agriculture Applications	Roemi Fernandez	Proceedings of the 21th International Conference CLAWAR 2018	September 10-12, 2018	ELSEVIER - CLAWAR ASSOCIATION	September 10-12, 2018 Panama	167-174	y	y	y		y	
			Innovative Robo application: The CATCH Experiment (in german)	Dragoljub Surdilovic	wt Werkstattstechnik WT-Online	H9	VDI	2017	600-604	y	y	y		y	

	DUALARM WORKER	1	A case study of automated dual-arm manipulation in industrial applications (*Submitted*)	Corresponding author: J. Cortés	N/A	N/A	N/A	2019	N/A	y	n	y		
	FASTKIT	6	Proceedings of the Third International Conference on Cable-Driven Parallel Robots	N/A	N/A	N/A	Springer	2017	pp. 268-279	y	n	y		y
			2018 IEEE International Conference on Robotics and Automation (ICRA)	N/A	N/A	N/A	N/A	2018	N/A	y	n	y		y
			Advances in Robot Kinematics	N/A	N/A	N/A	N/A	2018	N/A	y	n	y		y

			Proceedings of the ASME 2018 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference (IDETC/CIE)	August 26-29, 2018	N/A	N/A	N/A	2018, Quebec City, QC., Canada, .	N/A	y	n	y		y	
	FlexSight	2	Robust Intrinsic and Extrinsic Calibration of RGB-D Cameras	F. Basso, E. Menegatti and A. Pretto	IEEE Transactions on Robotics	N/A	IEEE	Vol: 34, Issue: 5, Oct. 2018	1315 - 1332	n	n	y		y	
			Learning from Successes and Failures to Grasp Objects with a Vacuum Gripper	L. Monorchio, D. Evangelista, N. Imperoli, and A. Pretto	Proc. of the IROS 2018 Workshop "Task-Informed Grasping for rigid and deformable object	N/A	N/A	2018	N/A	y	y	y		y	

					manipulation"									
	GRAPE	3	GRAPE: Ground Robot for vineyArd Monitoring and ProtEction	Ferran Roure, Germán Moreno, Marcel Soler, Davide Faconti, Daniel Serrano, Pietro Astolfi, Gianluca Bardaro, Alessandro Gabrielli, Luca Bascetta, Matteo Matteucci	Iberian Robotics conference	43061	Springer, Cham	2017	249-260	n	n	n	the conference does not allow open access publishing	y	

			Lessons Learned in Vineyard Monitoring and Protection from a GroundAutonomous Vehicle	Ferran Roure, Luca Bascetta, Marcel Soler, Matteo Matteucci, DavideFaconti, Jesus-Pablo Gonzalez and Daniel Serrano	N/A	N/A	Springer	2019	N/A	y	n	y		y	
			Vineyard autonomous navigation in the Echord++ GRAPE Experiment	P. Astolfi, A. Gabrielli, L. Bascetta,, M. Matteucci	16th IFAC Symposium on Information Control Problems in Manufacturing INCOM 2018	Annual conference	Elsevier	2018	704-709	n	n	n	the conference does not allow open access publishing	y	
	HOMEREHAB	5	Development of a Robotic Device for Post-Stroke Home Tele-	I. Díaz	Advances in Mechanical Engineering	N/A	SAGE Journals	January 2018	pp. 1-8	y	n	y		y	

			Rehabilitation												
			Evaluation of an Upper-Limb Rehabilitation Robotic Device for Home Use from Patient Perspective	J.M. Catalan	4th International Conference on NeuroRehabilitation (ICNR2018)	N/A		October 16-20, 2018	pp. 449-453	n	n	y		y	
			Patient evaluation of an upper-limb rehabilitation robotic device for home use	J.M. Catalan	IEEE International Conference on Biomedical Robotics and Biomechatronics (BioRob)	N/A	N/A	August 26-29, 2018	pp. 450-455	n	n	y		y	
			HOMEREHAB: Development of Robotic Technology for Post-Stroke	L.D. Lledó	Jornadas Nacionales de Robótica, Spanish Robotics Conference	N/A	N/A	June 8-9, 2017	N/A	n	n	y		y	

			Home Tele-Rehabilitation											
			Robotic Technology for Post-Stroke In-Home Tele-Rehabilitation	M. Chiurazzi	International Workshop on Assistive & Rehabilitation Technology (IWART)	N/A	N/A	December 14-16, 2016	pp. 17-18	n	n	y		y	
	HyQ-REAL	5	A Brief Overview of a Novel, Highly-Integrated Hydraulic Servo Actuator with Additive-Manufactured Titanium Body	Claudio Semini	Workshop at IEEE IROS conference	N/A	IEEE	2016	4 pages	y	y	y		y	

			Highly-Integrated Hydraulic Smart Actuators and Smart Manifolds for High-Bandwidth Force Control	Victor Barasuol	Frontiers in Robotics and AI	N. 51	Frontiers in	2018	N/A	y	y	y		y	
			Heuristic Planning for Rough Terrain Locomotion in Presence of External Disturbances and Variable Perception Quality	Michele Focchi	Springer Track in Advanced Robotics series - ECHORD++ book	N/A	Springer	2018/ 2019	N/A	?	?	y		y	
			Validation of Computer Simulations of the HyQ Robot	Marco Frigerio	CLAWAR conference proceedings	N/A	World Scientific	2017	415-422	y	n	y		y	

			Viscosity-based Height Reflex for Workspace Augmentation for Quadruped al Locomotion on Rough Terrain	Michele Focchi	IEEE IROS 2017 conference	N/A	IEEE	2017	N/A	y	n	y		y	
	Keraal	7	Computational Architecture of a Robot Coach for Physical Exercises in Kinesthetic Rehabilitation	NGUYEN Sao Mai	IEEE International Symposium on Human and Robot Interactive Communication	N/A	IEEE	2016	N/A	n	n	y		y	
			A humanoid robot for coaching patients for physical rehabilitation exercises	NGUYEN Sao Mai	Asian Conference on Computer Aided Surgery	N/A	N/A	2016	N/A	y	n	y		y	

			Cognitive architecture of a humanoid robot for coaching physical exercises in kinaesthetic rehabilitation	NGUYEN Sao Mai	10th International Workshop on Cognitive Robotics, in IROS	N/A	N/A	2016	N/A	y	n	y		y	
			Télé-rééducation fonctionnelle dans le cadre du projet VITAAL	THEPAUT Andre	Actualités en Médecine Physique et de Réadaptation	1	N/A	2017	18-19	n	n	y		y	
			Multi-Level Motion Analysis for Physical Exercises Assessment in Kinaesthetic Rehabilitation	DEVANNE Maxime	International Conference on Humanoid Robotics (Humanoids)	N/A	IEEE-RAS	2017	N/A	y	n	y		y	

			A co-design approach for a rehabilitation robot coach for physical rehabilitation based on the error classification of motion errors	DEVANNE Maxime	IEEE IRC workshop on Collaboration of Humans, Agents, Robots, Machines and Sensors	N/A	N/A	2018	N/A	y	n	y		y	
			Rééducation fonctionnelle assistée par robot humanoïde	THEPAUT Andre	Des robots au service des soignés, et des soignants.	N/A	Eres	2018	N/A	y	n	n	book chapter	y	
	MAX ES	1	MAX ™	C.Mercier	La voix du Nord	daily	N/A	March 2017	N/A	y	y	y			
	SAFERUN	3	Safety and efficiency management in LGV operated warehouses	Marina Raineri	J. of Robotics and Computer-Integrated Manufacturing	N/A	Elsevier	In press (2019)	N/A	y	y	y		y	

			Optimality criteria for the path planning of autonomous industrial vehicles	Marina Raineri	Springer Track in Advanced Robotics series - ECHORD++: Innovation from LAB to MARKET	N/A	Springer	In press (2019)	N/A	y	n	n	lack of information on open access,	y	
			Online velocity planner for Laser Guided Vehicles subject to safety constraints	Marina Raineri	The 2017 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2017)	N/A	IEEE	Vancouver, Canada, 2017	6178 - 6184	n	n	n	Open access not available	y	
	WIRES	6	The WIRES Experiment: Tools and Strategies for Robotized Switchgear Cabling	Gianluca Palli	Procedia Manufacturing	11	Elsevier	2017	355-363	y	y	y		y	

			Integration of Robotic Vision and Tactile Sensing for Wire-Terminal Insertion Tasks	Daniele De Gregorio	IEEE Transactions on Automation Science and Engineering	in press	IEEE	2018	N/A	n	n	n	no funds available to publish in an open	y	
			Tactile-Based Manipulation of Wires For Switchgear Assembly	Salvatore Pirozzi	IEEE/ASME TRANSACTIONS ON MECHATRONICS	in press	IEEE	2018	N/A	n	n	n	no funds available to publish in an open	y	
			Design and Evaluation of Tactile Sensors for the Estimation of Grasped Wire Shape	Salvatore Pirozzi	IEEE International Conference on Advanced Intelligent Mechatronics	July 3-7	IEEE	2017	490-496	n	n	n	publisher's licensing agreement would not permit publishing in a repository	y	

			Let's take a Walk on Superpixels Graphs: Deformable Linear Objects Segmentation and Model Estimation	Daniele De Gregorio	Asian Conference on Computer Vision	N/A	N/A	2018	N/A	n	n	n	publisher's licensing agreement would not permit publishing in a repository	y	
			Automatized Switchgear Wiring: An Outline of the WIRES Experiment Results	Gianluca Palli	Echord++ Scientific Book	N/A	Spinger	2018	N/A	n	n	n	publisher's licensing agreement would not permit publishing in a repository	y	

Section A2: List of dissemination activities

The dissemination activities are always a crucial point in European projects and especially in a European project with such a high impact as ECHORD^{++}. The purpose of those dissemination activities is the creation of promoting material (websites, leaflets etc.), the use of social media, the participation in conferences, seminars, workshops and other events and finally, the promotion of the project through press releases and articles published. On the figure 20 you can see the different ways that our partners chose to disseminate their project.

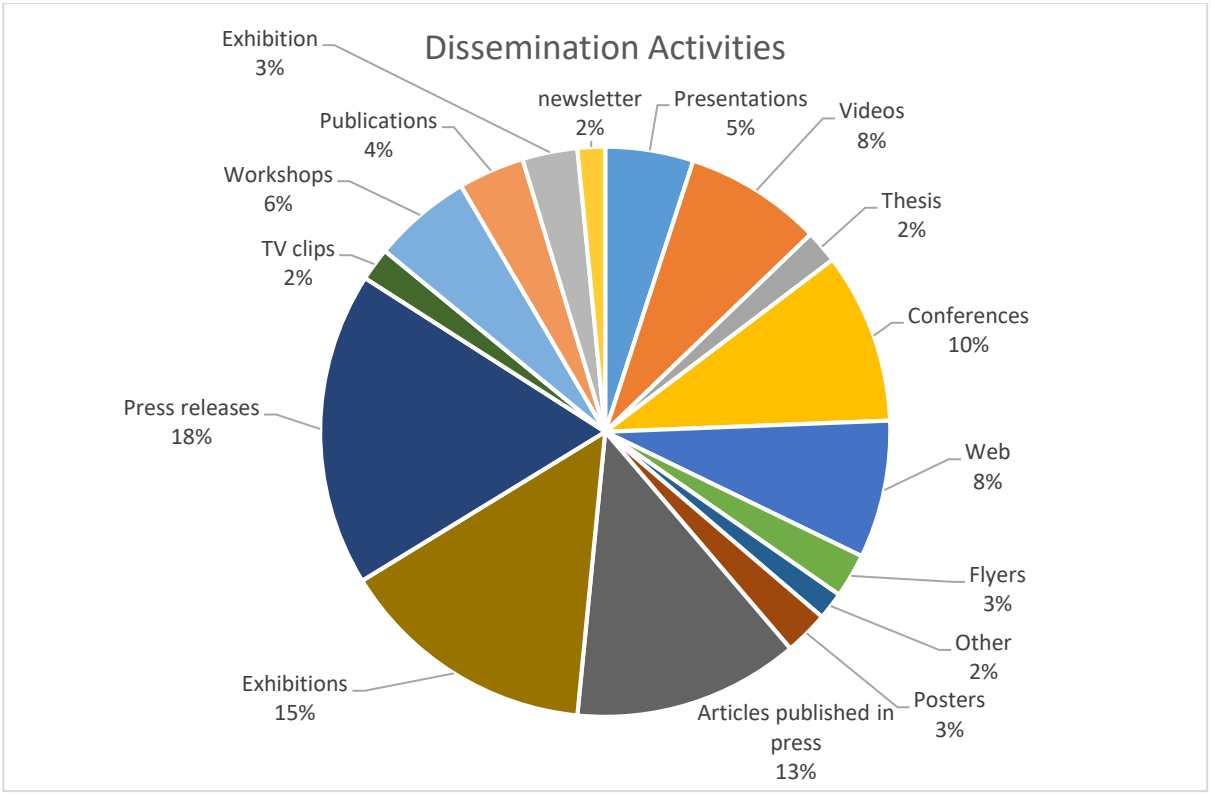

Figure 20 - Types of Dissemination activities from partners of Call 1 and Call 2

NO.	Type of activities[13]	Main leader	Title	Date/Period	Place	Type of audience[14]	Size of audience	Countries addressed
1	Other		ECHORD++ Kick-Off-Meeting	October 22, 2013	Paris			
2	Exhibition	UPC	Smart City Expo	November, 20 2013	Barcelona			
3	Presentation		Horizon 2020 Infoday	January 13, 2014	Luxembourg			
4	Presentation		Robotics in Horizon 2020	January 22, 2014	London			
5	Presentation		PCP Concertation Meeting	February 10, 2014	Brussels			
6	Other	SSSA	RIF Infoday	February 11, 2014	Pontedera			
7	Other	UPC	Barcelona Living Lab	February 21, 2014	Barcelona			
8	Other	SSSA	Evolution - Development - Innovation	March 7, 2014	Peccioli			
9	Conference	TUM	European Robotics Forum	March 12, 2014	Rovereto			
10	Poster	TUM	Industrial technologies	April 11, 2014	Athens			
11	Exhibition	TUM	RoboBusiness Europe	May 26, 2014	Billund			
12	Conference		IEEE International Conference on Robotics and Automation (ICRA)	June 1, 2014	Hongkong			
13	Exhibition	TUM	Automatica	June 3, 2014	Munich			
14	Other	UPC	Science & Technology Party	June 14, 2014	Barcelona			

[13] A drop down list allows choosing the dissemination activity: publications, conferences, workshops, web, press releases, flyers, articles published in the popular press, videos, media briefings, presentations, exhibitions, thesis, interviews, films, TV clips, posters, Other.

[14] A drop down list allows choosing the type of public: Scientific Community (higher education, Research), Industry, Civil Society, Policy makers, Medias, Other ('multiple choices' is possible).

15	Presentation		I4MS	June 18	Berlin			
16	Exhibition	TUM	IAS13	July 15, 2014	Padova			
17	Other		Japan Academia Industry	September 24, 2014	Munich			
18	Conference		ICT Proposers Day	October 9, 2014	Florence			
19	Other	BRL	RIF Info Day	October 23, 2014	Bristol			
20	Other	BRL	RIF Info Day	October 24, 2014	Bristol			
21	Presentation	TUM	fortiss	October 28, 2014	Munich			
22	Exhibition	TUM	MEDICA	November 12, 2014	Düsseldorf			
22	Exhibition	UPC	Smart City Expo	November 18, 2014	Barcelona			
23	Other	BRL	RIF Opening	November 26, 2014	Bristol			
24	Other	TUM	Market consultation day – PCP Pilot in healthcare	December 3, 2014	Munich			
25	Other	CEA	RIF Opening	January 14, 2015	Paris-Saclay			
26	Other	SSSA	RIF Opening	February 9, 2015	Peccioli			
27	Exhibition	UPC	RoboBusiness Europe	April 27, 2015	Milan			
28	Other	BRL	BBC Panorama	August 26, 2015	Bristol			
29	Conference	BRL	Smart Agriculture Conference	September 8, 2015	Birmingham			
30	Exhibition	BRL	Venture Fest Wales	September 29, 2015	Cardiff			
31	Conference	BRL	FT Future of Manufacturing	September 30, 2015	London			
32	Conference/Workshop	UPC	IROS	October 2, 2015	Hamburg			
33	Exhibition	UPC	Smart City Expo	November 17, 2015	Barcelona			
34	Other		euRobotics Brokerage Day	November 18, 2015	Brussels			
35	Other	BRL	STEM Mas-terclass	January 12, 2016	Bristol			
36	Workshop	BRL	Business Workshop. Introduction to Mechatronics	January 21, 28, March 17, 24, 2016	Bristol			
37	Other	BRL	Presentation of the RIF to the Welsh Government	February 1, 2016	Bristol			
38	Other	BRL	SME Day (FET)	February 24, 2016	Bristol			

39	Other	BRL	ESTnet Awards	March 2, 2016	Cardiff			
40	Workshop	BRL	Workshop: Introduction to Robots	March 3, 2016	Bristol			
41	Other	BRL	British Science Week	March 11, 2016	Bristol			
42	Exhibition	BRL	Venture FEST East Midlands	March 16, 2016	Leicester			
43	Exhibition	TUM	bauma	April 11, 2016	Munich			
44	Presentation	BRL	MOD Presentation	April 15, 2016	Filton			
45	Exhibition	TUM	Hannover Messe	April 25, 2015	Hannover			
46	Other	BRL	Glos Business Show	May 18, 2016	Cheltenham			
47	Exhibition	UPC	Innorobo	May 24, 2016	Paris			
48	Exhibition	TUM	RoboBusiness Europe	June 1, 2016	Odense			
49	Other	UPC	Festa de la Ciencia	June 18, 2016	Barcelona			
50	Exhibition	UPC	Automatica	June 21, 2016	Munich			
51	Other	SSSA	ForItAAL Summer School	June 2016	Peccioli			
52	Other	BRL	Science Museum Robot Show	July 4, 2016	London			
53	Other	UPC	EFTA	September 6, 2016	Berlin			
54	Exhibition	BRL	Venturefest Wales	September 28, 2016	Cardiff			
55	Conference	UPC	IROS	October 9, 2016	Daejon			
56	Other	BRL	Venturefest South West	October 18, 2016	Exeter			
57	Exhibition	UPC	Smart City Expo	November 17, 2016	Barcelona			
58	Workshop	SSSA	Italian-Japanese Workshop	November 2016	Peccioli			
59	Workshop	SSSA	Workshop with ARtex	December 2016	Peccioli			
60	Exhibition	UPC	Global Robot Expo	February 2, 2017	Madrid			
61	Conference	SSSA	European Robotics Forum	March 22, 2017	Edinburgh			
62	Exhibition	TUM	Hannover Messe	April 24, 2017	Hannover			
63	Exhibition	UPC	EC Committee of Regions	May 10, 2017	Brussels			

64	Exhibition	UPC	Innorobo	May 15, 2017	Paris			
65	Workshop	UPC	Festa de la Ciencia	May 27, 2017	Barcelona			
66	Conference	UPC	FIABCI 2017	May 28, 2017	Andorra			
67	Presentation	TUM	ECHORD^{++} at IIT	July 31, 2017	Genoa			
68	Exhibition	SSSA	International Robotics Festival	September 7, 2017	Pisa			
69	Presentation	RUR	Hubs, Platforms and Pilots in Horizon 2020	September 14, 2017	Oslo			
70	Conference	UPC	IROS 2017	September 25, 2017	Vancouver			
71	Exhibition	UPC	Smart City Expo	November 14, 2017	Barcelona			
72	Other	UPC	European Robotics Week	November 20, 2017	Brussels			
73	Conference	UPC	European Robotics Forum	March 13, 2018	Tampere			
74	Exhibition	UPC	Automatica	June 19, 2018	Munich			
75	Conference	UPC	IROS	October 1, 2018	Madrid			
76	Exhibition	TUM	GovTech Summit	November 12, 2018	Paris			
77	Exhibition	TUM	MEDICA	November 12, 2018	Düsseldorf			
78	Exhibition	UPC	Smart City Expo	November 13, 2017	Barcelona			
79	Conference	TUM	DIH annual event	November 27, 2018	Warsaw			
80	Conference	UPC	European Robotics Forum	March 20, 2019	Bucharest			
81	Information (Breakfast)	TUM	EU Parliament with Host Pilar del Castillo Vera	April 2, 2019	Brussels	Members of the Parliament and the Commission	23	all

Section A3: Press clippings

Medium	Type	Date	Topic	Country	trade press	initiated by
www.bcn.cat	Website	19/11/2013	Smart City Expo/UPC	Spain		core consortium
www.regiondigital.com	Website	21/11/2013	Smart City Expo/UPC	Spain		core consortium

www.digitalextremadura.com	Website	21/11/2013	Smart City Expo/UPC	Spain		core consortium
Ansa	News agency	12/02/2014	General Information on project and SSSA/Infoday	Italy		core consortium
agronotizie.imagelinenetwork.com	Website	12/02/2014	General Information on project and SSSA/Infoday	Italy	x	core consortium
Il Tirreno	Newspaper	12/02/2014	General Information on project and SSSA/Infoday	Italy		core consortium
www.controcampus.it	Website	12/02/2014	General Information on project and SSSA/Infoday	Italy	x	core consortium
pisainformaflash.it	Website	12/02/2014	General Information on project and SSSA/Infoday	Italy		core consortium
GoNews.it	Website	12/02/2014	General Information on project and SSSA/Infoday	Italy		core consortium
Pagina Q - La pagina quotidiana Pisa	Newspaper	12/02/2014	General Information on project and SSSA/Infoday	Italy		core consortium
La Nazione Pontedera	Newspaper	13/02/2014	General Information on project and SSSA/Infoday	Italy		core consortium
Il Tirreno Pontedera	Newspaper	13/02/2014	General Information on project and SSSA/Infoday	Italy		core consortium
Pisatoday.it	Website	13/02/2014	General Information on project and SSSA/Infoday	Italy		core consortium
QuiNewsvaldera.it	Website	13/02/2014	General Information on project and SSSA/Infoday	Italy		core consortium
robohub.org	Website	04/03/2014	Fist call for experiments	Switzerland	x	core consortium
www.zombieslounge.com	Website	10/03/2014	First call for experiments	India	x	core consortium
http://www.roboticstoday.com	Website	20/08/2014	Automatica video	Netherlands	x	core consortium
http://spectrum.ieee.org	Website	22/08/2014	Automatica video	USA	x	core consortium
robohub.org	Website	22/08/2014	Automatica video	Switzerland	x	core consortium
http://www.33rdsquare.com	Website	22/08/2014	Automatica video	USA	x	core consortium
http://futurescope.co	Website	26/08/2014	Automatica video	Germany	x	core consortium
http://robotenomics.com	Website	26/08/2014	Automatica video	USA	x	core consortium
El periodico de Catalunya	Newspaper	17/11/2014	PDTI urban robotics	Spain		core consortium
http://www.elperiodicomediterraneo.com/noticias/sociedad/nuevos-robots-municipales_905308.html	Newspaper	17/11/2014	PDTI urban robotics	Spain		core consortium

http://www.lavozdigital.es/agencias/20141117/economia/coches-hibridos-robotica-redes-inteligentes_201411171903.html	Website	17/11/2014	Smart City Expo/UPC	Spain		core consortium
http://www.presspeople.com/nota/upc-presenta-solucions-intel-ligents-per	Website	17/11/2014	Smart City Expo/UPC	Spain		core consortium
http://www.expansion.com/agencia/efe/2014/11/17/20127333.html	Website	17/11/2014	Smart City Expo/UPC	Spain	x	core consortium
http://www.eldiariomontanes.es/agencias/201411/17/coches-hibridos-robotica-redes-242681.html	Website	17/11/2014	Smart City Expo/UPC	Spain		core consortium
http://www.finanzas.com/noticias/empresas/20141117/coches-hibridos-robotica-redes-2807284.html	Website	17/11/2014	Smart City Expo/UPC	Spain	x	core consortium
http://www.lavanguardia.com/vida/20141117/54419960471/coches-hibridos-robotica-y-redes-inteligentes-en-el-salon-smart-city-2014.html	Website	17/11/2014	Smart City Expo/UPC	Spain		core consortium
http://www.lasprovincias.es/agencias/201411/17/coches-hibridos-robotica-redes-242681.html	Website	17/11/2014	Smart City Expo/UPC	Spain		core consortium
http://www.elcorreo.com/agencias/201411/17/coches-hibridos-robotica-redes-242681.html	Website	17/11/2014	Smart City Expo/UPC	Spain		core consortium
http://www.ideal.es/agencias/20141117/economia/coches-hibridos-robotica-redes-inteligentes_201411171903.html	Website	17/11/2014	Smart City Expo/UPC	Spain		core consortium
http://www.elconfidencial.com/ultima-hora-en-vivo/2014-11-17/coches-hibridos-robotica-y-redes-inteligentes-en-el-salon-smart-city-2014_420851/	Website	17/11/2014	Smart City Expo/UPC	Spain		core consortium
http://www.larioja.com/agencias/201411/17/coches-hibridos-robotica-redes-242681.html	Website	17/11/2014	Smart City Expo/UPC	Spain		core consortium
http://www.diariosur.es/agencias/201411/17/coches-hibridos-robotica-redes-242681.html	Website	17/11/2014	Smart City Expo/UPC	Spain		core consortium
http://www.diariovasco.com/agencias/201411/17/coches-hibridos-robotica-redes-242681.html	Website	17/11/2014	Smart City Expo/UPC	Spain		core consortium
http://noticias.lainformacion.com/economia-negocios-y-finanzas/transporte-por-carretera/coches-hibridos-robotica-y-redes-inteligentes-en-el-salon-smart-city-2014_mdZdWpZFhhUIvXBKSxmyv/	Website	17/11/2014	Smart City Expo/UPC	Spain		core consortium
http://locampusdiari.com/arxius/26330	Website	18/11/2014	Smart City Expo/UPC	Spain	x	core consortium
http://energuia.com/2014/11/coches-hibridos-robotica-y-redes-inteligentes-en-el-salon-smart/	Website	18/11/2014	Smart City Expo/UPC	Spain	x	core consortium
http://www.naciodigital.cat/latorredelpalau/noticia/37203/upc/presenta/seus/projectes/al/smart/city/expo/world/congress	Website	18/11/2014	Smart City Expo/UPC	Spain		core consortium

http://www.catalunyavanguardista.com/catvan/la-ciudad-del-futuro/	Website	18/11/2014	Smart City Expo/UPC	Spain		core consortium
https://elpais.com/ccaa/2014/11/18/catalunya/1416329905_278937.html	Newspaper	18/11/2014	Smart City Expo/UPC	Spain		core consortium
Diari de Terassa	Newspaper	20/11/2014	Smart City Expo/UPC	Spain		core consortium
http://btv.cat/btvnoticies/2014/11/20/robotica-inspeccio-clavegueram-smart-city/	TV	20/11/2014	PDTI urban robotics	Spain		core consortium
http://www.compromisorse.com/rse/2014/11/20/6-soluciones-inteligentes-para-la-ciudad-del-futuro/	Website	20/11/2014	Smart City Expo/UPC	Spain	x	core consortium
http://www.dggeriatrie.de/home-54/aktuelle-meldungen/890-oeffentliche-ausschreibung-foerdergelder-fuer-robotereinsatz-in-der-geriatrie.html	Website	22/11/2014	PDTI healthcare call	Germany	x	core consortium
http://www.roboticstoday.com/News/echord-integrates-public-bodies-3087	Website	24/11/2014	Market consultation PDTI	Netherlands	x	core consortium
http://cadenaser.com/emisora/2014/11/25/radio_barcelona/1416909234_461294.html	radio	25/11/2014	PDTI urban robotics	Spain		core consortium
http://www.swinnovation.co.uk/2014/11/bristol-robotics-innovation-facility-opens-support-small-companies/	Website	27/11/2014	RIF@BRL launch	United Kingdom	x	core consortium
https://www.youtube.com/watch?v=Gv8BBCS2WFA	TV	08/12/2014	LA-ROSES experiment	Italy		experiment
http://exotrainer.weebly.com/uploads/5/0/2/1/50217627/p%C3%A1ginas_desdeadjacentgovernment_health_february_2015.pdf	Newsletter	01/02/2015	EXOTrainer Experiment	Spain	x	experiment
iltirreno.gelocal.it	Newspaper	16/02/2015	MOTORE^{++} experiment	Italy		experiment
ansa.it	News agency	16/02/2015	MOTORE^{++} experiment	Italy		experiment
http://www.firenzepost.it/	News website	16/02/2015	MOTORE^{++} experiment	Italy		experiment
http://www.tiscali.it/	News website	16/02/2015	MOTORE^{++} experiment	Italy		experiment
ilsecoloxix.it	Newspaper	16/02/2015	MOTORE^{++} experiment	Italy		experiment
http://www.agenziaitalia.it	News agency	16/02/2015	MOTORE^{++} experiment	Italy		experiment
corriere.it	Newspaper	16/02/2015	MOTORE^{++} experiment	Italy		experiment
toscanatv.com	TV	16/02/2015	MOTORE^{++} experiment	Italy		experiment
goNews.it	News website	16/02/2015	MOTORE^{++} experiment	Italy		experiment
notizie.virgilio.it	News website	16/02/2015	MOTORE^{++} experiment	Italy		experiment
Controradio	Radio	16/02/2015	MOTORE^{++} experiment	Italy		experiment
http://www.pisainformaflash.it/	News website	16/02/2015	MOTORE^{++} experiment	Italy		experiment
intoscana.it	News website	16/02/2015	MOTORE^{++} experiment	Italy		experiment
ilsitodifirenze.it	News website	16/02/2015	MOTORE^{++} experiment	Italy		experiment
italyNews.it	News website	16/02/2015	MOTORE^{++} experiment	Italy		experiment

it.notizie.yahoo.com	News website	16/02/2015	MOTORE^{++} experiment	Italy		experiment
Quotidiano di Ragusa e dintorni	Newspaper	16/02/2015	MOTORE^{++} experiment	Italy		experiment
La Prima Pagina - Toscana	Newspaper	16/02/2015	MOTORE^{++} experiment	Italy		experiment
http://www.gazzettadifirenze.it/	News website	16/02/2015	MOTORE^{++} experiment	Italy		experiment
La Stampa	Newspaper	16/02/2015	MOTORE^{++} experiment	Italy		experiment
http://www.quiNewsvolterra.it/	News website	16/02/2015	MOTORE^{++} experiment	Italy		experiment
Il Corriere di Puglia e Lucania	News website	16/02/2015	MOTORE^{++} experiment	Italy		experiment
Pisa Today	News website	16/02/2015	MOTORE^{++} experiment	Italy		experiment
Agenzia Impress	News agency	16/02/2015	MOTORE^{++} experiment	Italy		experiment
N24G - News24Games	News website	16/02/2015	MOTORE^{++} experiment	Italy	x	experiment
ilmeteo.it	News website	16/02/2015	MOTORE^{++} experiment	Italy		experiment
datamanager.it	News website	16/02/2015	MOTORE^{++} experiment	Italy	x	experiment
http://nextme.it/	News website	16/02/2015	MOTORE^{++} experiment	Italy	x	experiment
adnkronos	News website	16/02/2015	MOTORE^{++} experiment	Italy		experiment
http://www.telemeditalia.it/it/ej-tecsanitar/content/entry/0/179/3596/motore-il-robot-per-la-riabilitazione-a-domicilio.html#.VqiPMlnQgsQ	News website	16/02/2015	MOTORE^{++} experiment	Italy	x	experiment
http://247.libero.it/focus/31723697/0/robot-per-la-fisioterapia-a-domicilio/	News website	16/02/2015	MOTORE^{++} experiment	Italy		experiment
http://www.futuraera.it/motore-il-robot-per-la-fisioterapia-a-domicilio/	News website	19/02/2015	MOTORE^{++} experiment	Italy	x	experiment
http://www.panorama.it/scienza/salute/robot-per-riabilitazione-domicilio-dopo-ictus/	Magazine	20/02/2015	MOTORE^{++} experiment	Italy		experiment
Il messagero	Newspaper	25/02/2015	MOTORE^{++} experiment	Italy		experiment
http://www.corrierecomunicazioni.it/it-world/32834_e-health-arriva-il-motore-per-la-riabilitazione-post-ictus.htm	News website	02/03/2015	MOTORE^{++} experiment	Italy	x	experiment
https://www.key4biz.it/robot-domestici-ed-industriali-18-22-marzo-competizione-internazionale-a-pisa/	Website	16/03/2015	RoCKIn event at RIF@Pisa-Peccioli	Italy	x	core consortium
http://www.goNews.it/2015/03/17/il-contest-dei-robot-con-rockin-si-sfideranno-sei-gruppi-di-ricercatori/	Website	17/03/2015	RoCKIn event at RIF@Pisa-Peccioli	Italy		core consortium
http://www.quiNewsvaldera.it/la-guerra-dei-robot-e-alla-casa-domotica.htm	Website	17/03/2015	RoCKIn event at RIF@Pisa-Peccioli	Italy		core consortium
http://www.corriereuniv.it/cms/2015/03/sfida-di-robot-nellarena-di-pisa/	Website	18/03/2015	RoCKIn event at RIF@Pisa-Peccioli	Italy		core consortium
http://www.goNews.it/2015/03/18/inizia-il-primo-talent-dei-robot-automi-in-gara-per-dimostrare-chi-sara-il-migliore/	Website	18/03/2015	RoCKIn event at RIF@Pisa-Peccioli	Italy		core consortium

http://www.ilcuoioindiretta.it/dalla-provincia/item/38652-nel-pisano-primo-talent-dei-robot.html	Website	18/03/2015	RoCKIn event at RIF@Pisa-Peccioli	Italy		core consortium
http://iltirreno.gelocal.it/pontedera/cronaca/2015/03/18/News/alla-casa-domotica-il-primo-talent-con-i-robot-protagonisti-1.11069978	Newspaper	18/03/2015	RoCKIn event at RIF@Pisa-Peccioli	Italy		core consortium
http://www.diregiovani.it/home-diregiovani/39070-rockin-contest-robot-domotica-pisa-santanna.dg	Website	19/03/2015	RoCKIn event at RIF@Pisa-Peccioli	Italy	x	core consortium
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http://www.wired.it/scienza/lab/2015/03/20/competizione-italiana-robot/	Magazine	19/03/2015	RoCKIn event at RIF@Pisa-Peccioli	Italy	x	core consortium
http://www.ehealthNews.eu/open-calls/4319-funding-opportunity-comprehensive-geriatric-assessment-cga	Website	06/05/2015	PDTI healthcare call	Germany	x	core consortium
http://www.b4bschwaben.de/nachrichten/kaufbeuren-ostallgaeu_artikel,-AGCO-entwickelt-MARS-Roboter-fuer-die-Landwirtschaft-_arid,145944.html	Website	06/05/2015	start of MARS experiment	Germany	x	experiment
http://www.ballensilage.com/dateien/aktuell_2382.html	Website	09/05/2015	start of MARS experiment	Germany	x	experiment
http://www.reussir91.com/actualites-breves	Website	11/05/2015	Second call for experiments	France	x	core consortium
http://www.n24.de/n24/Mediathek/videos/d/6754606/am-roboter-geht-kein-weg-vorbei.html	TV	04/06/2015	Safe Human Robot Cooperation - SAPARO	Germany		experiment
http://www.sienafree.it/economia-e-finanza/264-economia-e-finanza/74109-ihimer-spa-e-imer-group-alla-smau-di-firenze	Newspaper	08/06/2015	2F Experiment	Italy		experiment
http://techspark.co/event/an-introduction-to-mechatronics-day-two/	Website	26/06/2015	BRL workshop	United Kingdom	x	core consortium
http://www.ulm-News.de/weblog/ulm-News/view/dt/3/article/43545/Roboterschwaerme_auf_schwaebischen_Feldern.html	Website	30/06/2015	start of MARS experiment	Germany		experiment
http://www.augsburger-allgemeine.de/neu-ulm/Statt-Traktoren-sollen-bald-Roboter-ueber-die-Felder-rollen-id34793902.html	Newspaper	15/07/2015	MARS experiment	Germany		experiment
http://www.eeweb.com/websites/echord	Website	20/07/2015	General Information on project	USA	x	core consortium
http://exotrainer.weebly.com/media.html	TV	26/07/2015	EXOTrainer Experiment	Spain		experiment
http://www.20minutos.es/noticia/2522757/0/exoesqueleto-bionico/ninos-paraplejicos/levantarse-caminar/	Newspaper	28/07/2015	EXOTrainer Experiment	Spain		experiment
http://www.rtve.es/alacarta/videos/telediario/innovador-exoesqueleto-permitira-caminar-ninos-paraplejia/3231327/	TV	28/07/2015	EXOTrainer Experiment	Spain		experiment

Antenne 1	Radio	29/07/2015	MARS experiment	Germany		experiment
http://www.smartandhealth.com/index.php/homepage-2/95-talent/220-innovacion-bionica-calidad-vida	Website	22/09/2015	EXOTrainer Experiment - Interview with Elena Garcia	Spain	x	experiment
http://www.crit-research.it/events/sinergie-regionali-e-progetti-finanziati-storie-di-successo/?unlocked=7131	News website	22/09/2015	TIREBOT experiment	Italy	x	experiment
http://www.pneurama.com/it/rivista_articolo.php/Corghi-vince-con-l-innovazione-?ID=23273	Magazine	29/09/2015	TIREBOT experiment	Italy	x	experiment
http://www.unindustriareggioemilia.it	website	29/09/2015	TIREBOT experiment	Italy	x	experiment
Emilianet	News website	30/09/2015	TIREBOT experiment	Italy	x	experiment
Gazzetta di Reggio	Newspaper	30/09/2015	TIREBOT experiment	Italy		experiment
Prima Pagina Reggio	Newspaper	30/09/2015	TIREBOT experiment	Italy		experiment
GripNews.it	News website	30/09/2015	TIREBOT experiment	Italy	x	experiment
http://www.hs-ulm.de/en/nocache/org/kom/MedienPublikationen/kompaktJournalundNewsletter/_docs/KOMPAKT01_2015.pdf	Magazine	01/10/2015	MARS experiment	Germany	x	experiment
http://www.pneusNews.it/2015/10/02/corghi-linnovazione-e-vincente/	News website	02/10/2015	TIREBOT experiment	Italy	x	experiment
http://www.notiziariomotoristico.com/News/6775/attrezzature-corghi-dove-linnovazione-e-di-casa	News website	15/10/2015	TIREBOT experiment	Italy	x	experiment
http://www.quiNewsvaldera.it/peccioli-sulla-fila-spunta-un-robot-da-150mila-euro.htm	Newspaper	07/11/2015	Dual arm robot @ SSSA	Italy		core consortium
http://www.bloomberg.com/News/articles/2015-11-11/robots-now-punch-people-to-make-tomorrow-s-machines-safer	News website	11/11/2015	Safe Human Robot Cooperation - SAPARO	USA	x	experiment
http://www.bristolhealthpartners.org.uk/latest-News/2015/11/18/how-will-robots-change-our-lives/468	website	18/11/2015	How will robots change our lives?	UK	x	core consortium
http://www.naciodigital.cat/noticia/98363/cinc/exemples/fer/smart/ciutats/pre	News website	18/11/2015	Smart City World Congress 2015	Spain		core consortium
La Vanguardia	Newspaper	19/11/2015	Smart City World Congress 2016	Spain		core consortium
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http://www.33rdsquare.com/2016/01/reinhard-lafrenz-named-new-secretary.html	News website	29/01/2016	Reinhard's leave	USA	x	core consortium

http://www.roboticstoday.com/News/reinhard-lafrenz-named-new-secretary-general-of-eurobotics-3133	News website	29/01/2016	Reinhard's leave	Netherlands	x	core consortium
http://industrialupdates.com/2016/02/05/eurobotics-appoints-new-secretary-general/#	News website	05/02/2016	Reinhard's leave	United Kingdom	x	core consortium
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www.swp.de/ulm/lokales/ulm_neu_ulm/Roboter-saeen-den-Mais;art4329,3708965	Newspaper	01/03/2016	MARS experiment	Germany		experiment
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http://cordis.europa.eu/News/rcn/131255_en.html	News website	03/03/2016	Start of PDTI	Belgium	x	core consortium
http://spectrum.ieee.org/automaton/robotics/humanoids/video-friday-watson-support-group-for-robots-russian-humanoid-anymal-quadruped	News website	04/03/2016	Anymal/MODUL	USA	x	experiment
http://robohub.org/a-new-quadrupedal-robot-the-anymal/	News website	04/03/2016	Anymal/MODUL	Switzerland	x	experiment
http://roboticsandautomationNews.com/2016/03/07/billion-dollar-brain-exclusive-interview-with-professor-alois-knoll/3263/	News website	07/03/2016	Interview with Alois Knoll	United Kingdom	x	core consortium
https://www.produktion.de/abonnement/heftarchiv/ausgabendetail/heft/produktion-2016-12.html?epaperPage=8	Magazine	23/03/2016	So schützen Sie Ihre Mitarbeiter vor Robotern - SAPARO	Germany	x	experiment
VDI Nachrichten	Newspaper	15/04/2016	MARS experiment	Germany	x	experiment
https://ec.europa.eu/digital-single-market/en/node/81845	website	22/04/2016	Hannover Messe	Belgium		core consortium
Echo & Citizen	Newspaper	11/05/2016	RIF Bristol @ Glos Biz Show	UK		core consortium
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South West Business Insider	website	18/05/2016	Start-up Support - Case Study	UK	x	core consortium
Medical Xpress	website	18/05/2016	Start-up Support - Case Study	UK	x	core consortium
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Zee News	website	22/05/2016	Start-up Support - Case Study	India		core consortium
http://www.robobusiness.eu/rb/end-user-driven-development-and-implementation-of-healthcare-robots/	News website	24/05/2016	PDTI healthcare	Denmark	x	core consortium
Care Appointments	website	27/05/2016	Start-up Support - Case Study	UK	x	core consortium
The Independent	Newspaper	01/06/2016	Start-up Support - Case Study	UK		core consortium
https://issuu.com/stadtbuero/docs/greta_1606?e=0	Magazine	01/06/2016	Robots and politics	Germany	x	core consortium
South West Business Insider	Magazine	01/06/2016	Start-up Support - Case Study	UK	x	core consortium
https://www.roboticsbusinessreview.com/top_5_reasons_why_european_robotics_thrives_in_denmark/	Magazine	05/06/2016	Top 5 Reasons Why European Robotics Thrives in Denmark	USA	x	core consortium
https://www.roboticsbusinessreview.com/top_5_reasons_why_european_robotics_thrives_in_denmark/	Magazine	05/06/2016	Robotics in Denmark	USA	x	core consortium
http://www.profi.de/News/MARS-Mission-in-der-Landtechnik-1808722.html	Magazine	06/06/2016	start of MARS experiment	Germany	x	experiment
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http://www.abc.es/sociedad/abci-primer-exoesqueleto-para-ninos-4931606306001-20160608020017_video.html	Newspaper	08/06/2016	Exotrainer	Spain		experiment
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La Sexta Noche	TV	26/06/2016	Exotrainer	Spain		experiment
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Tagblatt.ch	Newspaper	08/07/2016	Anymal/MODUL	Switzerland		experiment
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https://www.ke-next.de/videos/wie-roboterschwaerme-die-landwirtschaft-veraendern-sollen-202.html	News website	18/08/2016	MARS experiment	Germany	x	experiment
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http://viewer.getpixelbook.com/issue/fe8c96c46745af4a82c08fd87784c08b/pixelbook-com-tecnichenuove-ortopediciesanitari-os-2016-006	Magazine	01/09/2016	LINARM^{++} experiment	Italy	x	experiment
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TechSpark	website	30/09/2016	FutureSpace Incubator	UK		core consortium
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http://cordis.europa.eu/News/rcn/135935_en.html	News website	19/10/2016	SAGA experiment	Belgium	x	experiment
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http://www.publicnow.com/view/7A7526106D3FCC9CCDA158AA5E3971B247AB53CA?2016-12-13-11:00:18+00:00-xxx4777	News website	13/12/2016	SAFERUN experiment	Italy		experiment
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http://www.unipr.it/notizie/veicoli-autonomi-sicuri-il-dipartimento-di-ingegneria-dellinformazione-coordina-il-progetto	News website	13/12/2016	SAFERUN experiment	Italy		experiment
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http://www.fruchtportal.de/News/artikel/025897/catch-setzt-zur-ernte-von-einlegegurken-auf-robotik	News website	15/12/2016	CATCH experiment	Germany	x	experiment
Gazetta di Parma	Newspaper	29/12/2016	SAFERUN experiment	Italy		experiment
http://www.20minutos.es/noticia/2922951/0/tecnova-inicia-2017-con-proyecto-para-ampliar-6-9-hectareas-su-area-tecnologia-invernada/	Newspaper	29/12/2016	INJEROBOTS experiment	Spain		experiment
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http://www.automazioneindustriale.com/luniversita-di-parma-coordina-il-nuovo-progetto-europeo-saferun/	News website	11/01/2017	SAFERUN experiment	Italy	x	experiment
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http://www.rai.it/dl/RaiTV/programmi/media/ContentItem-72cb7c49-2252-4e7f-a982-44b7a814e3b3.html	TV	18/01/2017	HyQ-REAL experiment	Italy		
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http://www.grape-project.eu/wp-content/uploads/2017/02/20170202-provinciacremona.pdf	Newspaper	02/02/2017	Grape experiment	Italy		experiment
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VDE dialog	Magazine	15/04/2017	ECHORD^{++}	Germany	x	core consortium
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Gazetta di Parma	Newspaper	24/04/2017	SAFERUN experiment	Italy		experiment
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https://ing.dk/artikel/robotter-med-kunstig-intelligens-skal-fjerne-batterier-elektronikaffald-198146	Magazine	08/05/2017	AAWSBE1 experiment	Denmark	x	experiment
https://ing.dk/artikel/robotter-med-kunstig-intelligens-skal-fjerne-batterier-elektronikaffald-198146	Magazine	08/05/2017	AAwsbe	Denmark		

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https://horizon-Magazine.eu/article/eu-s-future-cyber-farms-utilise-drones-robots-and-sensors_en.html	News website	24/08/2017	SAGA experiment	Belgium	x	experiment

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https://www.fruchtportal.de/artikel/catch-ing-robotik-fur-die-gurkenernte/031194	News website	22/11/2017	CATCH experiment	Germany	x	experiment
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https://voltaico.lavozdegalicia.es/2017/12/espana-primer-exoesqueleto-portable/	News website	11/12/2017	Exotrainer	Spain	x	experiment

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https://www.enisa.es/es/comunidad-enisa/casos-de-exito/marsi-bionics-un-ejemplo-de-transferencia-tecnologica	News website	20/12/2017	EXOTRAINER	Spain		
http://w+A216:D249ww.universitari.eu/2017/01/veicoli-autonomi-sicuri-luniversita-di-parma-coordina-il-progetto-europeo-saferun/	News website	11/01/2017	SAFERUN experiment	Italy		experiment
http://www.bitmat.it/blog/News/70547/robot-servizio-conquistano-sempre-piu-settori [1]	News website	05/01/2018	SAGA and MARS	Italy	x	core consortium
http://www.automazioneNews.it/robot-servizio-conquistano-sempre-piu-settori/	News website	16/01/2018	SAGA and MARS	Italy	x	core consortium
http://teleducato.it/News.php?id_News=33029	News website	30/01/2018	SAFERUN experiment	Italy	x	experiment
https://medizin-und-technik.industrie.de/medicine-and-technology-engineering-for-the-medical-device-industry/	Magazine	Feb-18	Exotrainer, CLARC	Germany	x	core consortium
https://phys.org/News/2018-02-lightweight-robots-harvest-cucumbers.html	Magazine	01/02/2018	Catch	International		
https://eandt.theiet.org/content/articles/2018/02/robots-set-to-replace-humans-on-cucumber-flyers-on-german-farms/	Magazine	02/02/2018	Catch	International		
http://www.seedquest.com/solutions.php?type=solution&id_article=95375&id_region=&id_category=&id_crop	News website	02/02/2018	Catch	International		
https://www.futuretimeline.net/blog/2018/02/5-2.htm	blog	05/02/2018	Catch	International		
https://www.roboticsresear.ch/articles/13693/lightweight-robots-harvest-cucumbers		05/02/2018	Catch	Schweiz		
https://www.greenhousecanada.com/News/picking-cucumbers-by-robot-hand-32316	Magazine	05/02/2018	Catch	Canada	x	
https://www.newfoodMagazine.com/News/64408/end-cucumber-flyers-robot/	Magazine	05/02/2018	Catch	UK	x	
https://www.gabot.de/ansicht/fraunhofer-mit-leichtbau-robotern-auf-gurkenernte-389780.html	News website	07/02/2018	Catch	Germany		
https://www.elektrotechnik.vogel.de/ein-leichtbau-roboter-fuer-die-gurkenernte-a-683776/	Magazine	07/02/2018	Catch	Germany		
http://www.almeriahoy.com/2018/02/primer-robot-para-realizar-injertos.html	News website	09/02/2018	INJEROBOTS experiment	Spain		experiment
http://www.digitaljournal.com/tech-and-science/technology/automating-agriculture-with-light-weight-robots/article/514470	Magazine	09/02/2018	Catch	International		

https://www.goedemorgensierteelt.nl/bloemen-planten/nieuws/vet-robot-oogst-komkommers/	News website	09/02/2018	Catch	Netherlands		
https://www.hortoinfo.es/index.php/6699-robot-injerto-090218	News website	09/02/2018	INJEROBOTS experiment	Spain	x	
http://www.innovagri.es/actualidad/el-primer-robot-para-injertos-horticolas.html	News website	12/02/2018	INJEROBOTS experiment	Spain	x	experiment
https://www.groentennieuws.nl/article/169284/robot-als-redding-voor-duitse-augurkenoogst//	News website	12/02/2018	Catch	Netherlands		
https://biooekonomie.de/nachrichten/neuer-ernteroboter-fuer-gurken	News website	14/02/2018	Catch	Germany	x	
https://www.ingenieur.de/technik/fachbereiche/landtechnik/kuenftig-sollen-roboter-die-gurken-ernten/	News website	14/02/2018	Catch	Germany		
https://www.springwise.com/eu-project-develops-robotic-cucumber-harvester/	News website	15/02/2018	CATCH experiment	UK	x	experiment
https://www.springwise.com/eu-project-develops-robotic-cucumber-harvester/	Magazine	15/02/2018	Catch	International		
https://geekerhertz.com/article/a-helping-robot-hand-to-harvest-vegetables	News website	16/02/2018	Catch	International		
https://www.canadianpackaging.com/automation/lightweight-robots-harvest-cucumbers-159205/	Magazine	16/02/2018	Catch	Canada	x	
https://www.robotics.News/2018-02-17-robots-automating-harvesting-cucumbers-germany.html	Magazine	17/02/2018	Catch	International	x	
https://www.naturalNews.com/2018-02-17-robots-automating-harvesting-cucumbers-germany.html	News website	17/02/2018	Catch	International		
https://newatlas.com/cucumber-harvesting-robot/53425/	News website	18/02/2018	Catch	International		experiment
http://agrodiariohuelva.es/2018/02/18/presentado-el-primer-robot-para-realizar-injertos-de-horticolas/	News website	18/02/2018	INJEROBOTS experiment	Spain	x	
https://www.digitaltrends.com/cool-tech/cucumber-picking-robot/	News website	19/02/2018	Catch	International		experiment
https://www.ideaconnection.com/new-inventions/robotic-cucumber-harvester-12798.html	News website	19/02/2018	Catch	International		
https://www.infohightech.com/un-robot-a-double-bras-pour-donner-un-coup-de-main-ou-deux-lors-de-la-recolte-du-concombre/	News website	19/02/2018	Catch	International		
https://internetofbusiness.com/robotic-cucumber-harvest-fraunhofer/	News website	21/02/2018	CATCH	International		

https://www.vision-systems.com/articles/2018/02/researchers-develop-lightweight-dual-arm-vision-guided-robot-system-for-cucumber-harvesting.html	Magazine	21/02/2018	Catch	International	x	
https://emoneypak.com/harvesting-robot-to-save-a-big-slice-of-cucumber-market/	News website	21/02/2018	Catch	International		
http://www.industryeurope.net/Article/11900/Harvesting-robot-to-aid-Europes-struggling-farming-market/	News website	26/02/2018	CATCH experiment	UK	x	experiment
https://www.springerprofessional.de/production---production-technology/machinery/lightweight-robots-harvest-cucumbers/15499638	News website	01/03/2018	Catch	Germany		
http://www.seedquest.com/solutions.php?type=solution&id_article=95375&id_region=&id_category=&id_crop	Newspaper	28/03/2018	Catch	International		
https://blogrecherche.wp.imt.fr/en/2018/04/04/robot-algorithms-physical-rehabilitation/	News website	04/04/2018	KERAAL experiment	France	x	experiment
https://www.robotik-produktion.de/allgemein/robots-in-depth-sebastian-weisenburger/	Newsletter	11/04/2018	ECHORD^{++}	Germany	x	core consortium
https://www.distrelec.de/current/de/automatisierung/lernen-sie-roboter-kennen-die-die-work-life-balance-verbessern/	News website	16/04/2018	Catch	Germany	x	
http://www.elektronikfokus.dk/robotsystem-sorterer-miljoefarligt-affald-med-kunstig-intelligens/&OpointData=4048f9e37d03946aa060e90b403c4ae1JmlkX3NpdGU9MTAzODkyJmlkX2FydGljbGU9NTM3NCZpZF91c2VyPTI4NDAmaWRfYXBwbGljYXRpb249MTAwMDM1OSZsYW5nPWVu	Magazine	25/04/2018	AAwsbe	Denmark	x	
https://www.altomteknik.dk/nyheder/2018/04/25/teknologisk-institut-nyt-robotsystem-sorterer-miljoefarligt-og-ressourcefyldt-affald-med-kunstig-intelligens/&OpointData=0b444c31f9a49d2d359d95d8c65745b9JmlkX3NpdGU9MTAzODE1JmlkX2FydGljbGU9ODUxNSZpZF91c2VyPTI4NDAmaWRfYXBwbGljYXRpb249MTAwMDM1OSZsYW5nPWVu	Magazine	25/04/2018	AAwsbe	Denmark		
https://itreload.dk/artikel/it/nyt-robotsystem-sorterer-miljfarligt-og-ressourcefyldt-affald-med-kunstig-intelligens&OpointData=4fec91b4dce32ce109e1ae0d85ac16e7JmlkX3NpdGU9OTQ3NzMmaWRfYXJ0aWNsZT0yNTI1JmlkX3VzZXI9Mjg0MCZpZF9hcHBsaWNhdGlvbj0xMDAwMzU5Jmxhbmc9ZW4=	Magazine	26/04/2018	AAwsbe	Denmark	x	
https://www.jernindustri.dk/article/view/599076/intelligent_robot_frasorterer_dyrebart_skrot	Magazine	26/04/2018	AAwsbe	Denmark		

https://www.metal-supply.dk/article/view/599056/intelligent_robot_frasorterer_dyrebart_skrot&OpointData=30072e2256e469547b2d6213977cd30aJmlkX3NpdGU9MTI1NjUmaWRfYXJ0aWNsZT02MDM3OSZpZF91c2VyPTI4NDAmaWRfYXBwbGljYXRpb249MTAwMDM1OSZsYW5nPWVu	Magazine	26/04/2018	AAwsbe	Denmark	x	
https://www.electronic-supply.dk/article/view/599055/intelligent_robot_frasorterer_dyrebart_skrot&OpointData=1c90dbadb8fff2a6edaecc2f81e6426aJmlkX3NpdGU9MTI1NjQmaWRfYXJ0aWNsZT0zMzM5MCZpZF91c2VyPTI4NDAmaWRfYXBwbGljYXRpb249MTAwMDM1OSZsYW5nPWVu	Magazine	26/04/2018	AAwsbe	Denmark	x	
https://elek-data.dk/artikel/produktion/dansksvensk-robotsystem-sorterer-elektronikaffald&OpointData=a12cf5ed3c63f4340d4091a3c774d542JmlkX3NpdGU9MTc3OTgmaWRfYXJ0aWNsZT0xMDUxMCZpZF91c2VyPTI4NDAmaWRfYXBwbGljYXRpb249MTAwMDM1OSZsYW5nPWVu	Magazine	30/04/2018	AAwsbe	Denmark		
https://www.tu.no/artikler/roboter-med-kunstig-intelligens-skal-fjerne-batterier-fra-elektronikk-avfall/382707	News website	10/05/2018	AAwsbe	Norway		
https://www.jernindustri.dk/article/view/469385/robotter_med_kunstig_intelligens_skal_sortere_miljofarligt_affald	Magazine	18/05/2018	AAwsbe	Denmark	x	
El Periódico de Catalunya 22/05/2018	Newspaper	22/05/2018	ARSI	Spain		
EL periodico de Catalunya	Newspaper	22/05/2018	ARSI	Spain		
https://ipaper.ipapercms.dk/TechMedia/TekniskNyt/2018/7/?page=4#/	Magazine	12/06/2018	AAWSBE1 experiment	Denmark	x	experiment
https://www.innovations-report.de/html/berichte/messenachrichten/robotik-live-auf-der-automatica-fraunhofer-ipk-fuehrt-automatisierungsloesungen-vor.html	News website	12/06/2018	CATCH experiment	Germany	x	experiment
https://www.produktion.de/technik/das-sind-die-neuen-roboter-auf-der-automatica-2018-107.html	News website	19/06/2018	ISYBOT	Germany	x	core consortium
https://www.youtube.com/watch?v=K35eYEqEx1Q&feature=youtu.be	YouTube	21/06/2018	ECHORD^{++}	International		
https://www.zdnet.com/pictures/11-fabulous-futuristic-robots-from-automatica-2018/	News website	22/06/2018	Automatica	USA	x	core consortium
https://medium.com/@ReachRobotics/top-robotic-innovations-at-automatica-2018-7329497690a8	News website	26/06/2018	AAwsbe	International		

https://japan.cnet.com/article/35121699/	Magazine	03/07/2018	AAWSBE1, ANYMAL, CATCH, FLEXSIGHT, CLARC, LINARM, SAGA, SIAR	Japan	x	
El Periódico de Catalunya 18/07/2017	Newspaper	18/07/2018	ARSI	Spain		
https://www.zdnet.com/pictures/11-fabulous-futuristic-robots-from-automatica-2018/	Magazine	22/07/2018	AAWSBE1, ANYMAL, CATCH, FLEXSIGHT, CLARC, LINARM, SAGA, SIAR	International	x	
https://healthcare-in-europe.com/de/News/roboter-exoskelette-co-ein-ausblick-auf-die-pflege-der-zukunft.html	Magazine	22/08/2018	Exotrainer, CLARC, Assesstronic, Linarm	Germany	x	core consortium
https://www.fluid.de/anwendungen/spezialanwendungen/ernteroboter-die-zukunft-der-landwirtschaft-326.html	Magazine	23/08/2018	SAGA, CATCH	Germany	x	core consortium
https://www.interempresas.net/Horticola/Articulos/223341-CT-Tecnova-recibe-primer-accesit-a-innovacion-tecnologica-en-Premios-Innovagro-2018.html	Newspaper	13/09/2018	INJEROBOTS experiment	Spain		
Interempresas.net	News website	27/09/2018	ARSI	Spain	x	
http://www.rtve.es/alacarta/videos/espana-directo/espana-directo-05-10-18/4777498/#	TV	05/10/2018	EXOtrainer, SIAR, CLARC	Spain		core consortium
https://www.diariosur.es/universidad/cinco-entidades-representativas-20181005153622-nt.html	Magazine	05/10/2018	EXOTRAINER	Spain	x	
https://www.sueddeutsche.de/muenchen/freising/vortrag-in-weihenstephan-roboter-auf-dem-acker-1.4238029	Newspaper	03/12/2018	MARS experiment	Germany		experiment
https://www.roboticsbusinessreview.com/unmanned/european-swarm-robotics/	News website	07/12/2018	MARS, ECHORD	International	x	
https://dronedj.com/2019/01/09/gdu-launches-saga/	News website	09/01/2019	SAGA	International	x	
http://www.sevillaactualidad.com/sevilla/116773-proyecto-clarc-un-robot-para-evaluar-pacientes-en-el-virgen-del-rocio/	Newspaper	25/01/2019	CLARC	Spain		experiment
https://www.europapress.es/esandalucia/sevilla/noticia-virgen-rocio-lidera-oferta-europea-crear-robot-ayude-evaluacion-motora-pacientes-20190125170144.html	Newspaper	25/01/2019	CLARC	Spain		
https://pixelbook.tecnichenuove.com/Newsstand/macchineagricole/viewer/guest/com.tecnichenuove.macchineagricole.ma.2019.001/	Magazine	11/02/2019	CATCH, GARotics, MARS	Italy		experiment

Section A4: Press releases and events

Date	Topic	Initiated by
03/03/2014	Press release concerning the first call for experiments	TUM
10/03/2014	New Scientific magazine visit. News feature & Photo-shoot for future edition. Tour of RIF and talk about E^{++} programme.	BRL
12/03/2014	BBC News at Six. National news article on British Robotics filmed within RIF area of the BRL. RIF@Bristol programmed the Baxter robot to provide a live demo.	BRL
21/08/2014	Press release: Automatica video on future of robotics	TUM

Section A5: Advertisements

Medium	Type	Date	Topic	Country
Gazeta Wyborcza	newspaper	03/03/2014	1st call for experiments	Poland
Expansión	newspaper	03/03/2014	1st call for experiments	Spain
Les Echos	newspaper	04/03/2014	1st call for experiments	France
The Engineer	magazine	10/03/2014	1st call for experiments	UK
Messe Kurier	trade fair newspaper	03/06/2014	E^{++} @ Automatica	Germany

SECTION B (confidential or public)

Section B1: List of application for patents, trademarks, registered designs, etc.

Patents and trademarks									
No. of patent or trademark	Patent or Trademark ?	Type of IP Rights	Confidential (YES/NO)	If it is confidential please give us the reason ?	Foreseen embargo date (dd/mm/yyyy)	Application reference (e.g. EP123456)	Subject or title of application	Applicants	CE Certification (for hardware only) (YES/NO)
MODUL	Patent	n.a.	No	n.a.	n.a.	EP16181251	Joint unit, joint system, robot for manipulation and/or transportation, robotic exoskeleton system and method for manipulation and/or transportation	Hutter, Marco	No
WIRES	Patent	n.a.	Yes	Commercial Exploitation	n.a.	n.a.	n.a.	n.a.	n.a.

Section B2: List of exploitable foreground

Experiments		Exploitable Foreground								
		Type of Exploitable Foreground (Choose from the list)	**Description of Exploitable Foreground**	**Confidential (YES/NO)**	**Foreseen embargo date (dd/mm/yyyy)**	**Exploitable product(s) or measure(s)**	**Sector of Application**	**Timetable comercial or any other use**	**Patents or other IPR exploitation (licences)**	**Owner & Other Beneficiary(s) involved**
	CoHRoS	General advancement of knowledge	Teaching methods for high-DOF robots have been advanced	no	Unknown	None	n.a.	n.a.	n.a.	n.a.
	GARotics	General advancement of knowledge	Harvesting tool for green asparagus	yes	Unknown	None	Green asparagus harvesting	not predictable	n.a.	STRAUSS + CWS
		General advancement of knowledge	Asparagus detection	yes	Unknown	None	Green asparagus harvesting	not predictable	n.a.	STRAUSS + CWS
	LINarm^{++}	General advancement of knowledge	Measurement system for physiological measurements	no	Unknown	None	Rehabilitation, human-computer interaction	NONE	NONE	UL
		General advancement of knowledge	New variable stiffness actuators	no	Unknown	LINarm2 and LINarm3	Industry and Medical	N/A	N/A	CNR
		General advancement of knowledge	Multimodal control for rehabilitation platforms	no	Unknown	None	Medical	N/A	N/A	CNR
	MObile robo T for upper limb neurOrtho Rehabilitation	Commercial exploitation of R&D results	Improvement in the design and firmware of the device. Proof of efficacy of the device	no	Unknown	MOTORE^{++}	Healthcare	Product is already on the market since June 2016	PTC in the background	Humanware SRL
		Commercial exploitation of R&D results	Software License	yes	Unknown	None	Robotics	n.a.	yes	ETH

	pickit	General advancement of knowledge	Development of sensor	no	Unknown	new picking architecture and design of sensor	Robotics	n.a.	n.a.	n.a.
	SAPARO	General advancement of knowledge	Innovative technology for Safety in Human Robot cooperation	no	Unknown	Tactile floor with visualization system	Industrial automation	n.a.	n.a.	n.a.
	TIREBOT	General advancement of knowledge	Collaborative strategy for safe assistance	no	Unknown	None	Collaborative Robotics	n.a.	n.a.	n.a.
		Commercial exploitation of R&D results	Collaborative mobile robot for mounting wheels	no	Unknown	None	Automotive	n.a.	n.a.	n.a.
	AAWSBE1	General advancement of knowledge	In depth knowledge of what to expect from a deep learning solutions and how to tweak it	no	Unknown	Quality control and identification	Production	n.a.	n.a.	Refind / DTI
		Commercial exploitation of R&D results	Improved Deep learning training and test platform	no	Already	Backend for all their products	Not specific	n.a.	n.a.	Refind
		Commercial exploitation of R&D results	DTI Pickware easy binding between DTI Vision Box 2 and robot for pick and place	no	2019	Combined quality control and pick and place	Production	n.a.	n.a.	DTI
		Commercial exploitation of R&D results	DTI Vision Box 2	no	Already	Quality control with data logging	Production	n.a.	n.a.	DTI
		Commercial exploitation of R&D results	WEEE sorting	no	2020	Pre-sorting in feed to trad. Recycling. Battery	Recycling	n.a.	n.a.	Refind / DTI

						chemistry sorting.				
	CATCH	General advancement of knowledge	The CATCH experiment has attracted a huge interest from scientific and large community, focusing on specific critical developments and improvements of robotic harvesting identified in the practical project work, and utilize the added value an of the achieved project results.	no	Unknown	Dual-arm robotic system, grippers, vision system, detection and localization algorithms, control algorithms	Precision agriculture, industry	n.a.	n.a.	n.a.
	DUALARMWORKER	Exploitation of R&D results via standards	Integration of Work-Cell with Dual-Arm Motion Planning	yes	Unknown	Software and Hardware	Robotics, manufacturing industry	n.a.	n.a.	TECNALIA
		General advancement of knowledge	Library for Dual-Arm Motion Planning	no	Unknown	Software	Robotics, manufacturing industry	n.a.	n.a.	CNRS
	GRAPE	General advancement of knowledge	Lesson learned on using localization and navigation algorithms in vineyard environments	no	None	Results of the validation experiments and comparison	Agriculture robotics	Under publication	None	EURECAT

		General advancement of knowledge	Methodologies and know-how on plant detection and vineyard monitoring, including robot positioning, robotic arm localization, scanning process, 3D reconstruction, real-time video streaming, multispectral imaging and plant growth monitoring	no	None	Methodology and experimental results	Agriculture robotics	Under publication	None	EURECAT
	HOMEREHAB	Commercial exploitation of R&D results	HomeRehab system license	yes	7/1/2019	Full HOMEREHAB system	Clinical Rehabilitation	n.a.	Utility model	CEIT/UMH
	HyQ-REAL	General advancement of knowledge	HyQ-REAL quadruped robot	yes	Unknown	a quadruped robot and a locomotion framework	research, nuclear, rescue, maintenance, surveillance, agriculture, construction.	not clear yet	working on software license	IIT
		Commercial exploitation of R&D results	ISA for many types of robot arm/leg applications	no	Unknown	An integrated servo actuator, suitable for HyQ-REAL type applications and other applications that require high fidelity position and force control in a compact, low mass, package	robot arm/leg applications in many sectors	Low rate production and sales from Sep 2018.	n.a.	Moog

		General advancement of knowledge	Exploit the experience of the HyQ-REAL project to develop a compact, high performance, direct drive servo valve in a cartridge configuration. This valve will have performance characteristics suitable for high fidelity control of force and torque based systems.	yes	Unknown	A compact "Sub-miniature" cartridge style Direct Drive servo valve with high bandwidth >200Hz+, and low internal friction. Versions with and without on-board loop closure electronics.	robotics, motorsport, aerospace, etc.	planned market introduction December 2019.	n.a.	Moog
		General advancement of knowledge	Exploit the experience of the HyQ-REAL project to development of a family of "Smart Manifolds".	yes	Unknown	These "Smart Manifolds" have similar characteristics to the MOOG ISA, but can be used to control, and communicate with, a third party actuation device. They are suitable for HyQ-REAL type applications and other applications that require high fidelity position and force control in	robotics, motorsport, aerospace, etc.	planned market introduction December 2019.	n.a.	Moog

						a compact, low mass, package				
	Keraal	General advancement of knowledge	Algorithm for assessing human motions	no	Unknown	None	n.a.	n.a.	n.a.	n.a.
		General advancement of knowledge	Algorithm to choose advice for movement improvement	no	Unknown	None	n.a.	n.a.	n.a.	n.a.
		General advancement of knowledge	Economical model for a robot coach	yes	1/1/2020	None	health tech	n.a.	n.a.	n.a.
	SAFERUN	Commercial exploitation of R&D results	A velocity planner able to push up the efficiency of LGVs while preserving safe working conditions	no	Unknown	LGVs implementing the new planner can drive feaster and safe, improving the overall performance of automated warehouses	Industrial automation	Starting from Q2 2019 the feature will be sold in all new projects	n.a.	Elettric80 SpA (as owner) and its customers (as other beneficiaries)
		General advancement of knowledge	New trajectory planning concepts to be used for the generation of safe and fast motions	no	Unknown	Scientific papers	Industrial automation	n.a.	n.a.	University of Parma
	SAGA	General advancement of knowledge	Object recognition software using embedded camera systems	no	None	Can be exploited by any (mobile) robotic application with vision software	n.a.	n.a.	n.a.	n.a.

		Commercial exploitation of R&D results	Indoor navigation using ultra-wideband technology	no	None	State estimation filters for UAVs	n.a.	n.a.	n.a.	n.a.
		Commercial exploitation of R&D results	Monitoring of crops by UAV using RTK GPS system	no	None	UAV with RTK GPS and Camera system	n.a.	n.a.	n.a.	n.a.
		General advancement of knowledge	Swarming UAVs	No	None	Distributed monitoring or measurement by UAVs	n.a.	n.a.	n.a.	n.a.
		General advancement of knowledge	Image acquisition and onboard processing by UAV using embedded electronics	No	None	Camera system integrated with NVIDIA Jetson TX1	n.a.	n.a.	n.a.	n.a.
		General advancement of knowledge	Simulation of UAV behaviour using UWB navigation in a swarm	No	None	UAV simulation environment	n.a.	n.a.	n.a.	n.a.
		General advancement of knowledge	Design of gimbal stabilizer for camera system on UAV	No	None	2-axis stabilizer system for mobile robotics camera	n.a.	n.a.	n.a.	n.a.
	WIRES	Commercial exploitation of R&D results	Component detection algorithm	NO	Unknown	Software	Robotic assembly	1 year	licenses	UNIBO
		Commercial exploitation of R&D results	Cable manipulation system	NO	Unknown	Robotic Gripper	Robotic assembly	2 years	n.a.	UNIBO
		General advancement of knowledge	Tactile sensor	NO	Unknown	Tactile sensor	Robotic assembly	n.a.	n.a.	SUN
		Commercial exploitation of R&D results	Software for the extraction	yes	Unknown	Software	Manufacturing	1 year	licenses	UNIBO

			of the switchgear data							
		Commercial exploitation of R&D results	Cable tracking system for cluttered environments	yes	Unknown	Software	Robotic assembly	1 year	licenses	UNIBO
		Commercial exploitation of R&D results	Task planner for cabling activities	yes	Unknown	Software	Robotic assembly	1 year	licenses	UNIBO

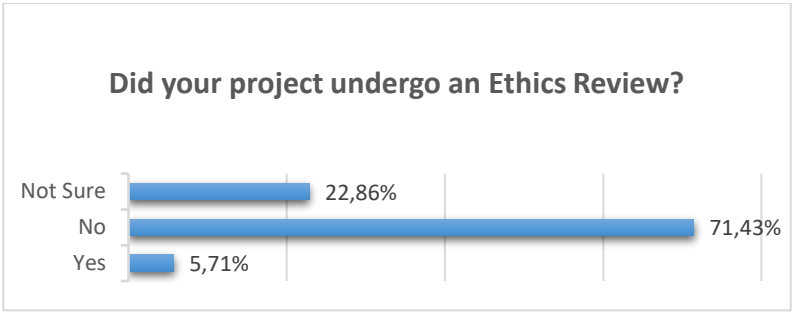
3 Report on societal implications

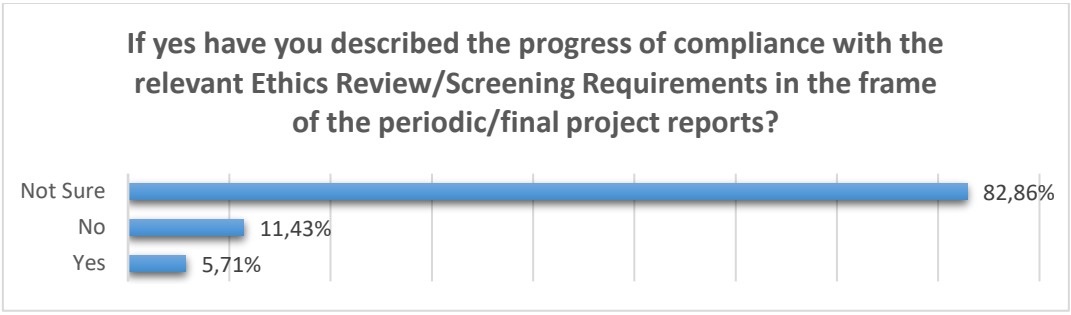
The evaluation, based on the data from the questionnaire will assist the Commission to obtain statistics and indicators on societal and socio-economic issues addressed by projects. As well as producing specific statistics, the replies will also help identify those projects that have shown a real engagement with broader societal issues, and thereby identify interesting approaches to these issues and best practices. The following statistical information was collected from all the 31 experiments of ECHORD^{++} and 4 PDTI experiments. The survey was separated into three different questionnaires in order to collect all the necessary information requested by the European Commission.

A. Ethics

1. Ethics Review in General

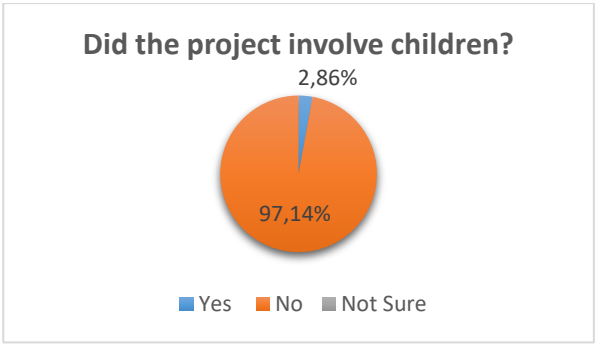
The EU defines issues as human rights and protection of human beings, animal protection and welfare, data protection and privacy, environmental protection, malevolent use of research results, and compliance with international, EU and national law as ethics. Beside this very broad definition of ethics in research, the EU released in April 2019 ethics guidelines specifically for artificial intelligence. The official questionnaire applied in this report was made earlier and did not include these new guidelines. A simple question as “Does your prototype destroy jobs?” (asked at automatica 2018) produces in most of the cases helpless mimics and is obviously not a question that fits in the everyday job of a robotic scientist. So they will answer with “No” or “not sure”, because they do not know, which kind of “ethics” is applicable.

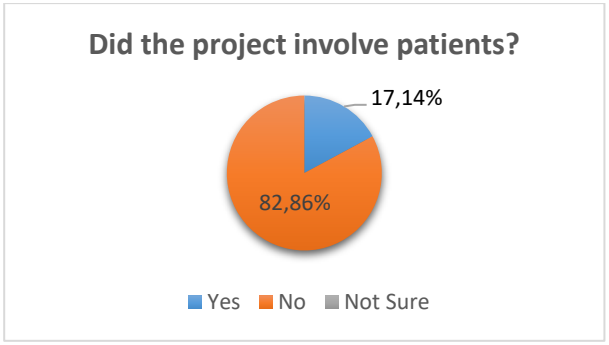


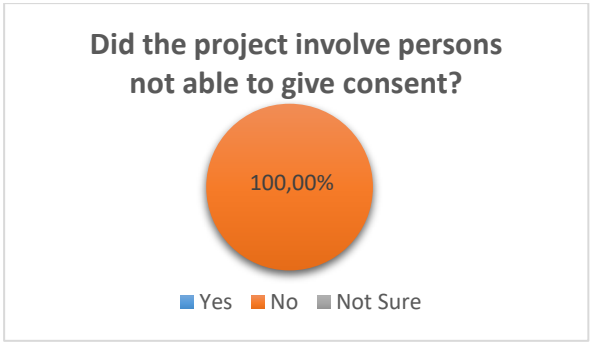


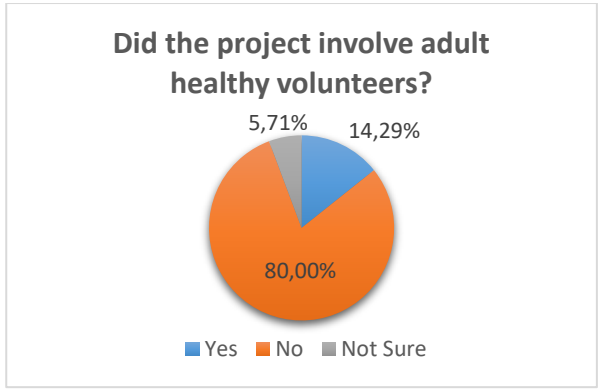
2. Research on Humans

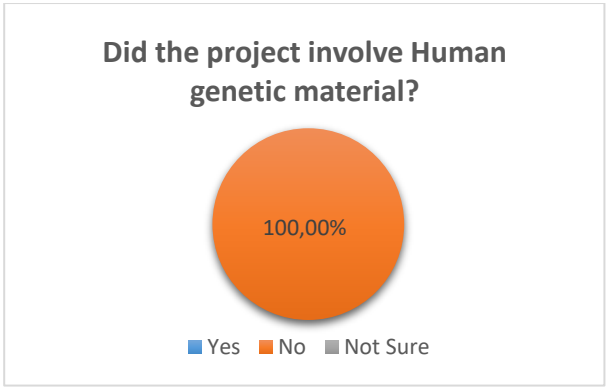
All healthcare experiments involved of course patients, especially when they reached the stadium after the fundamental research. Only the Exotrainer project involved children, patients in the other projects were elderly persons or persons with some demand on rehabilitation after trauma or operation. To ameliorate the research results data was of course collected on the different experiments.

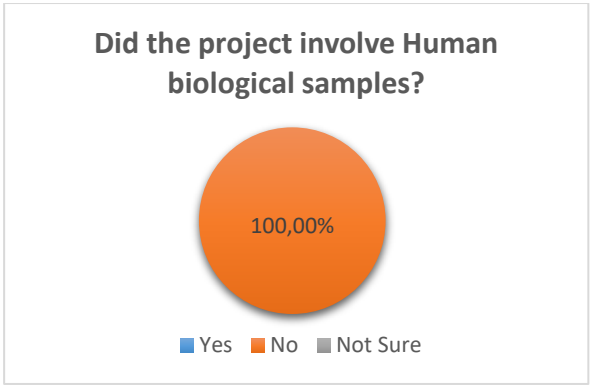


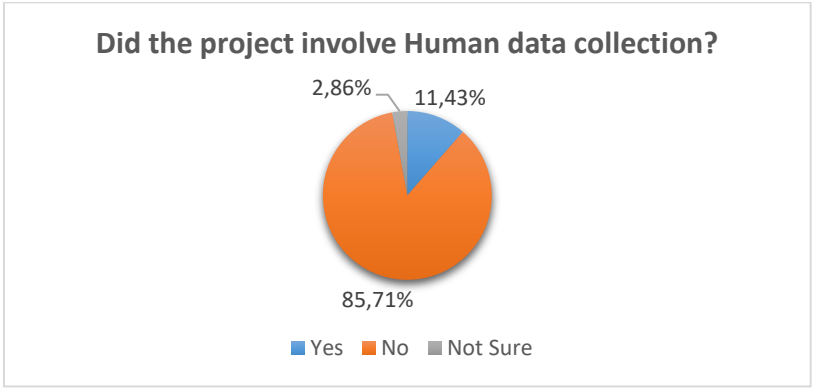






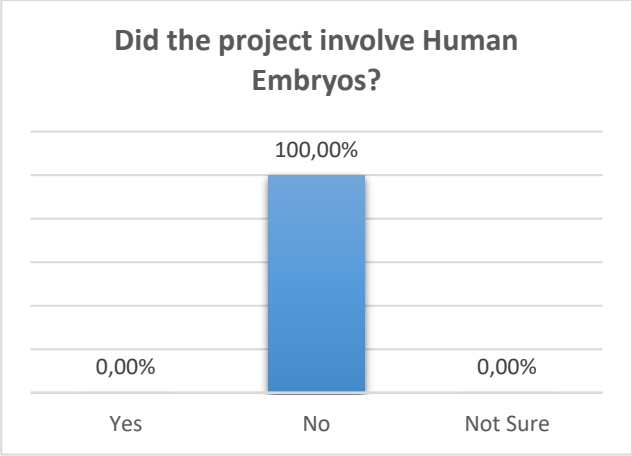


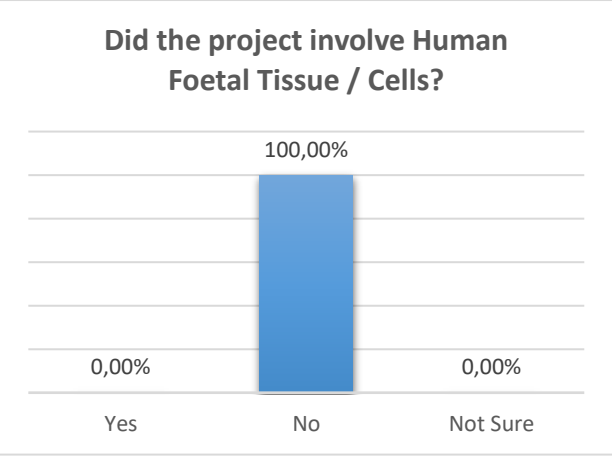


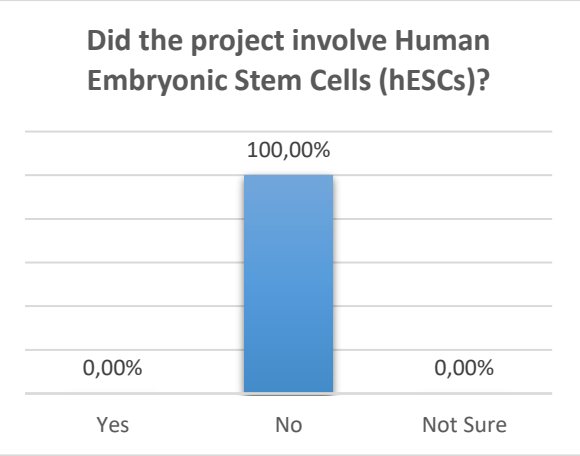


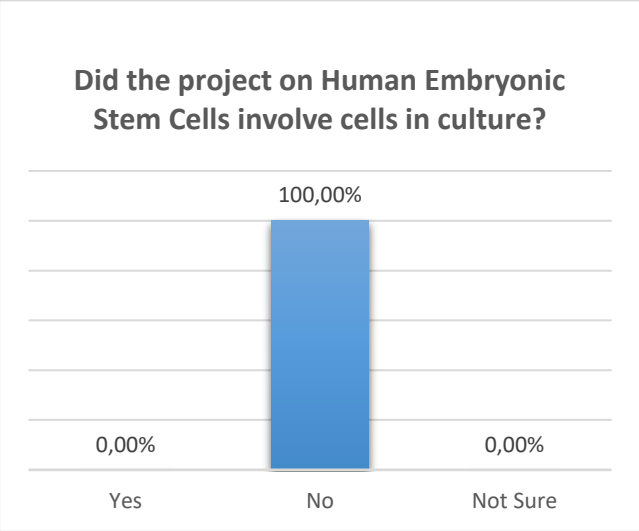
3. Research on Human Embryo/Foetus

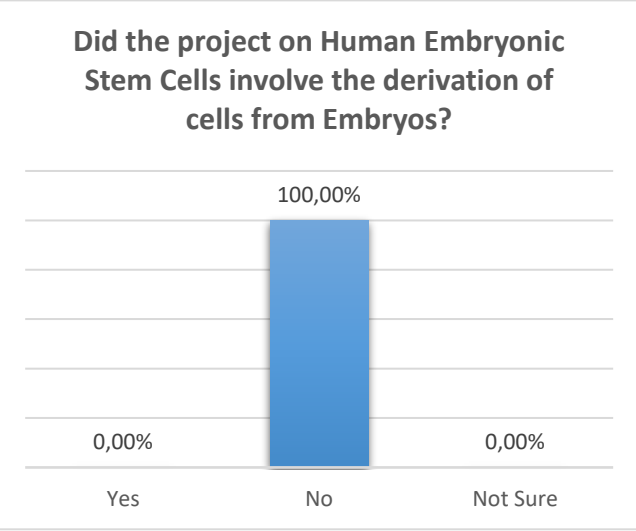
No project in ECHORD++ needed to involve human or animal embryo, foetus or stem cells.


Did the project involve Human Embryos?
100,00%
0,00%
0,00%
Yes
No
Not Sure


Did the project involve Human Foetal Tissue / Cells?
100,00%
0,00%
0,00%
Yes
No
Not Sure

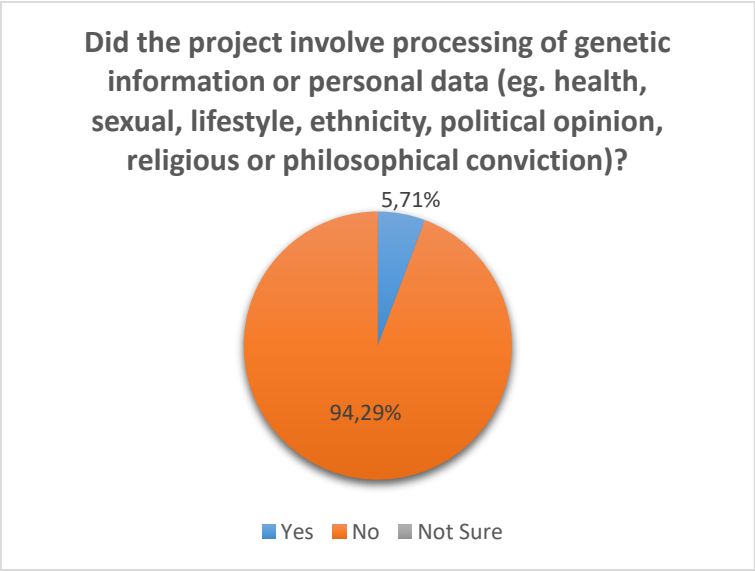

Did the project involve Human Embryonic Stem Cells (hESCs)?
100,00%
0,00%
0,00%
Yes
No
Not Sure

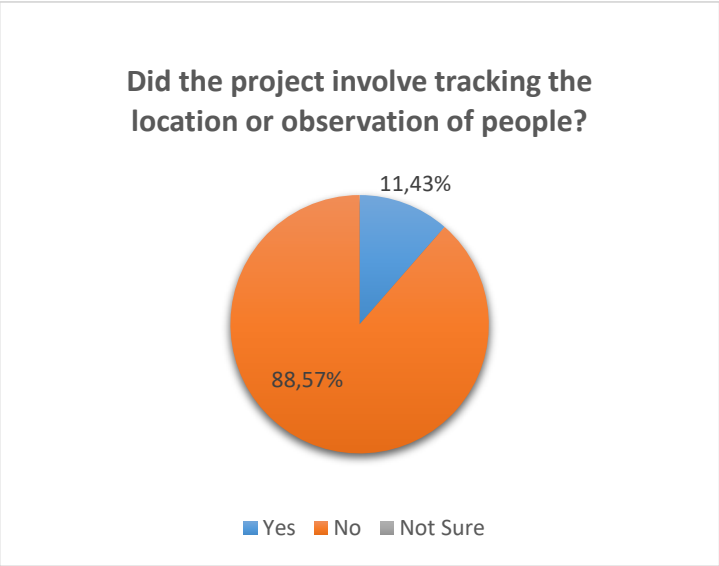

Did the project on Human Embryonic Stem Cells involve cells in culture?
100,00%
0,00%
0,00%
Yes
No
Not Sure


Did the project on Human Embryonic Stem Cells involve the derivation of cells from Embryos?
100,00%
0,00%
0,00%
Yes
No
Not Sure

4. Privacy

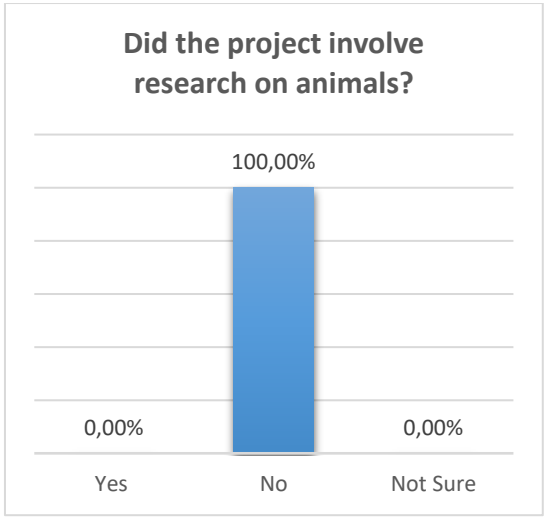
Healthcare projects need to process also other information about e.g. lifestyle to be able to improve the developed robots. More specifically, MOTORE++ and ASSESTRONIC experiments due to the physiology of their experiments, involved a lot of questions about both genetic information and personal data. As an example many questions of CLARC users focus on the ability of elderly persons to run everyday challenges. The Barthel test addresses questions as “Are you able to eat alone” or “do you need help with grooming or toilet use” and these data are important for the doctor to plan the therapy. There were also experiments like SAPARO, KERAAL, CoCoMaps and CLARC that had to track the location or observe people.

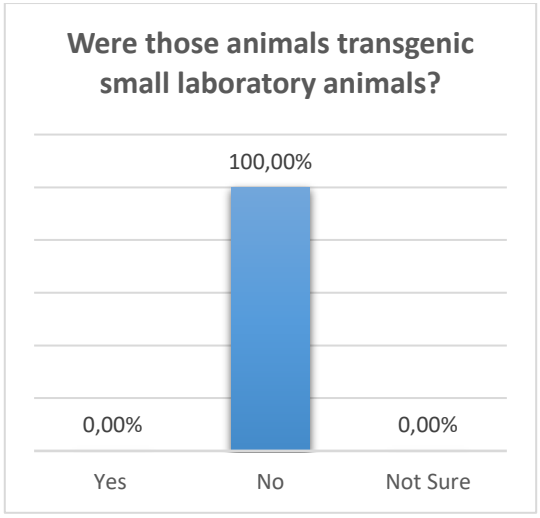


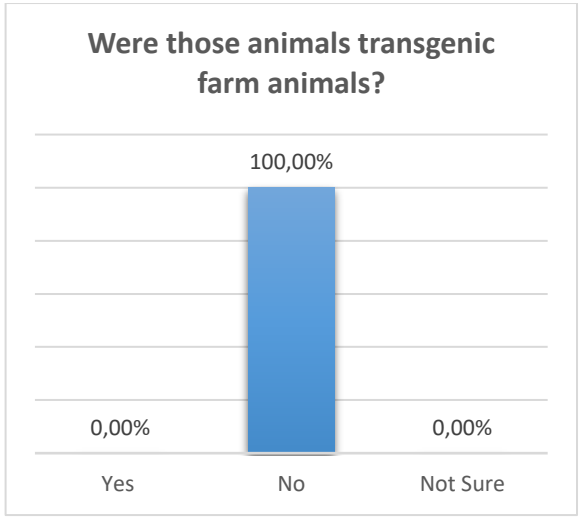


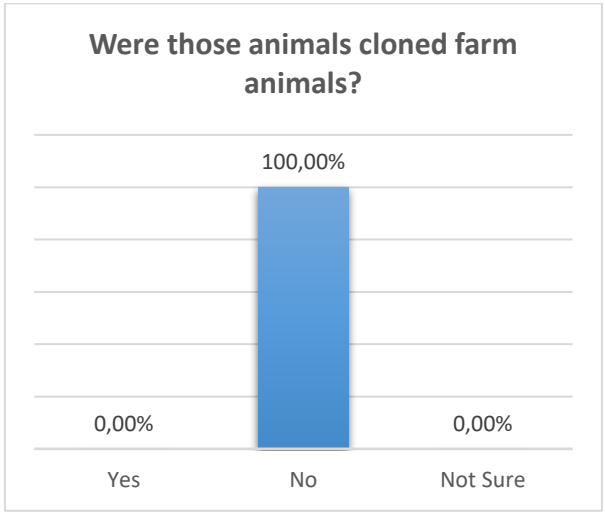
5. Research on Animals

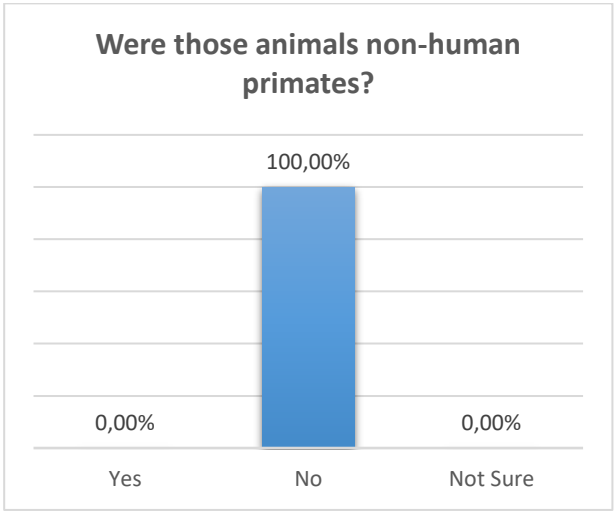
No ECHORD++ project needed to involve any research with animals.







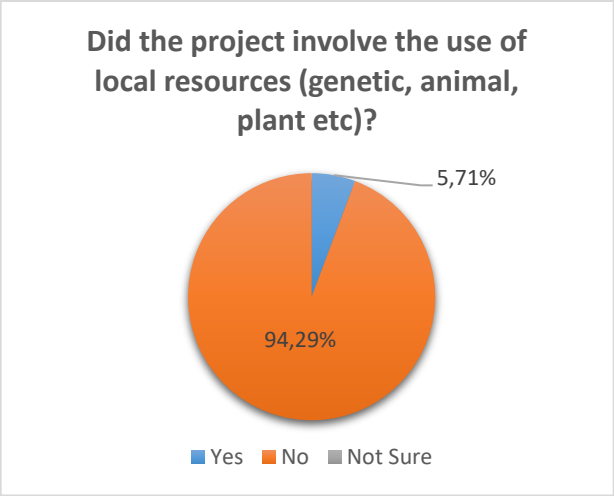


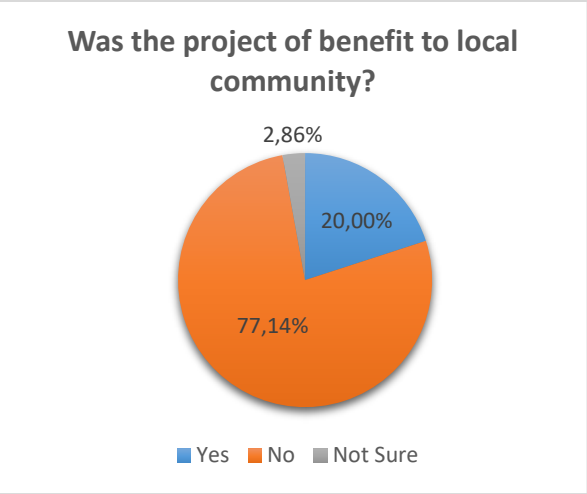


6. Research Involving Developing Countries

ECHORD++ involved a wide network of European countries, but no developing countries. However, some projects might of course also be used in other countries: e.g. is CATCH planning to adapt its prototype to the harvest of coffee beans in Columbia. It was developed for harvesting cucumbers for the European market, because farmers need to collect only small cucumbers for producing sour cans, so they have to harvest several times during the summer. This specific ability

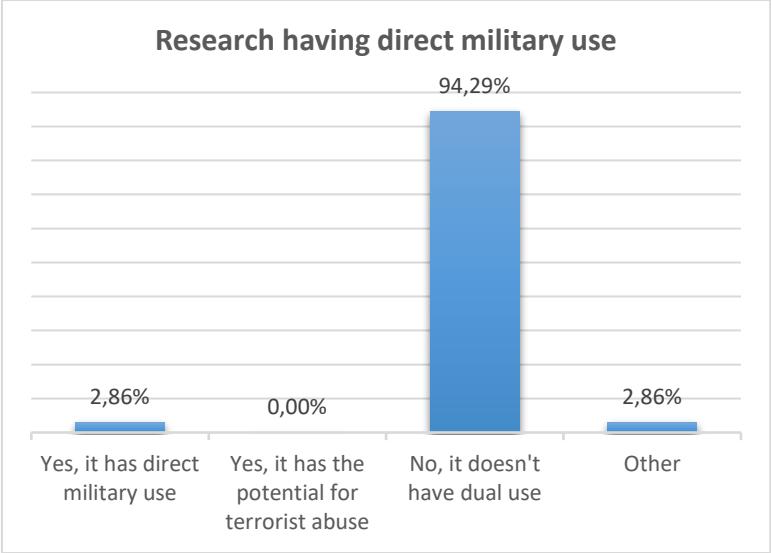
makes it also convenient to be adapted to coffee beans because many workers in Columbia's coffee plantations left to the big cities because of the war. Additionally, SAGA and INJEROBOT used local plants in order to fulfil their tasks. SAGA used local plants in order to develop and test the on-board vision recognition. For a similar reason, INJEROBOT used several species of local plants to train and develop the two anthropomorphic robots using grafting techniques.





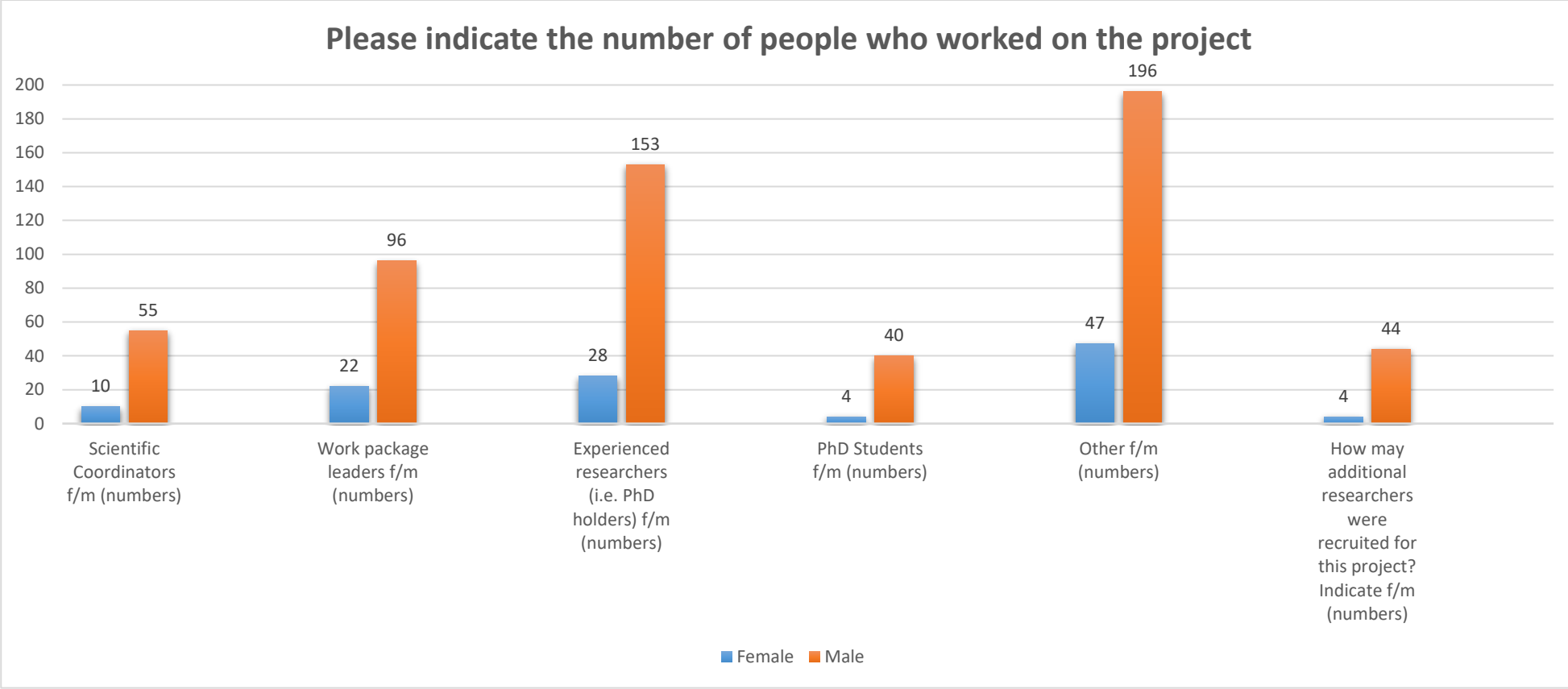
7. Dual Use

No project in ECHORD++ was developed to be used in a military surrounding, but EXOTrainer, MODUL and HyQ-REAL might be used, e.g. as transportation system to dangerous or hazardous areas. MODUL and HyQ-REAL are robots, which can be used in potentially difficult surrounding (water, stairs, uneven area, radiation), so a military use is not completely eliminated. Additionally, EXOTrainer can potentially be used as an exoskeleton for soldiers so again military use cannot be completely eliminated.



B. Workforce Statistics

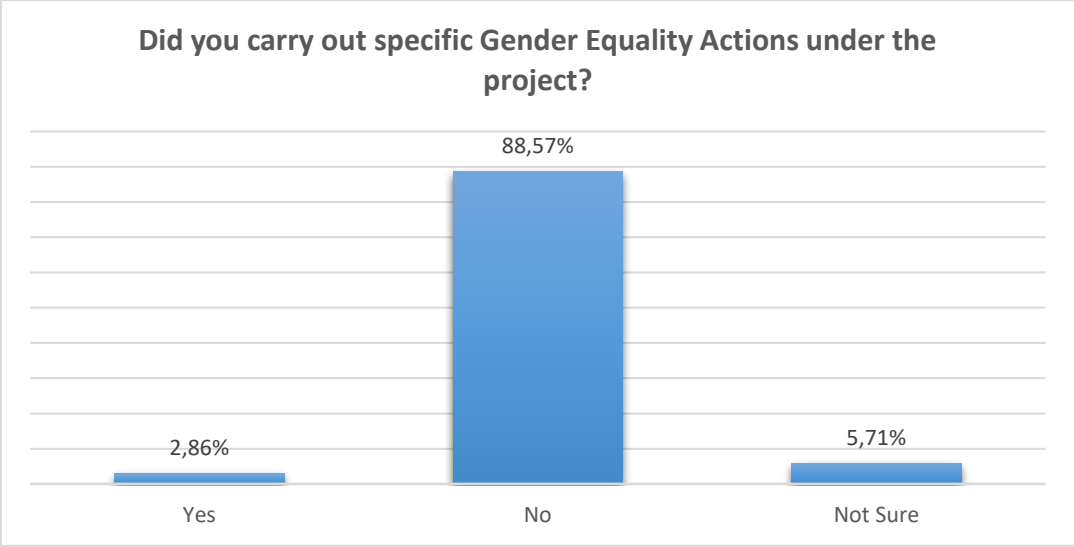
Remarkable in this statistics is the low number of female scientists, which is a common problem since many years. Although many efforts are made by many institutions this graphics shows that the situation is still not satisfactory at all. All efforts have to last on for the next years and probably even more have to be done in the future. This indicated the number of PhD students: female students are only 10%!

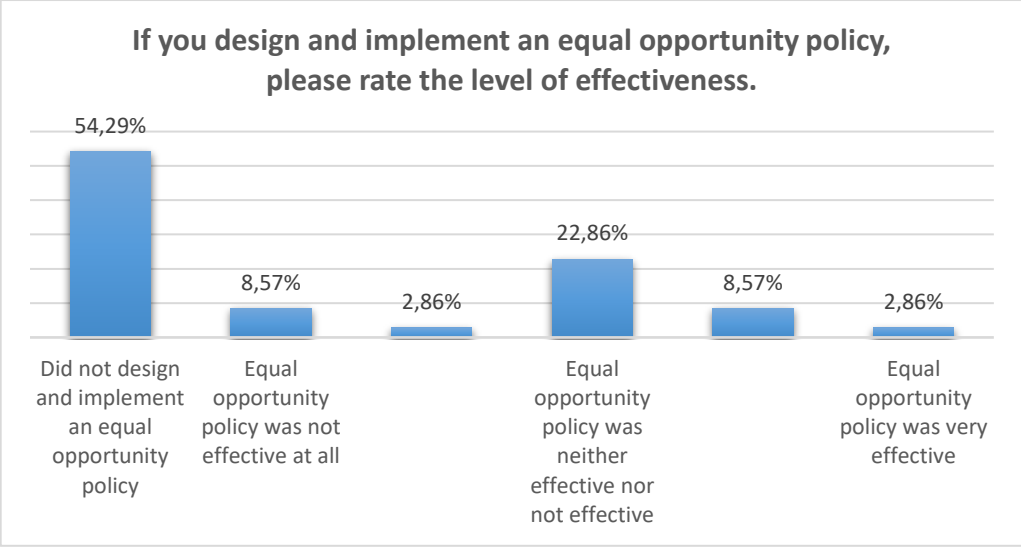


C. Gender Aspects

The only poor result of ECHORD^{++} is shown in this issue. In almost 89% of the projects, no gender action at all was carried out and only 3% acknowledged the effectiveness of their means and policy. 0,00% found that targets achieved a balance in the workforce. No scientist saw a gender dimension with the research content, which might be a result of only a few female scientists in the team.

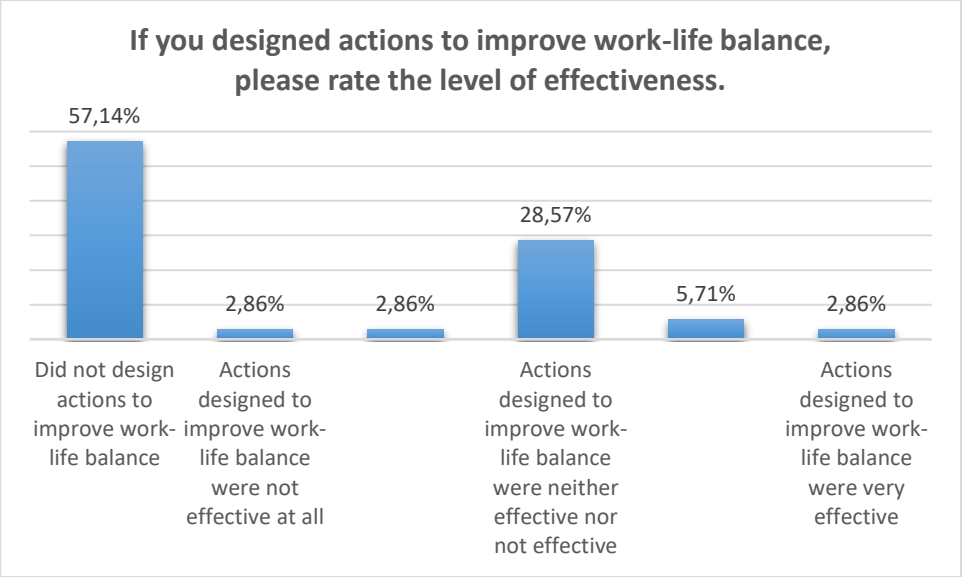
Work-Life balance also was obviously not a big issue for the scientists in ECHORD^{++}: 57% did not design any actions to improve the work-life balance. This is quite clear as long as most of the scientists are male, because they traditionally do not take over many of the tasks in the family. This will probably change in the future so this aspect will become more important.

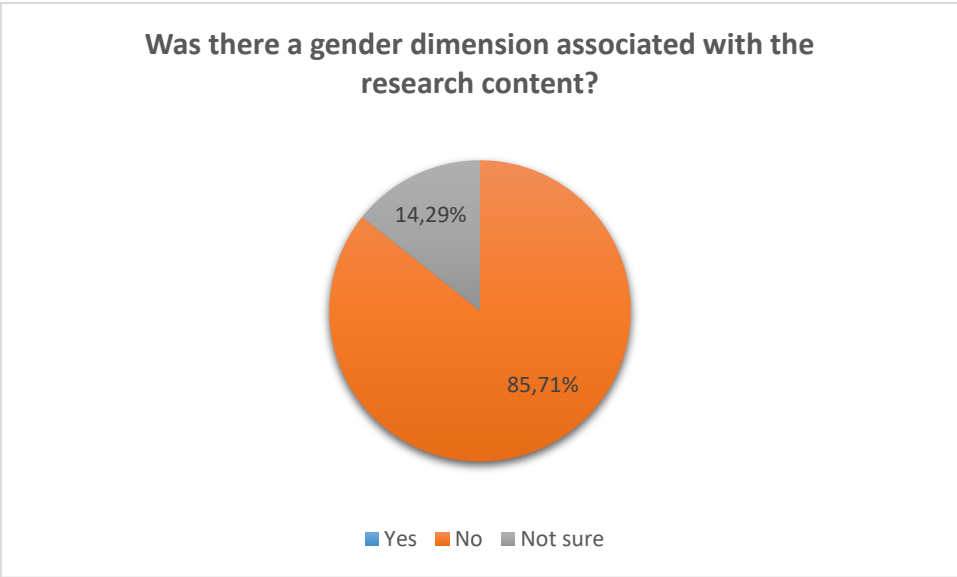

Did you carry out specific Gender Equality Actions under the project?
88,57%
2,86%
5,71%
Yes
No
Not Sure


If you design and implement an equal opportunity policy, please rate the level of effectiveness.
54,29%
8,57%
2,86%
22,86%
8,57%
2,86%
Did not design and implement an equal opportunity policy
Equal opportunity policy was not effective at all
Equal opportunity policy was neither effective nor not effective
Equal opportunity policy was very effective

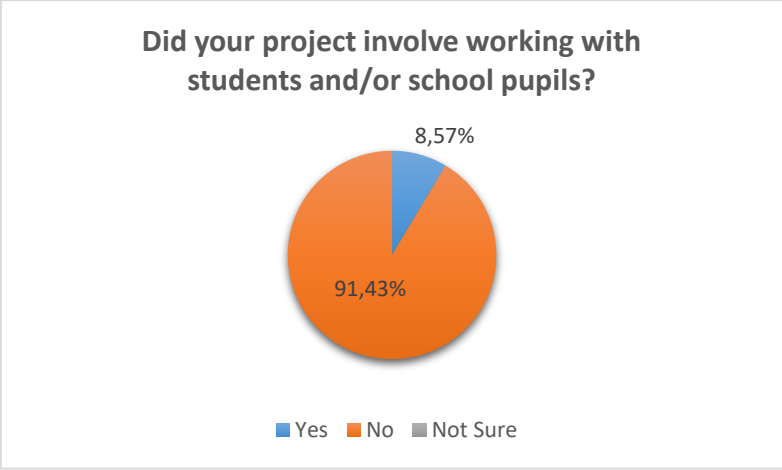

If you set targets to achieve a gender balance in the workforce, please rate the level of effectiveness.
54,29%
8,57%
0,00%
31,43%
5,71%
0,00%
Did not set targets to achieve a gender balance in the workforce
Targets to achieve a gender balance in the workforce were not effective at all
Targets to achieve a gender balance in the workforce were neither effective nor not effective
Targets to achieve a gender balance in the workforce were very effective

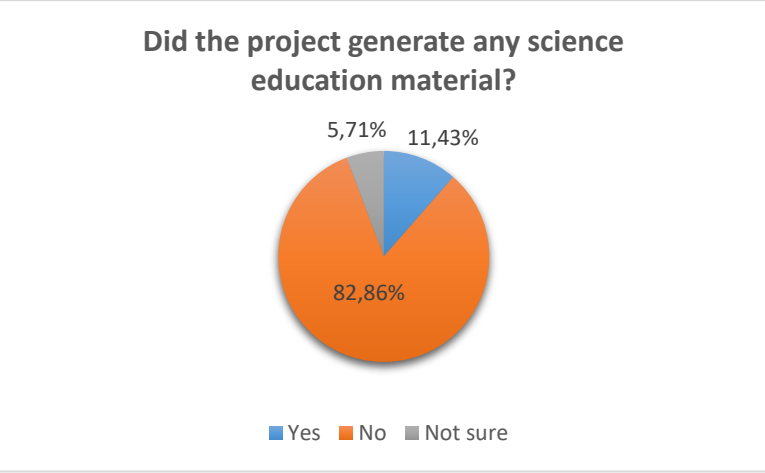

If you organise conferences and workshops on gender, please rate the level of effectiveness.
60,00%
11,43%
0,00%
25,71%
2,86%
0,00%
Did not organise conferences and workshops on gender
The conferences and workshops organised on gender were not effective at all
The conferences and workshops organised on gender were neither effective nor not effective
The conferences and workshops organised on gender were very effective

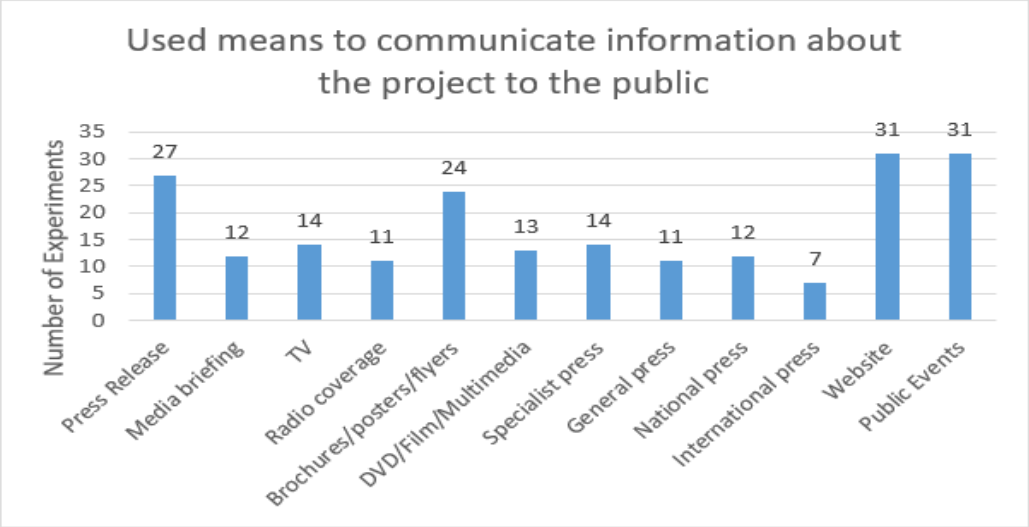




D. Synergies with Science Education



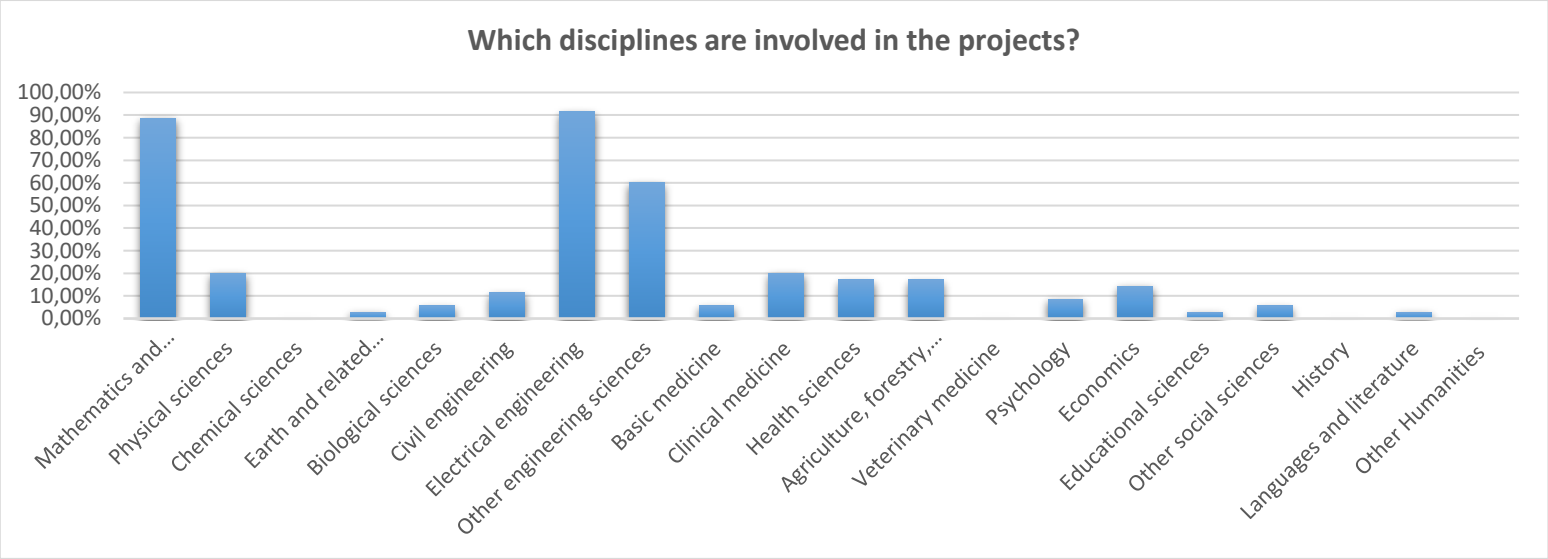




Striking here is, that most of the projects used websites and events to promote their projects. The graph and the questions to that issue still base on the traditional ways as press releases and print media and TV and broadcasting. Nowadays probably the social media is much more important, so ECHORD++ used for example twitter and YouTube. Concerning the ECHORD^{++} Public relations team, the website, the YouTube channel and Twitter were indeed the ways which attracted the most visitors beside the events.

E. Interdisciplinarity

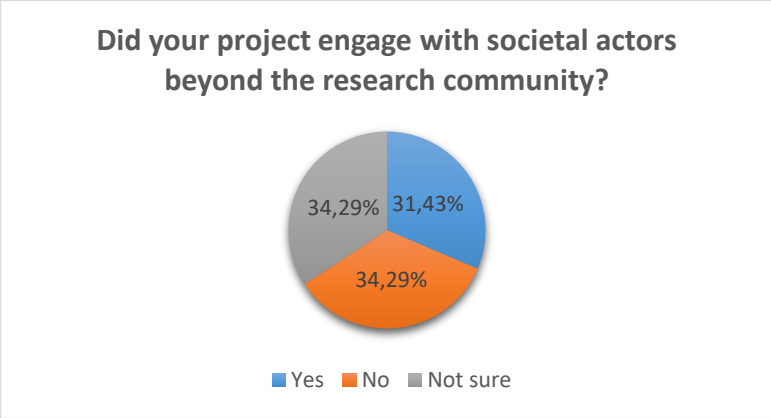
This graph shows impressively the broad application area of the whole ECHORD^{++} project, ranging from the natural sciences over medicine up to the social sciences. Anyway, mathematics, computer science and engineering sciences were the main disciplines, of course.

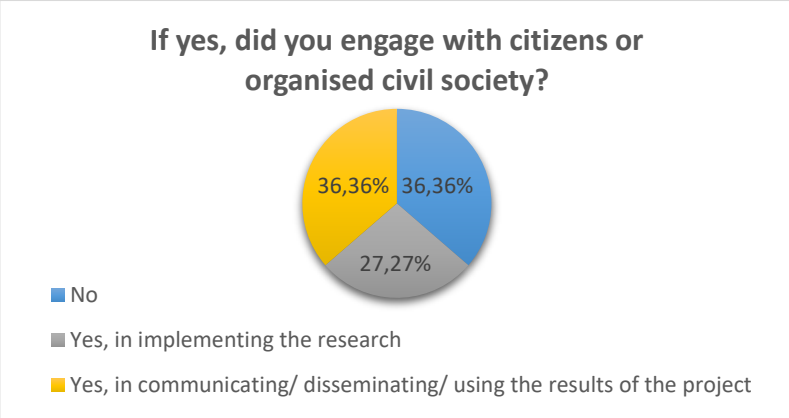


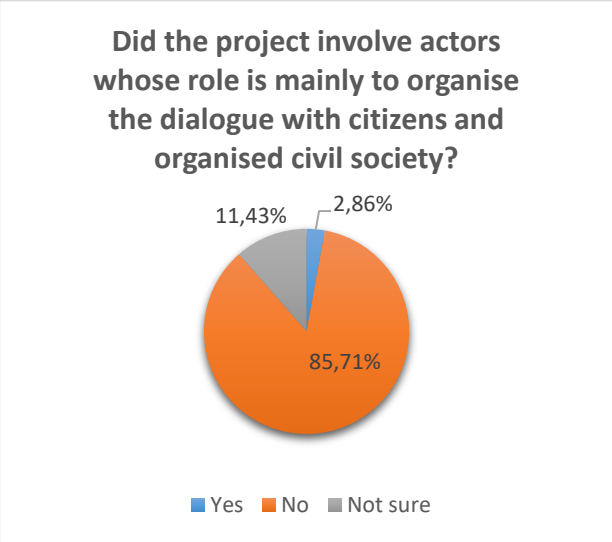
F. Engaging with Civil society and policy makers

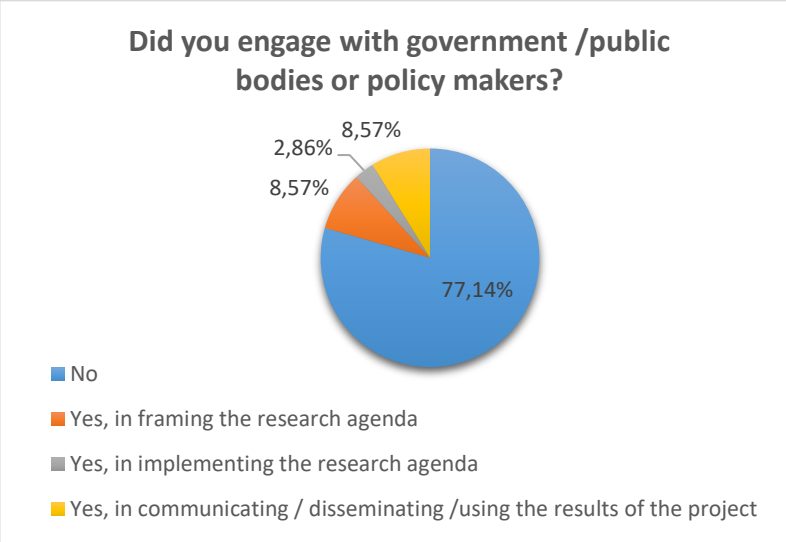
Only one third did not interact with societal actors beyond the own community. Two thirds of the ones who interacted picked citizens or civil societies as targets for their interaction. The aim is to communicate and implement the results of their research to the public, so there is no reason to complain about science in the ivory tower. It definitely left the dreaming spires as the questionnaire impressively shows.

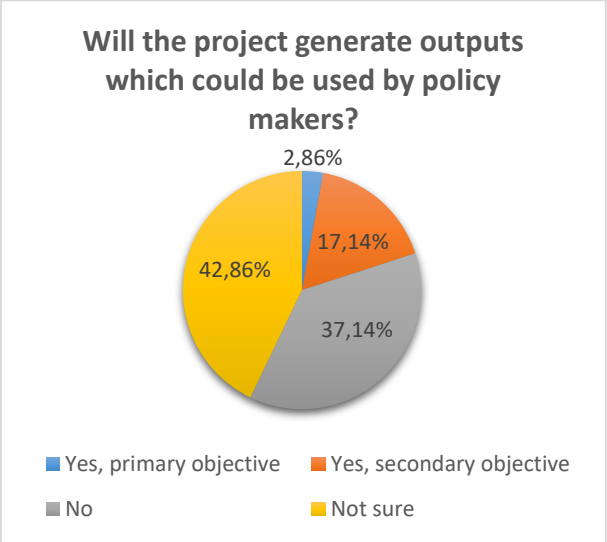
Surprisingly this is made only by the scientists themselves, 85% did not engage a professional for communication. There seems to be a great obstacle or ignorance how to approach to government, policy makers or public bodies, because 77% said “no” to this question. Unfortunately, the questionnaire was answered in written form, so it was not asked what the reasons are. One reason could be the answer on the next question: only 20% are sure that the output of their project can be used by policy makers. These 20% see the impact of their research mainly in agriculture, the public health sector and in research and innovation. This is mainly congruent with the special funding for healthcare and urban robotics by the PDTI concept in ECHORD^{++}. The agricultural projects in ECHORD^{++} were very successful from the beginning and well known in their community, although the application of robotics in agriculture is still a bumpy road (at least in Germany).

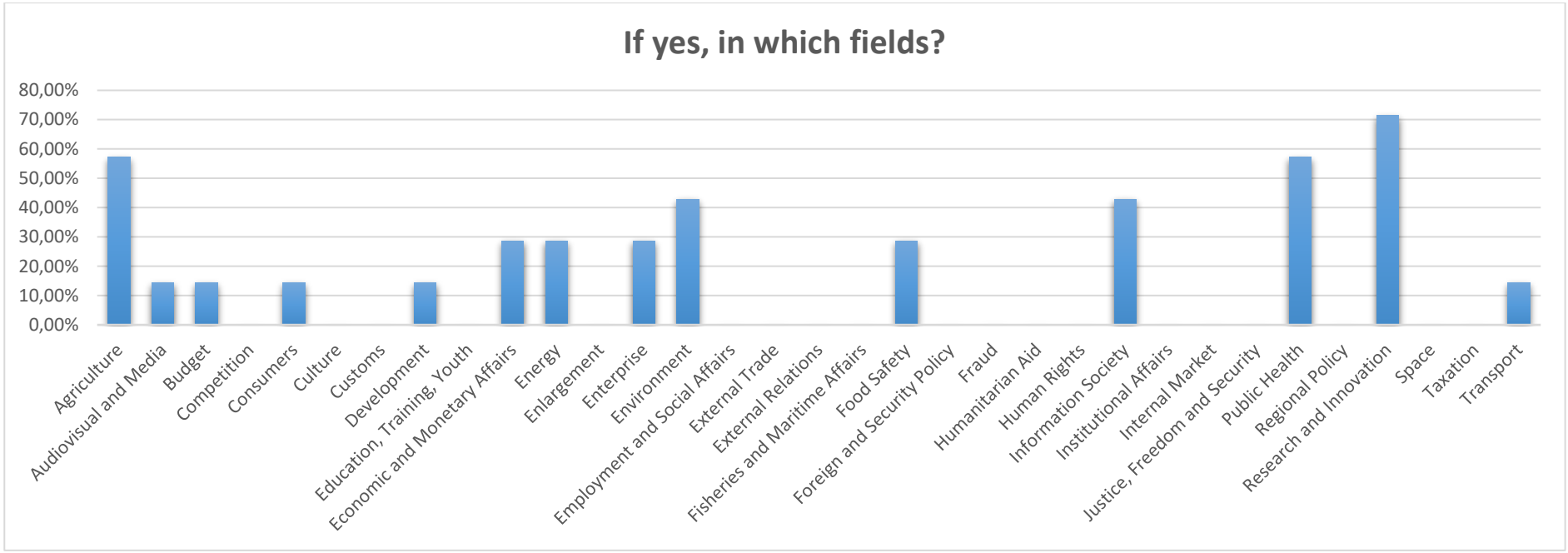

Did your project engage with societal actors beyond the research community?
31,43%
34,29%
34,29%
Yes
No
Not sure

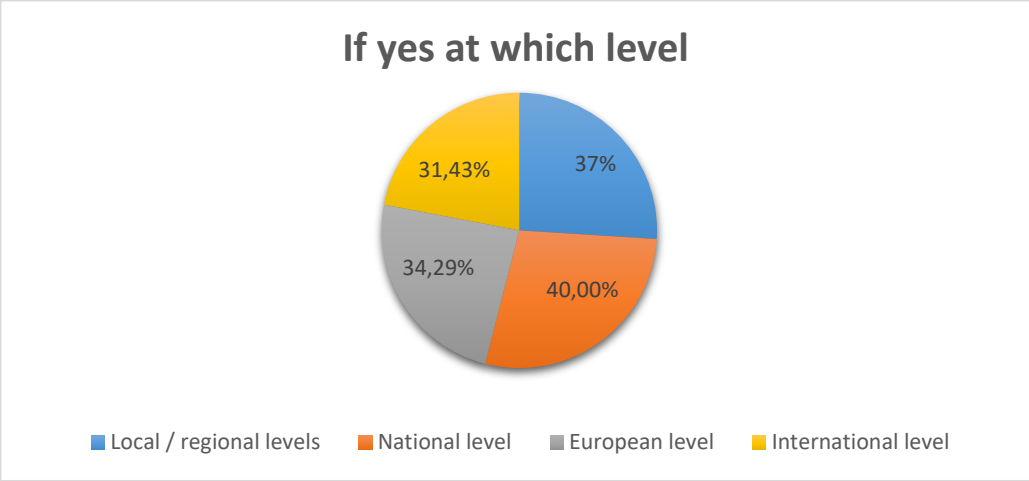

If yes, did you engage with citizens or organised civil society?
36,36%
36,36%
27,27%
No
Yes, in implementing the research
Yes, in communicating/ disseminating/ using the results of the project

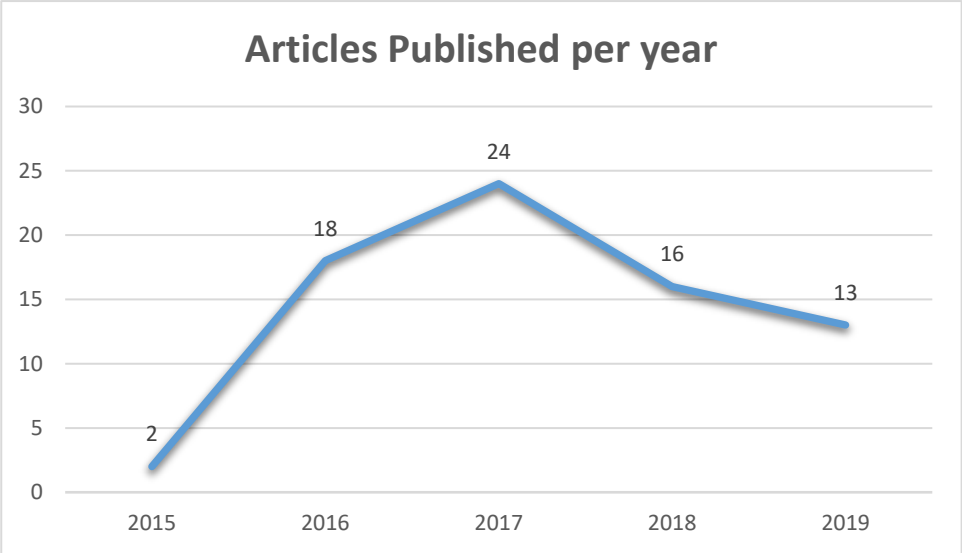

Did the project involve actors whose role is mainly to organise the dialogue with citizens and organised civil society?
11,43%
2,86%
85,71%
Yes
No
Not sure


Did you engage with government /public bodies or policy makers?
8,57%
2,86%
8,57%
77,14%
No
Yes, in framing the research agenda
Yes, in implementing the research agenda
Yes, in communicating / disseminating /using the results of the project


Will the project generate outputs which could be used by policy makers?
2,86%
17,14%
42,86%
37,14%
Yes, primary objective
Yes, secondary objective
No
Not sure


If yes, in which fields?
80,00%
70,00%
60,00%
50,00%
40,00%
30,00%
20,00%
10,00%
0,00%
Agriculture
Audiovisual and Media
Budget
Competition
Consumers
Culture
Customs
Development
Education, Training, Youth
Economic and Monetary Affairs
Energy
Enlargement
Enterprise
Environment
Employment and Social Affairs
External Trade
External Relations
Fisheries and Maritime Affairs
Food Safety
Foreign and Security Policy
Fraud
Humanitarian Aid
Human Rights
Information Society
Institutional Affairs
Internal Market
Justice, Freedom and Security
Public Health
Regional Policy
Research and Innovation
Space
Taxation
Transport


If yes at which level
37%
40,00%
34,29%
31,43%
Local / regional levels
National level
European level
International level



G. Use and Dissemination

From the total amount of the published articles, 27 was provided open access. Additionally, 17 published in open access journals. A total amount of 25, were published in open repositories. For the rest of 46 articles that the open access was not provided the reasons are varying. The most common ones are that the publisher's licensing agreement didn't permit publishing in a repository, no funds available to publish in an open access as well as lack of information on open access.

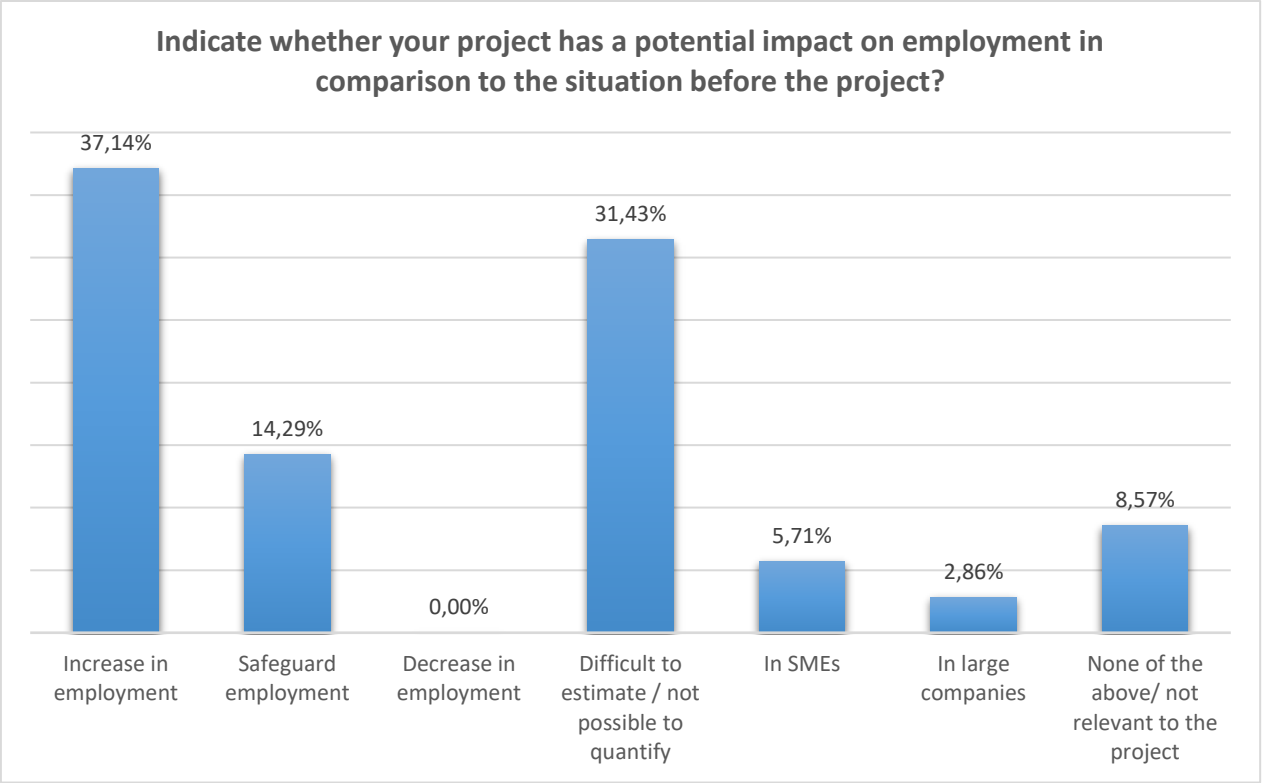
From both calls, 2 patents have been made: One is from MODUL experiment and more specifically the Joint unit, joint system, robot for manipulation and/or transportation, robotic exoskeleton system and method for manipulation and/or transportation. From the second call, WIRES experiments patented the software for further commercial exploitation.

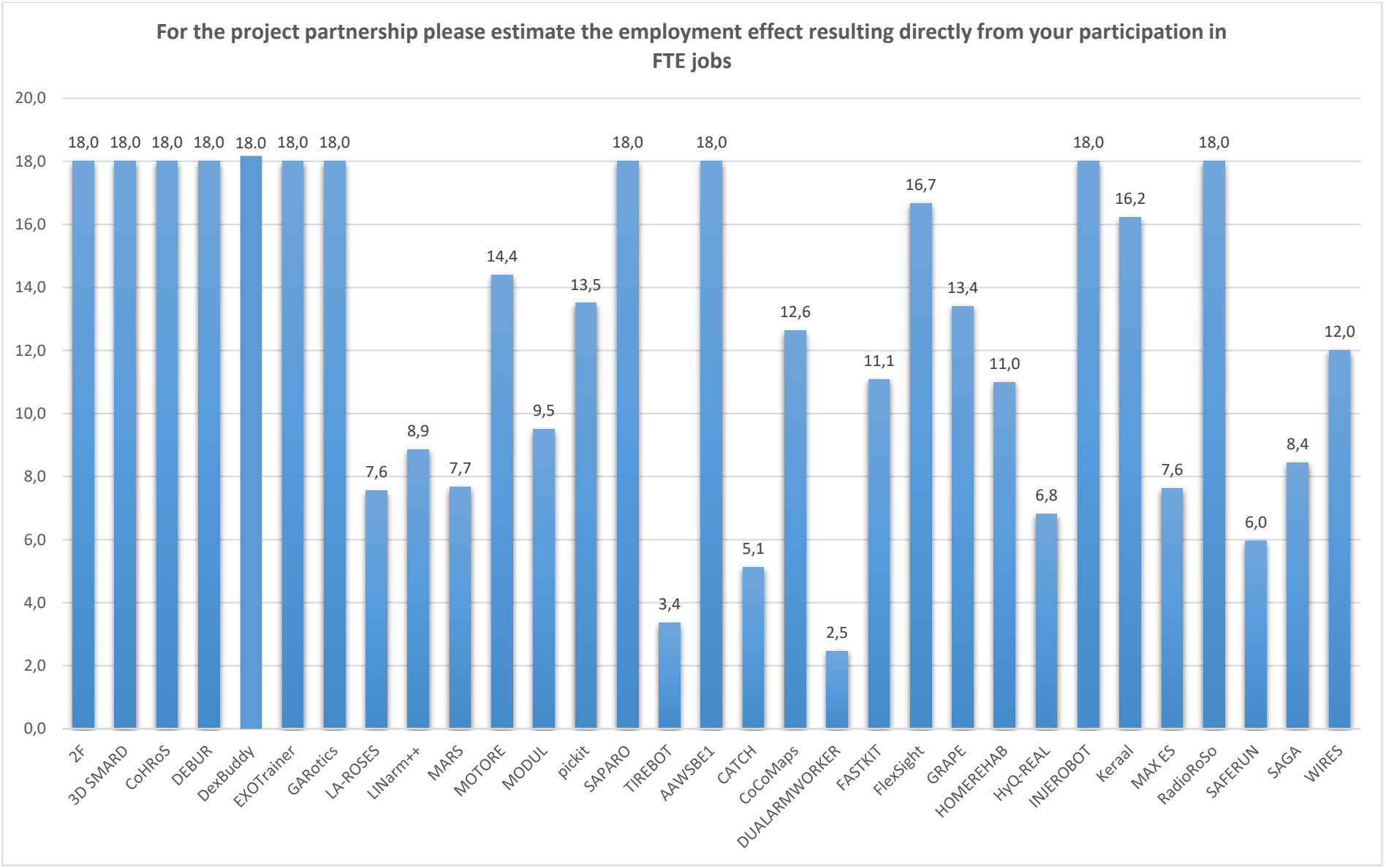
In the Table 1 we can see the three spin-off companies that created during ECHORD^{++} period.

Experiment	**Start-up**
MODUL	ANYbotics AG
HOMEREHAB	IDRhA- Innovative devices for Rehabilitation and Assistance
FlexSight	FlexSight Srl

Table 1 Experiments and start-ups from Call 1 and Call 2

The approximate number of the additional jobs in these companies is nearly 70 new positions. More specifically, ANYbotics AG is today a successful team of 30 employees. IDRhA is composed by a small group of approximately 10 members that create innovative devices for rehabilitation and assistance. The FlexSight Srl. project involves 11 employees so far and finally Marsi-bionics that could potentially benefit thousands of children, is composed by a dynamic team of 18 professionals.




For the project partnership please estimate the employment effect resulting directly from your participation in FTE jobs
20,0
18,0
16,0
14,0
12,0
10,0
8,0
6,0
4,0
2,0
0,0
18,0
18,0
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7,6
8,9
7,7
14,4
9,5
13,5
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3,4
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12,6
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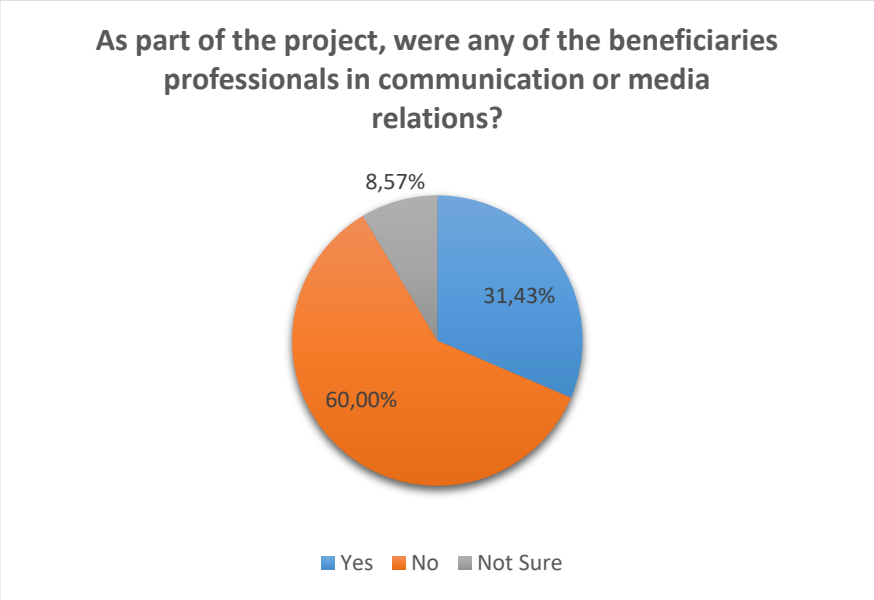
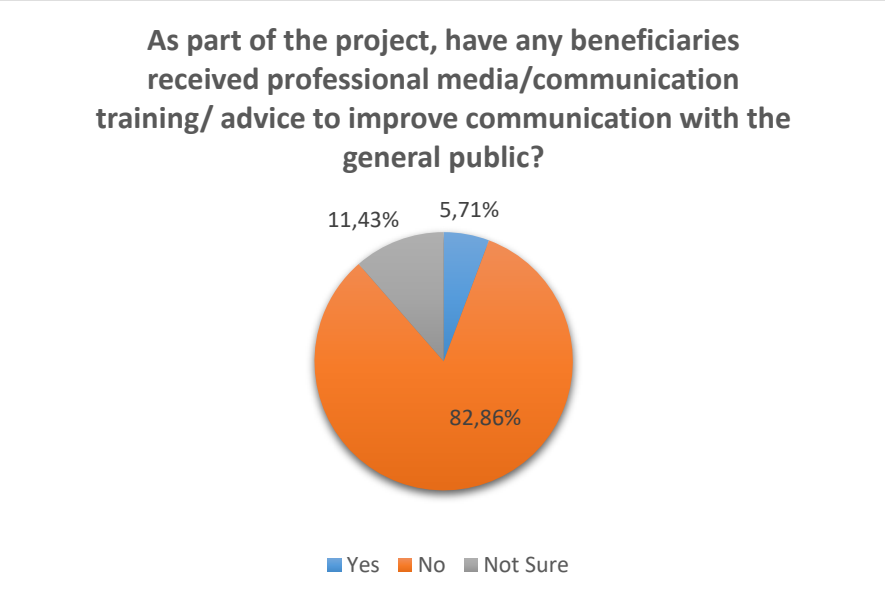
11,1
16,7
13,4
11,0
6,8
18,0
16,2
7,6
18,0
6,0
8,4
12,0
2F
3D SMARD
CoHRoS
DEBUR
DexBuddy
EXOTrainer
GARotics
LA-ROSES
LINarm++
MARS
MOTORE
MODUL
pickit
SAPARO
TIREBOT
AAWSBE1
CATCH
CoCoMaps
DUALARMWORKER
FASTKIT
FlexSight
GRAPE
HOMEREHAB
HyQ-REAL
INJEROBOT
Keraal
MAX ES
RadioRoSo
SAFERUN
SAGA
WIRES

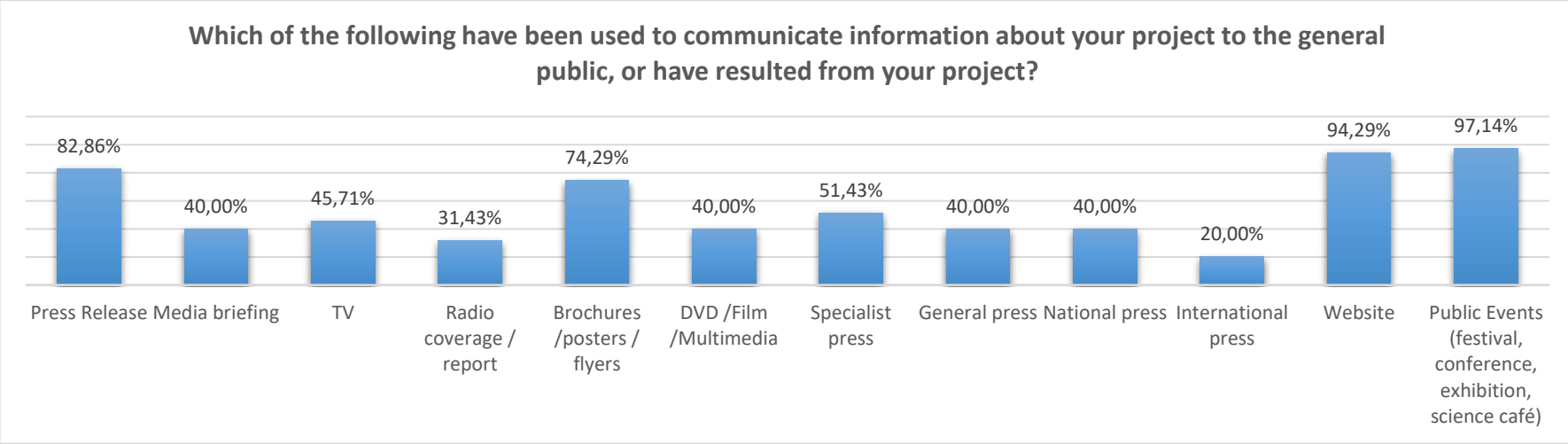
H. Media and Communication to the general public



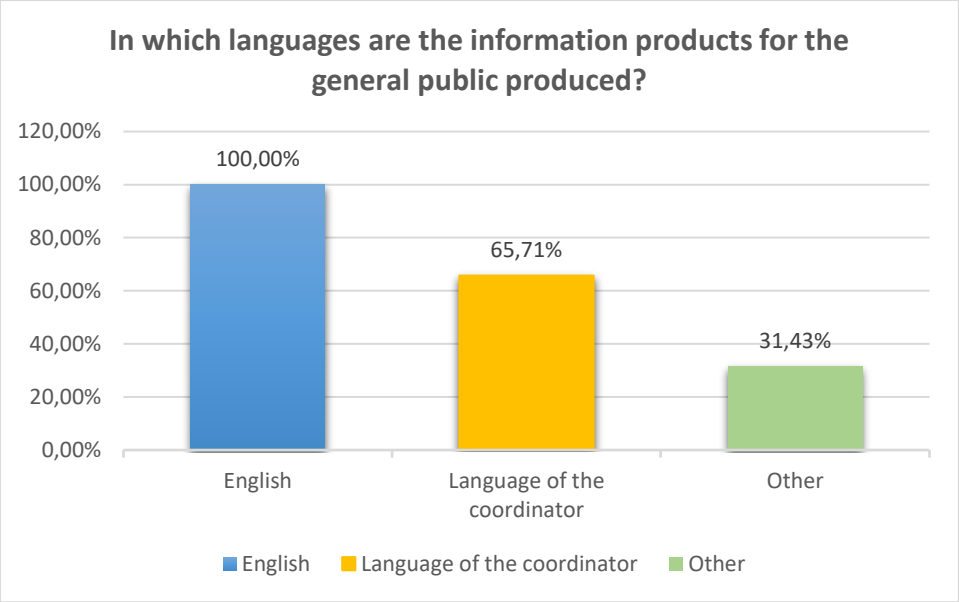


Only 31% of the partners have an own professional team for communication and media relations, e. g. all projects with a Fraunhofer Institute as partner. They do a very professional public relations work and are therefore quite present in the media, e.g. the CATCH project. This is especially interesting because at least in Germany robotics in agriculture is very special subject (with low positive response in the farmers' community) and the community is very small. So the media response is almost overwhelming.

Surprisingly only 6% of the projects answered that they had no training or advice to improve communication with the general public. On the other hand there was a professional PR training in the beginning of ECHORD^{++}. Obviously this information got lost during the runtime. The reason is that the scientist mostly have limited contracts and leave the universities and/or projects after a quite short time. The lesson learned is to repeat such trainings every one or two years at least for newly arrived scientists in the project.



Although the projects missed a training in communication with the public, public events was one of the most chosen options (97%), followed by the websites (94%) and press releases (83%). The new and nowadays much more important channels are social media, but they were not asked. So, the questionnaire should be adapted in the future. ECHORD^{++} used Twitter and a LinkedIn group, there are even more conceivable depending on the stakeholder group which is important to address.



Since we know that readers and journalists in all European countries prefer information in their own language, this result is astonishing. 100% were produced in English and 65% in addition in the coordinator's language. English is only reasonable for information which is published in interregional media and can be received in different countries. In most of the cases it is much more successful to produce information in the language of the country and to use English only for big fairs as automatica or Medica with a very international audience.