The City of the Future. The Challenge of the ECHORD++ Project

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Abstract. Focussed on application-oriented research and development, ECHORD++ (E++) is being funded by the European Comission in the 7PM for five years to improve and increase the innovation in robotic technology. Activities include small-scale projects and a "structured dialogue" incorporating public entities and citizens. Three instruments and processes are being developed under the ECHORD++ project: experiments (EXP), Research Innovation Facilities (RIF) and Public end-user Driven Technological Innovation (PDTI), all of them aimed at improving and increasing the innovation in robotic technology within SMEs companies and addressing answers to societal and industrial needs in different scenarios. This paper describes the outcomes and results of the project, the tasks of communication and dissemination and the structured dialogue between all the involved stakeholders.

Keywords: Pre-commercial Procurement; Smart Cities; Public End-users Driven Technological Innovation

JEL Codes: H42 (Publicly Provided Private Goods); R53 (Public Facility Location Analysis • Public Investment and Capital Stock); L53 (Enterprise Policy)

1. Introduction

The aim of this white paper is to introduce the novel PDTI process with the intention of boosting the innovative research in technologies and specifically in robotic technology and to contribute and join efforts to improve public services. After an overview of the innovative public procurement instruments, the PDTI process is described with emphasis in its relationships with one of these instruments, the Pre-Commercial Procurement (PCP) process, looking to investigate the 4 phases proposed in this instrument. The case study of the Echord++ PDTI in Urban scenarios brought us the opportunity to more deeply develop the phase 0 of a common PCP through a group of Activities for Understanding Public Demand with the active participation of the end users. Finally, this first Annual White Paper describes the outcomes and findings in robotic technology in urban scenarios and the future proposals for innovative public precommercial procurements.

Different policies from the European Commission have looked to take advantage of the very large volume of public procurement in helping to create an innovative Europe and solving the lack of an innovation-friendly market (Aho and Others, 2006). The Europe 2020 strategy includes innovative public procurement as one of the key market-based policy instruments for smart, sustainable and inclusive growth. Currently being around 19.4% of the Gross Domestic

Product in Europe, Public Procurement has an immense potential to fully exploit research and technology for innovation while also delivering more cost effective and better quality of public services. In some cases, the technologies needed to make these breakthroughs exist or are close to the market; in other situations, investment in R&D is needed to assure the progress of technological solutions that meet the defined societal needs. In this last case, the instrument used by public entities is a Pre-Commercial Procurement (PCP), located into the procedures of Innovative Public Procurement. During the last years very few PCP have been initiated in Europe and in some cases the calls have been declared void. The possible reasons of this lack of success could be a range of deficiencies in the PCP process including information asymmetries, lack of interaction between buyers and potential suppliers, perceived exclusion of small companies, risk aversion on both the public and private sides (Georghiou and Others, 2014) and the lack of knowledge within public entities about what the technologies are and the problems they could solve.

However, the good results of the Innovative Public Procurement in the United States of America public sector, where spend in research, development and innovation is 20 times that in Europe, give us a clear goal to reach. It is in this scenario where the ECHORD++ project proposes the process “Public end users Driven Technological Innovation” (PDTI) to increase and improve the innovation in robotic technology developing deeper the phase 0 of the commonly accepted PCP definition. Situated in the demand-side innovation policy, the PDTI develops a group of tasks and activities aimed at developing a deeper knowledge of public demand and which could be defined as a public measure to accelerate innovations and/or speed up diffusion of innovations through increasing the demand, by specifying and defining new functional requirements for public products and services that could be met through robotic interventions. An intensive dialogue between all the stakeholders involved has been essential to narrow the wide field for innovative public procurement: public entities as procurers; technological consortiums as suppliers; users as surveyors and the research team as coordinator of all the process.

2. Overview of the innovative Public Procurement Instruments

Policy may act where the demand for innovations is insufficient, or non-existent, but where a technological product has a high potential benefit. Innovation life cycles are concerned with the life cycles of generation of technology from the perspective of the economy and society as a whole as opposed to the life cycle of a specific product (Cohen and Others, 2014). Two main public procurement instruments’ have been developed for use in the product innovation life cycle: Pre Commercial Procurement (PCP) and Public Procurement for Innovation (PPI). Public Procurement for Innovation (PPI) is procurement where contracting authorities act as a launch customer for innovative goods or services which are not yet available on a large-scale commercial basis, and may include conformance testing. Pre-commercial procurement (PCP) means procurement of research and development services involving risk and benefit sharing under market conditions, as well as the competitive development in phases, where there is a

separation of the research and development phase from the deployment of commercial volumes of end-products, Figure 1.

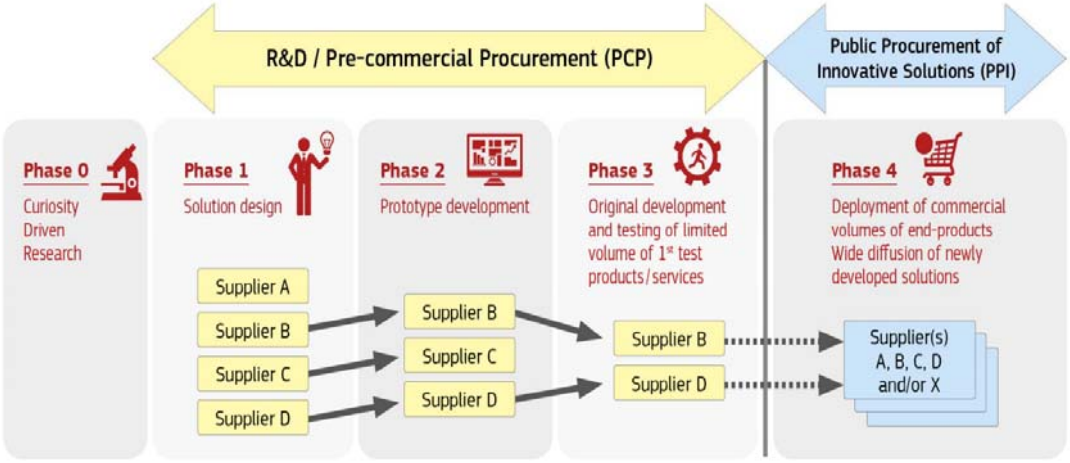

Figure 1. Innovation Procurement Instruments

Despite the perception of innovative procurement as something of a policy panacea and repeated efforts to put procurement budgets to work to drive innovation, efforts have been met with limited success. Numerous barriers exist from demand and supply side: there are market failures (information problems) and system failure (poor interaction); suppliers of potential new products and services often lack the knowledge on what customers might require in the future; user-producer interaction and communication rarely helps to produce synergetic results and innovative supplier firms perceive a lack of expertise within procurers and see it as a strong barrier to supplying innovative goods or services (Uyarra and Others, 2014).

On the other hand, a public call for RTD tenders or proposals, may not be well understood by potential suppliers. Its complexity requires much more comprehensive development of the preliminary phases of public requirements, which takes account of the specifications and features of the new technology. It is necessary to develop the initial phase, the phase 0, of the Pre-commercial Public procurement procedures, through activities aimed at understanding the requirements of both of the authorities and the users. Moreover, the innovative technology that can give a response to these needs has to be fully analysed to determine how it will improve the quality of the public service or to reduce its economic cost. The aim is that a joint consortium of industry and academia could offer innovative pre-commercial products linked to real demand.

The analysis presented in the document Quantifying Public Procurement of R&D of ICT solutions in Europe (Digital Agenda for Europe, SMART 2011/0036, European Union, 2014) highlights the poor initiatives developed by the 29 European Countries in regard to innovative public procurement. Only one country in Europe was working with policies aligned to innovative public procurement strategy in 2014: Spain. A series of policy measures supporting innovative public procurement in this country was the formal origin of the stimulus: the agreement of the Council of Ministers from 2/7/2010, where the State's Innovation Strategy was adopted; the Science, Technology and Innovation Act (Law 14/2011,

June 1st) explicitly mentions innovative public procurement, while an agreement of the Council of Ministers from 8/7/2011 sets out the procedure for the implementation of innovative public procurement in all ministerial departments and public bodies. 13 innovative public procurement contracts were awarded in Spain between October 2012 and April 2013, with a combined total value of about EUR 18 million. In Urban policies, the article Urban Competiveness and Public Procurements for Innovation presents the case study of six Nordic-Baltic Sea cities that have developed six specific Innovative Public procurements from 1998 to 2007. The authors of the article propound the position that the main triggers for procurement for innovation is based in the necessity of the cities to answer social needs. The experience of the Nordic-Baltic Sea cities reveals that, in general terms, the fact that there are a small number of cases relates to the reality that public procurement for innovation at the urban level is not very common. Public procurement for innovation has not, ubtil recently, been seen as an inherent part of the cities' innovation policy and mostly the cities tend to implement supply-side policy measures.

3. The PDTI process

Given this background, the lessons learned in the case study of the ECHORD++ project could help in the introduction of novel PDTI processes and generalize the process to other domains. Routed in the product innovation life cycle, and based on Pre-Commercial Procurements, the PDTI proposes a process that comprises two main phases (Figure 2):

- Activities for understanding public demand
- Activities for research and technological development of pre-commercial products.

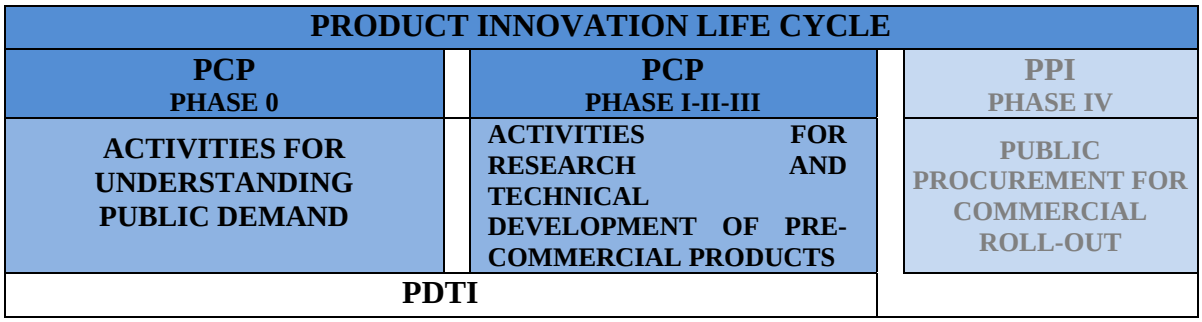

Figure 2. Relation between PCP and PDTI processes,

The "Activities for understanding public demand" increase and structure the tasks developed in the phase 0 of a traditional PCP. The "Activities for research and technological development of pre-commercial products", match the phases I, II and III of the PCP, ending in a pre-commercial product and making possible a Call for Commercial Tendering (PPI). Policy instruments mainly address the act of procurement itself and does not engage with the whole cycle from identification of needs. They also tend to omit the wider set of actors and stakeholders (Edler and Georghiou, 2007). To the importance of this identification of needs, as well as looking to bring future needs and future supply together at an early stage, the first part of the PDTI process, the Activities for understanding public demand, develops four qualitative phases inspired by the Delphi methodology (Dalkey and Helmer, 1963):

Brainstorming, Narrowing Down, Ranking and Challenge Description. This group of activities ends in a Call for Proposals /Tenders, initiating the Activities for research and technical development of pre-commercial products structured as a Pre-Commercial Procurement: Solution Design, Prototype Development and Small Scale Test Series (Figure 3).

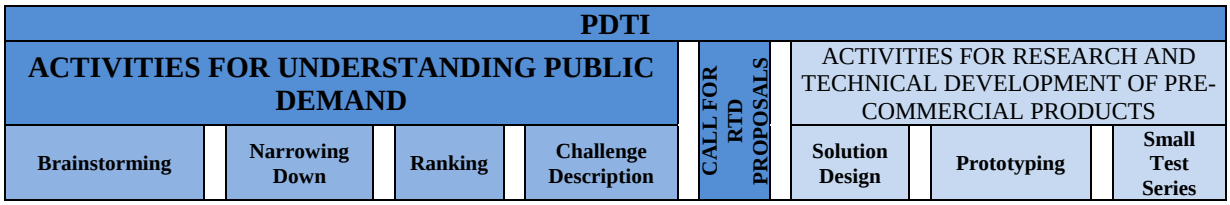

Figure 3. PDTI process and activities

4. The PDTI process: Activities for Understanding Public Demand

The novelty of the PDTI is to develop the phase 0 of a traditional PCP, putting more emphasis on the preliminary tasks and proposing a previous and critical phase of knowledge and interactivity between the stakeholders. The public entities (demand side) and the technological consortiums (suppliers) under the coordination of a research team and the supervision of the users constitute the stakeholders. Moreover, the innovation procurement requires a shared vision of the future needs between purchasers and suppliers, and a systematic way of identifying and characterizing those possible needs (Georghiou and Others, 2014).

This part of the PDTI process, Activities for Understanding Public Demand, is a qualitative procedure inspired by Delphi methodology and allows a group of stakeholders to systematically approach a particular task or problem (Paré and Others, 2013). In our case, the objective is the reliable and creative exploration of social needs related to public services that could be solved through technology and the production of sustainable information for decision making in the area of Innovative Public Procurement. The methodology employs iterations of questionnaires and feedback through series of rounds to develop a consensus of opinion from the participants. There is not a limit of time, but it is necessary to consider a minimum and a maximum number of rounds. After each step, specific documentation will be generated as the conclusion of the developed activities as well as the starting point of the next phase.

Figure 4 shows the methodology to develop the Activities for understanding public demand, the stakeholders involved, the tasks to develop and the documents elaborated in each one of the four phases. First of all, a Collaboration Agreement should be signed between all the stakeholders as an official requirement to start the process. This document will describe the roles of the different agents, the process and the proposed methodology.

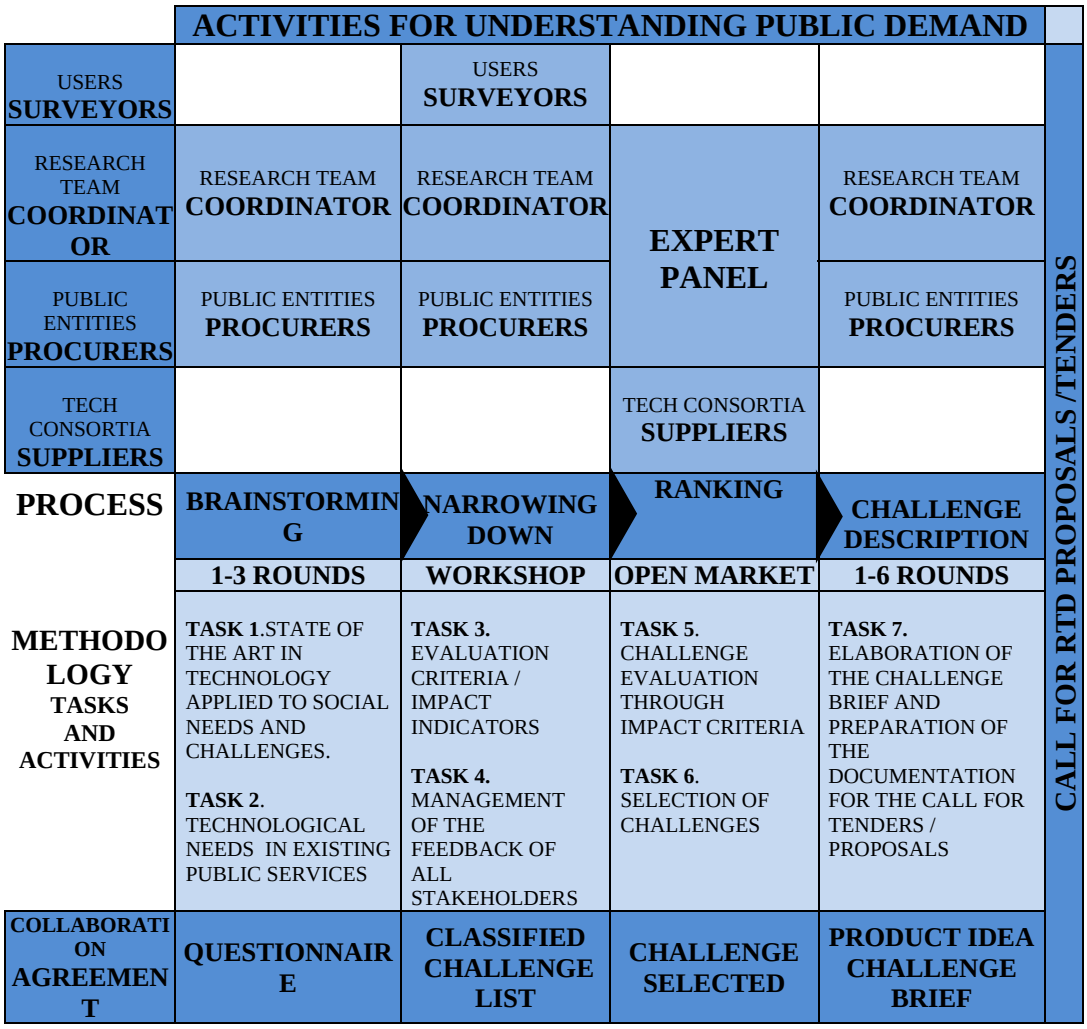

Figure 4. PDTI Activities for Understanding Public Demand: process, methodology, tasks and activities.

The stakeholders will be the Public Entities and their specific departments, the Users, the Users' Associations, the Industry, the Technology Manufacturers, and the Research and Academy Institutions and Organizations. They have different roles to play in PDTI. The procurers are the Public Entities; the suppliers are the technological consortiums; the surveyors are the users; and finally, the coordinator is the research team, which will give the technological support to the public sector for developing and implementing the innovation-oriented procurement. The role of the coordinator is needed to drive and lead the complete process based on innovation. Due to the complexity of this process, it is valuable that the coordinator has a team of people coming mainly from technological areas but also from other areas such as economics, psychology or political science fields (Edquist and Zabala-Iturriagagoitia, 2012).

The participation of users will take place all along the development of the PDTI to survey the process and participate in it, through different activities. The contact and participation of users can be done through local associations such as Living Labs. These living labs offer us a real-life test and experimentation environment where users and producers co-create innovation in a trusted and open ecosystem.

4.1. Brainstorming

The process starts with an identification of the real needs as perceived by the users and budget holders rather than procurement officials. At this stage two tasks are developed: Task 1. Analyze the state of the art in technology applied to social needs and technological challenges; Task 2. Analyze the technological needs in existing or new public services. Sometimes the identification of the needs is constrained by lack of knowledge of the innovation potential. The objective of this step is the elaboration of a Questionnaire of Public Needs and its associated Innovative Technology, based on an improvement of existing public services, the associated cost reduction or the creation of new services. At the same time the benefits of innovative technology can be introduced in public sector stakeholders. Interactive collaboration between organizations is extremely important for innovations to emerge, in the demand/pull side as in the supply/push side (Edquist and Zabala-Iturriagagoitia, 2012). The success arises through interactions between the stakeholders in several rounds. A questionnaire of the public needs and the associated innovative technological solutions is the tool used within each round. The information elaborated in each round will be collected, edited and returned by the coordinator to prepare the next round. Finally, a consensus final Questionnaire is elaborated.

4.2. Narrowing Down

This phase has the objective of focusing the needs proposed in the Questionnaire using specific criteria. It consists of two tasks. The objective of Task 3 is to obtain a group of impact indicators. Clear narrowing down instructions should be provided emphasizing the clarity and simplicity (Delbecq, Van de Ven & Gustafson, 1975). These impact indicators sometimes exist in the Public Entities, and in this case they can be used as starting point. In any case, a list of impacts indicators must be created and they will be used in the evaluation and selection of the Innovative Challenge List.

Task 4 consists in the management of the stakeholder feedback. One way to develop this phase is by organizing a workshop with the different stakeholders involved, discussing and receiving the feedback through the impact indicators and elaborating the Innovative Challenges List. Users, Industry and Academia Consortiums can be invited to participate in order to gain their opinion. Also, the use of social media allows a large number of people to be reached covering a wide spectrum of experience and expectations, however it is not always easy to obtain an actionable result. To gather users' opinion, it is very useful to organize activities with them all along the process. As we have said, the elaborated document at the end of this phase is the List of Innovative Challenges and each one of these selected challenges should be described and evaluated through the proposed impact indicators.

4.3. Ranking

The third phase of the Activities for understanding public demand is undertaken by an expert panel composed by designated people from the Public Entity and the Research Team. Task 6 consists of evaluating the List of innovative challenges while task 7 is where the selection of the public challenges is undertaken. The expert panel has to use the impact indicators; however other criteria can also be used in conjunction. In this process, the number of selected Public Challenges will depend on the budget of the Public Entity and of the potential market offered by the procurer weighted according to the size relative to the costs involved in the development of the Innovation.

4.4. Challenge Brief

The aim of this phase is to create the Challenge Brief. This is a document with a clear explanation of the public service and with enough information about the functions to be developed by the new technology. It is important to ensure that this Challenge Brief is not a common procurement document, but an innovative one, and has to be written taking into account the required innovative functionalities benefitting the public service instead of the standard requirements that could narrow the innovation field.

Further rounds of discussion between the public entity and the research team are required to ascertain the functionalities that meet the high-ranking innovative challenges. The definition of the functionalities should involve the end user of the public entity rather than general service personnel who are not directly involved in their implementation, especially if they do not have direct access to the relevant information (Dalpé, 1994). At least, 2-6 meetings are necessary in order to get to the Challenge Brief. This document has to specify the functionalities of the new technology, which must be chosen from the current functions, those that can be developed but are not standard and the new ones that will optimize the benefit to the public service.

The translation of needs/problems/challenges into functionalities requires highly developed competences, or at least understanding, at the technological level on the part of the procuring organization (Edquist and Zabala-Iturriagagoitia, 2012) and the role of the researchers in the consortium is essential. The Challenge Brief will be the main document for the Call for Proposals/Tenders and the starting point of the second part of the PDTI process, the “Activities for research and technical development of pre-commercial products”.

5. The case study of E++ PDTI in urban scenarios

Urban areas have been identified as one of the application scenarios for the E++ PDTI. Cities cover 2% of the earth surface, and they represent more than 50% of the world’s population (Lovins and Cohen, 2011). Smart cities have become an important area where technology has an important impact in the areas of energy, environment or mobility. However, these smart cities present challenges that cannot be solved with the products and services that already exist, but they can be solved if research is undertaken to find the best solutions. More

specifically, robotic technology will be one excellent capability that will able to solve problems that at present cannot be, or have not been, considered to answer urban challenges.

In this section we will explain, how the PDTI phase 0 described in the previous section has been applied to find robotic solutions to the urban challenges required by European cities. This work has been done by the Universitat Politècnica de Catalunya and the Technological University of Munich, inside of the E++ project.

The PDTI process is a tool for the municipalities to provide the enabling conditions for private sector exploring how local governments foster, support and aid in the creation and diffusion of innovation opportunities (Lember, Kalvet & Kattel, 2011) answering societal urban needs. On the other hand, robotic technology could give real answers to cities and citizens' challenges, but is not well known by the public procurers. This lack of sufficient procurement expertise for complex purchases involving innovation and the good preparation of the cities to receive new technological proposals have encouraged us to propose and develop the PDTI process in urban areas.

In October 2013 we started the Activities for understanding public demand, considering the following stakeholders: city councils as smart procurers; technological industry and academia consortiums as futures suppliers; citizens as surveyors; and the UPC research team as the coordinator. The objective was an open and coordinated structured dialogue between all the stakeholders involved following the four steps described previously.

We started with the Brainstorming phase, asking to the European City Councils about their Urban Challenges. We used a variety of different means: personal interviews with different departments, emails and telephone calls. We also analyzed the documentation of the Smart City World Congress 2012-2013 to understand the city challenges and, during the whole process, an essential task was to introduce the knowledge of robotic technology into the cities' departments, Mayor, and other people related with the city councils.

A first group of urban needs were developed, and we started to discuss how the robot technology could provide a solution for these needs. First, we discussed with the UPC team, which was composed of robot researchers, economists and architects, and the outcome was a first document specifying the city needs and the associated robot technology. Then we talked again with the city councils to see if those solutions were suitable. We undertook rounds of discussion and the outcome was the E++ Urban PDTI Questionnaire.

To prepare for the Narrowing Down phase we reviewed the existing documentation regarding impact and evaluation criteria and we asked to the City Councils about their public procurement evaluation. We also analyzed the document "Analysis of the feasibility studies from the Future Cities Demonstrator Program: Cities Solutions" (Arup, 2013), developed for the Cities of United Kingdom. This document analyzes the expected benefits to citizens, to city economy and local authorities. This identified three new solutions for the public sector services, the first one is based on improvements in the citizens' quality of life. The second one is based on the expected benefits from the future city economy characterized by the development of new products and services and catalyzing local start-ups. Finally, the third

one is focused around improvements on decision-making, collaboration and transparency, along with more efficient delivery of services and costs' reduction. Using these documents, we elaborated a list of impact criteria, which included the following elements: i) **Social and Cultural Impact**, to improve citizen's participation, independence, accessibility and mobility, and to improve the quality of life, better public services and replicability of the proposal in other districts and cities; ii) **Environmental Impact**, to improve resource efficiency, to improve sustainable mobility and potential for sustainable growth; iii) **Economic Impact**, to increase the support to small and medium companies and leverage private funding, increase or improve employment opportunities and the evaluation of the cost/benefit of the new technology; and iv) **Innovation Impact** based on the ability to execute, the evaluation of the risk/benefit of the proposal, the innovation in robotics and the capacity to integrate systems and synergies. Finally, we also evaluated the **City Presentation** and its implication in a Pre-Commercial Procurement Pilot with the objective to increase and improve technological robotic innovation through public demand in urban environments.

The third phase, the Ranking, consisted in the evaluation and selection of the most promising Urban Robotic Challenges to be funded through the E++ project. A first evaluation round was undertaken remotely by experts that evaluated and weighted the proposals, and the outcome was a list of weighted challenges. The second evaluation was done by a panel of experts, during a physical meeting that selected the ECHORD++ PDTI Urban Robotic Challenge. The selected proposal was: "To mechanize sewer inspections in order to reduce the labor risks, objectify sewer inspections and optimize sewer cleaning expenses of the city" presented by Barcelona City Council. The criteria used for evaluation was the same that was described in the others phases of the process. The final document included a prioritized challenges' list

Finally, we prepared the main document for the Call for RTD Proposals: the Challenge Brief. As we have said before, the translation of the needs into functional requirements requires a team of people with highly developed competences. The team was formed by four UPC robotics researchers and four people of the city council directly involved in the performance of the public service. During eight rounds we discussed the requirements of the new technology: "present" (actual requirements), "possible" (desired requirements) and "optimal" (optimal requirements) of the public service functions. The discussion finalized in a document, the Challenge Brief, where the functions were described with the inputs of the robotic team, looking to facilitate the innovation on one hand and answering the real needs of the public service on the other hand, that would give rise to a pre-commercial product.

The second part of the E++ PDTI will include the activities for research and technical development of the pre-commercial products and they will be developed during the next 34 months. This part will start with a Call for proposals and will be structured in the known three phases of a Pre-Commercial Procurement: solution design, prototype development and small scale test series (Figure 5).

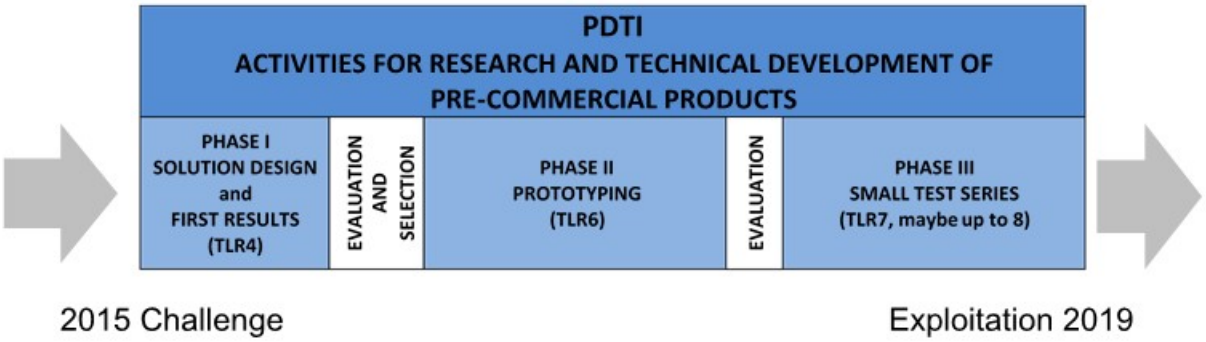

Figure 5. Activities for research and technical development of Pre-Commercial Products.

6. The outcomes of E++ Urban PDTI and the innovation in Urban Robotics

As we have said before, 14 urban robotic challenges were received from different European City Councils. The wide scenario of urban challenges was structured and analysed looking to stablish synergies between the urban needs proposed and under a new technological-urbanistic point of view. We structured them in three groups: city infrastructures, information and communication technologies related to different urban areas and technologic challenges for pedestrian areas at the city, (Figure 6).

INFRASTRUCTURES	**HELSINKI Finland**	**Traffic infrastructure inspection and maintenance.** Decreasing the cost of maintenance and increasing the area livability through robotisation of the city's maintenance traffic at the Smart Kalasatama designated smart city area, including both vehicles and installed infrastructure in the area.
INFRASTRUCTURES	**BARCELONA Spain**	**Automatic detection and road surface damage warnings.** To find a solution that can gather data and analyze the 11Mm2 of asphalt paving surfaces, road, cycle and pedestrian across the whole city.
INFRASTRUCTURES	**CORNELLA Spain**	**Improving waste management and street cleaning.** Perform tasks with less cost for the maintenance of parks and gardens.
INFRASTRUCTURES	**BARCELONA Spain**	**Utilities infrastructures condition monitoring.** To mechanize sewer inspections in order to reduce the labor risks, objectify sewer inspections and optimize sewer cleaning expenses of the city.
ICT AND ENVIRONMENT	**MALAGA Spain**	**Environmental monitoring and control.** This challenge aims at the deployment of a robotic collaborative network for monitoring and mitigating the presence of air pollutants (including pollen), as well as odors that may be unpleasant to citizens.
ICT AND TOURISM	**GREENWICH United Kingdom**	**Improving tourist services at the city.** To provide a cost effective way of interacting with visitors to provide accurate information based on real time management data as well as information on attractions and related services.
ICT AND PLANNING	**SEVILLA Spain**	**Improving the management, planning and urban city observations.** The use of aerial robots in the management, planning and urban city knowledge.
ICT AND MOBILITY	**SEVILLA Spain**	**Planning and information of urban accessible routes.** The robotic challenge is the realization of a LAND ROBOT prototype, as the basis for a battery of them deployed around the city taking mobility accessibility data with references that are inherent in the development of the Planner.
ICT AND SURVEILLANCE	**PADOVA Italy**	**Providing safe and secure environments for citizens.** The new technology should improve the limits of traditional surveillance cameras and should have more features (i.e. proactive action, movement ...) compared with the actual passive video surveillance/acquisition.
ICT AND MOBILITY	**VALENCIA Spain**	**Improving the management, planning and urban city observations.** An innovative monitoring system applied to urban bus lines to monitor Origin and Destination and sustainable mobility modes.
PEDESTRIAN AREAS	**BARCELONA Spain**	**Personalized mobility support for pedestrian areas.** To create a system or service that will guide the transport or mobility impaired through the neighborhood. The system must be integrated into the pedestrian area of the new city model raised.
PEDESTRIAN AREAS	**SITGES Spain**	**Providing safe and secure environments for citizens. N**ew robotic infrastructure where now there is a human intensive service. Objectives: noise reduction, surveillance and management of public spaces, especially in crowded events and support to disabled people in pedestrian areas.
PEDESTRIAN AREAS	**BARCELONA Spain**	**Goods distribution technology to improve local retail.** To create a sustainable system to make the distribution from the neighborhood Warehouse to each commerce. This robotic system must to be integrated in the pedestrian areas of new neighborhoods.
PEDESTRIAN AREAS	**COIMBRA Portugal**	**Personalized mobility support.** To contribute to the downtown urban life revitalization, improving the existing personalized transport as a key issue to connect activities and people. To select and apply the best mobility solution that can assure an effective transportation role in the downtown.

Figure 6. E++ Urban Robotic Challenges.

We also organized two workshops with local living labs and we started the recruitment of E++ citizens' collaborators, looking to receive their feedback through the different phases of the project. We used the E++ web site to publish this activity. 103 citizens were involved to survey the activities programed in E++ Urban PDTI and their first task was to evaluate the Robotic Urban Challenge List (Figure 7) at the Science and Technical Party celebrated in June 2014 in Barcelona. We arranged the survey according to ludic criteria, in order to motivate their feedback as a qualitative procedure. We received comments and suggestions that we collected and joined to the challenges' evaluation.

URBAN AREAS	CITY CHALLENGES	CITIZENS
INFRASTRUCTURE	Traffic infrastructure inspection and maintenance	6,44%
INFRASTRUCTURE	Automatic detection and road surface damage warnings	6,44%
INFRASTRUCTURE	Improving waste management and street cleaning	12,23%
INFRASTRUCTURE	Utilities infrastructure condition monitoring	6,44%
ICT & ENVIRONMENT	Environmental monitoring and control	11,30%
ICT &TOURISM	Improving tourist services at the city	3,92%
ICT & PLANNING	Improving the management, planning and urban city observations 1	5,98%
ICT & MOBILITY	Planning and information of urban accessible routes	5,98%
ICT & SURVEILLANCE	Providing safe and secure environment for citizens	3,64%
ICT & MOBILITY	Improving the management, planning and urban city observations 2	2,52%
PEDESTRIAN	Personalized mobility support for pedestrian areas	8,87%
PEDESTRIAN	Providing safe and secure environment for citizens	13,33%
PEDESTRIAN	Goods distribution technology to improve local retail	4,04%
PEDESTRIAN	Personalized mobility support	8,87%

Figure 7. Citizens' Evaluation.

7. Comparison and Conclusions

Urban competitiveness will drive municipalities to engage in the procurement for innovation, but the innovative public procurement is unknown for most of cities' procurers. Municipalities could boost procurement for innovation in the initiation phase of the technology life cycle, co-creating new solutions with the private sector to sustainability challenges and opportunities in the cities. The development of technology is the key to mastering these challenges and transformations in the European Cities and the PCPs and PDTIs are the right tools to accelerate them.

Few examples of Public Procurement for Innovation have been developed in Europe over the last few years. The last data presented by the European Commission DG CNECT Innovation Unit F2 in December 2015, showed that the ICT procurement amounts to 2,5% of GR (Gross Revenue) and the R&D procurement 0,1% of GR. As we have said at the beginning of this article, the United States of America public sector, invests $50Bn a year in PCPs as against €2,5Bn invested in the EU (European Commission 2015).

The case study of six Nordic-Baltic Sea cities (Lember, Kalvet & Kattel, 2011) brings us six specific Innovative Public procurements from 1998 to 2007. Tallinn faced the challenge of introducing a universal ticket system for public transport; Copenhagen's case was initiated because of an emerging need in educational policy; Malmö's photovoltaic energy-supply purchase was a direct result of its environmental policy; Stockholm public procurement for innovation is strongly driven by environmental goals and Helsinki case was launched to meet emerging problems in their public transport sector. In Spain, 83 procedures of innovative public procurement have been developed from 2011 to 2016; 56 are pre-commercial procurements and 6 have been presented by local authorities related to Smart Cities. In general terms the fact that there are a small number of cases relates to the reality that public procurement for innovation at the urban level is not very common. Public procurement for innovation has not been seen until now as an inherent part of the cities' innovation policy and, mostly, the cities tend to implement supply-side policy measures.

In spite of this, the European cities are prepared. Their competitiveness makes them strong and at the same time, the innovative public procurement makes them more competitive. The lead-user role played by the cities can have spectacular results in innovative public procurement and the case study of Echord++ and the development of the first part of the PDTI bring us a structured and proactive process to achieve them: 14 urban robotic challenges posed and defended by 10 European City Councils, all of them with robotic technology associated one step below an innovative RTD public call.

Cities and citizens have specific needs, not solved by existing market products, which require innovative solutions. These innovative solutions are based in new technologies that are unknown for public managers. At the same time, the technological consortia of industry and academia do not understand the real cities' challenges. In this scenario, the PDTI process sets the link to public entities for the development of innovative public procurement. It is clear that the Innovative public procurement increases the support to companies and leverages private funding. thereby increasing and improving employments opportunities in the cities. The few cases of public procurement for innovation have had a positive impact, not only on the providers but also with regard to the positive influence that public sector can have on innovation-friendly markets. A positive impact on companies is evidenced by the increased exports and changes in companies' routines having an end user driving their RTD development. The social impact improves citizens' accessibility and mobility in most of the cases as well as resulting in better public services.

The results achieved in the Echord++ PDTI process, during the first months of work, in a continuous learning by doing, brought fourteen innovative urban challenges proposed by

Cities' Councils across Europe. All of the challenges encompassed innovative technology, specifications about functionalities and were one step away from a call for RTD tenders. The role of the academia was essential, not only in technological topics but also in the management of the whole process.

All of these proposals could be the starting point of a new Innovative Public Pre-Commercial Procurement.

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