Deliverable D5.7

Small-scale test series and user-acceptance study (Phase III)

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Marie-Luise Neitz (Technical University of Munich)

Ana Puig-Pey (Polytechnic University of Catalonia)

Alberto Sanfeliu (Polytechnic University of Catalonia)

Franziska Kirstein (Blue Ocean Robotics)

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Executive summary

The current deliverable is connected to Phase III of the Public-End-User Driven Technological Innovation (PDTI) focusing on the two application areas Healthcare (Comprehensive Geriatric Assessment) and Urban Robotics (Sewer Inspection). It describes the activities pursued and the major achievements realized during Phase III (Small scale test series and user acceptance) of the development of robotics technology for the public sector (PDTI) in ECHORD ++. The activities performed during Phase III directly build on the prototypes and feasibility studies developed within Phase II.

The PDTI Sewer Phase III had a duration of 12 months. It started on December 15th, 2017 and ended on December 14Th, 2018. These 12 months consisted of four monitoring periods. In each one of these monitoring periods, several reports and tests were required from the consortia in order to evaluate the improvements with regard to the robotic platforms, the inspection functionalities, the operational procedures and the adaptation to market requirements. The evaluation results and recommendations of Phase II have been sent to the consortia on November 2017. In order to actively support market uptake till the last minute of ECHORD++, an exceptional in-person feedback and preparation for commercialization session was organized between the external reviewers and the two RTD development teams SIAR and ARSI.

The PDTI Healthcare Phase III started on 1st of June 2018 and ended on 31st of January 2019. During the first months of Phase III, the consortia continued their work based on the recommendations from the final evaluation of Phase II accompanied by conference calls to discuss the status and potential issues. Instead of a kick-off meeting, a midterm testing was organized, which took place in Vilanova i la Geltru, Barcelona Spain, at Hospital Sant Antoni Abat from 17th to 19th of October 2018. In the following months, the consortia and the monitoring team (consisting alternatingly of one business expert and one technical expert) had weekly business monitoring calls and technical calls after each submission of a deliverable as well as update calls in-between. The final evaluation of Phase III took place on 25th of January 2019 in Brussels and the panel meeting on 26th of January.

In both, PDTI healthcare and sewer, specific focus was placed on the business part. For all teams, a business workshop was organized during Phase III. Based on this, all four development teams have developed business plans. ASSESSTRONIC needs to further finetune the costs in their plan. Final evaluation results showed that three out of the four teams – ASSESSTRONIC, SIAR and ARSI – would need approximately two additional years to fully commercialize their solutions (the gap and the route to market being different for all three of them). CLARC has generated new third-party funded projects to further develop the technology and to exploit their scientific findings in education and research. In both applications – „Comprehensive Geriatric Assessment" and „Sewer Inspection" – the experiments would meet a high market potential. With sewer inspection – motivated and driven by core partner UPC – ECHORD++ has even identified a concrete new application area for robotics with a very high market potential.

Having performed also Phase III of PDTI, the core consortium of ECHORD++ is now able to fully assess the achievements and commercial potential of the different solutions. E++'s recommendations to the EC and the stakeholders involved in developing robotics technology for and with the public sector in the future are summarized in the last chapter.

Further information is provided in the following:

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Glossary of Terms

ECHORD++: European Coordination Hub for Open Robotics Development Plus Plus (E++ for short)

1   Introduction

The current deliverable is connected to Phase III of the Public-End-User Driven Technological Innovation (PDTI) focusing on the two application areas Healthcare (Comprehensive Geriatric Assessment) and Urban Robotics (Sewer Inspection). The activities performed during Phase III directly build on the prototypes and feasibility studies developed within Phase II. As outlined in deliverable 5.6., PDTI healthcare and PDTI sewer inspection implemented two different technology development philosophies: sequential development (PDTI Urban robotics with sewer inspection as the selected challenge) via agile approach in loops (PDTI healthcare with Comprehensive Geriatric Assessment being the selected challenge).

During the last Phase of PDTI, all four development teams worked on improving their prototypes in quality and reliability. As a result, SIAR presented a very advanced prototype, while ARSI significantly improved their software (data collection and image processing) in terms of speed, quality and reliability, but with less focus on the drone. In PDTI healthcare, CLARC put a lot of effort into their prototype and tested it with around 400 patients (an impressive sample, but not all of them showing geriatric deficiencies), while ASSESSTRONIC put fewer effort into developing the hardware (which is not the core part of their product), but focused very much on the business side of their development. ASSESSTRONIC collected feedback from a lower number of patients, but their sample was more adequate.

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 the coaching was done by experts of the E++ core consortium with both a technical as well as a commercial background.

With their solid prototype, SIAR generated interest beyond just sewer-monitoring applications. SIAR is in contact with potential customers interested in their hardware, but also with customer groups all over the world not necessarily interested in taking their hardware or software solution, but in contracting SIAR as a service provider on their own account. SIAR seems to have a very broad exploitation potential. ARSI - in contrast- can commercialize their solution only in conjunction with a service provider. Their software solution offers an immediate path to commercialization: Integrating data generation and image processing into a sensor which human workers carry while inspecting the sewer would immediately increase the quality of information for the service provider at low costs. Thus, ARSI could generate the funds to make trials with several off-the-shelf drones now being on the market (which was not the case when ARSI started). ARSI would need to combine their software with drones which have different capacities and different sizes to tackle different challenges in the sewer (different diameters, sewer architectures etc.). Combing the software of ARSI with the hardware of SIAR would facilitate the route to market for both solutions.

In PDTI healthcare, ASSESSTRONIC has managed to develop a modular, highly flexible solution which is scalable in price, depending on the set-up (full scope including Get-up-and-Go test or just completing questionnaires electronically via a tablet). ASSESSTRONIC also introduced the concept of providing the doctor with a tablet. The doctor can use this handheld device when interviewing the patients (not only for geriatric assessment). The public body in PDTI healthcare has recently introduced tablets in the hospital. The doctor is highly interested in the collection of data for the "Get-up-and-Go test" which would make the assessment of the motoric abilities of the patients over time more objective. The CLARC solution offers less direct commercialization potential. As in ARSI, the strong side of the CLARC solution is the software development, especially the interface for the healthcare professional. The reliability of the software used during the geriatric assessment still requires more improvement to become reliable in the real world. The future of the CLARC solution in terms of development and commercialization currently depends on the MetraLabs platform. The platform was selected (subsequent to a quite sound market analysis comparing eight different off-the shelf platforms) to replace the Giraff platform in the original proposal (this company declared their bankruptcy directly after the CLARC proposal was

selected for funding). Even though MetraLabs as a company are potentially interested in commercializing the solution and have an interest in entering the healthcare market, they have not a concrete future plan for the commercialization of the mobile platform (which is the basis of the CLARC robot) and its operating system yet. Also, the company is currently defining their future strategy and focus markets. Thus, the merits of CLARC are mainly geared to the findings around the user-centred design of socially assistive robots for older person. These findings have been published in the scientific community and will thus also be useful for current and future robot designers and developers.

All four development teams have developed business plans. ASSESSTRONIC needs to further finetune the costs in their plan. Three out of the four teams – ASSESSTRONIC, SIAR and ARSI – would need approximately two additional years to fully commercialize their solutions (the gap and the route to market being different for all three of them). CLARC has generated new third-party funded projects to further develop the technology and to exploit their scientific findings in education and research. In both applications – "Comprehensive Geriatric Assessment" and "Sewer Inspection" – the experiments would meet a high market potential. Especially through PDTI Urban Robotics, ECHORD++ – motivated and driven by the core partner UPC – has shown the potential impact of robotic solutions in the area of city infrastructure by demonstrating the added-value of using robots during sewer inspection (verified during multiple test in the field).

The following sections of this deliverable provide a more precise description of the activities and achievements in PDTI Urban Robotics and PDTI Healthcare in this final phase of developing robotics technology together with public stakeholders that was performed under the umbrella of ECHORD++.

2 PDTI Urban: Major activities and achievements in Phase III

2.1 Overview of the process

PDTI Phase III goal is for the in Phase II developed prototypes to achieve a TRL of 7-8, to improve the characteristics of the prototypes evaluated in Phase I and II, and to incorporate the technological improvements into the prototype that are needed to perform the inspection and clearance of the sewer network, which are mentioned in the Challenge Brief. At the same time this phase should offer a major step up in the marketability of the developed robotic solutions. The main objectives of Phase III are:

- Improvement of the prototypes developed in Phase II to achieve TRL7-8 level, which includes:
  - Improvements in mobility, autonomy and communications of the robotic solution.
  - Improvements in the inspection of serviceability, monitoring and the structural inspection of the sewer network.
  - Improvements in operational procedure required during the inspection.
- Data management proposal
- Market research to identify scalability and transferability of the solution.
- Periodical tests and final test.

2.2 PDTI Urban Robotics: Development of Deliverables and Evaluation Criteria for Phase III

PDTI sewer Phase III had a duration of 12 months. It started on December 15th, 2017 and ended on December 14th, 2018. During these 12 months, four monitoring periods were performed. In each one of these monitoring periods, several reports and tests were required to the consortia in order to evaluate the improvements in the robotic platforms, in the inspection functionalities, in the operational procedures and the market requirements. The evaluation results and recommendations of Phase II have been sent to the consortia on November 2017.

- Kick off Telco Phase III: December 19th, 2017

Deliverable 5.7 – Small scale test series and user acceptance

Explanation of the monitoring process and the evaluation criteria for Phase III. Proposals of the deliverables required, the dissemination and communication activities offered by ECHORD++ and the actions proposed to improve marketability.

1st Monitoring Period: 15/12/2017-14/03/2018.

09/03/2018. TELCO and report of the deliverables

Deliverables
D26-9 ARSI. Changes and Improvements based in Phase II final evaluation
D28-9 SIAR. Changes and Improvements based in Phase II final evaluation.

2nd Monitoring Period: 15/03/2017- 14/06/2018.

19/04/2018. MARKETING WORKSHOP. External experts' evaluation and discussion of the marketing proposals.

3/07/2018. TEST of serviceability inspection of the sewer network. Complete operational procedure.

Deliverables
D26-10 ARSI. Serviceability inspection. Tests and test results.
D26-11 ARSI. Marketability
D28-10 SIAR. Serviceability inspection. Tests and test results.
D28-11 SIAR. Marketability

3rd Monitoring Period: 15/06/2018-14/09/2018.

19/09/2018. TEST of structural inspection of the sewer network. Complete operational procedure. ARSI consortia cancelled the structural inspection test and justify it in the document "Phase III Evaluation Delay Justification"

Deliverables
D28-12 SIAR. Structural defects inspection. Tests and tests results.

4th Monitoring Period: 15/09/2018- 14/12/2018.

13/12/2018 FINAL TESTS AND EXPERT PANEL

Deliverables

D26-13 ARSI. Final prototype and validation for sewer inspections procedure
D26-14 ARSI. Technology readiness level and exploitation plan
D26-15 ARSI. Final multi-media report
D28-13 SIAR: Final prototype and validation for sewer inspections procedure
D28-14 SIAR Technology readiness level and exploitation plan
D28-15 SIAR Final multi-media report

Final evaluation of Phase III for the Urban Challenge, including demonstrations and expert panel evaluation, was performed on December 13th, 2018 at BCASA Network in the Forum area of Barcelona. The Expert panel took place at

the UPC Campus Besos. The evaluation during the test series were focused on the functions required by the end-user and how well the new robotic technology would solve them.

Table 1 Sewer inspection functionalities detailed in the challenge brief

FUNCTIONS			WEIGHT
Sewer serviceability inspection	Sewer performance 1000 lineal meter/labour day)		Crucial
	Images (Video)		Crucial
	Geometric analysis (scanning)		Crucial
	Monitoring	Air	Interesting
		Water	Interesting
Structural defect inspection			Interesting
Sampling			Interesting

The following section provides some background information on the activities of this Phase III.

Positive evaluation of the tasks and documentation required during the period.

The overview of the deliverables presented by both consortia is explained above. The information and explanation of the tasks done during this Phase III had a positive evaluation by the monitors (BCASA and UPC) and the external experts.

Prototypes.

SIAR solution has succeeded to develop a prototype which shows a lot of potential for commercialization and is already quite close to a market ready solution. It is evident that a tremendous amount of progress has been made from the beginning. The strength of the ARSI solution lies in the data handling. But the UAV platform is still an early prototype, which was completely redesigned from previous solution.

Operational procedures.

The operational procedure of the SIAR solution at the sewer is completely successful without a person entering into the sewer. It seems that postprocessing and reporting workflow need to be further improved. The envisaged deployment of the ARSI UAV can work, but the consortium should think about a solution without human workers entering the sewer, as human labour in the sewer becomes more and more restricted due to tighter security regulations.

On-site testing and demonstration.

Rainfall made the demos very difficult, but each team tested for two hours in the Barcelona sewer network in the Forum area. ARSI was not able to demonstrate a complete flight but they displayed the data obtained in previous flights to demonstrate their data handling with great success. SIAR demonstrated a complete trial with some loss of communication during the process. Successful images and 3D reconstruction made it possible to demonstrate the inspection of the sewer serviceability

Economic viability of developed products.

The SIAR team has developed a solution with a high potential for very significant impact on the market. The updated design is a good step towards approaching this market, e.g. due to improved robustness, materials and improved specs (sensors, image quality, repeaters). The ARSI solution needs to tackle shortcomings in flight stability and reliability to achieve a high impact and a commercially viable product. Inspecting sewers via a flying platform is a quick and versatile

solution, the data handling and interpretation already implemented provide an excellent starting point for a commercially viable solution.

On January 14th, 2019 a last meeting between the external reviewers and the SIAR and ARSI consortia took place in Barcelona. The aim of this meeting was to offer a summary of suggestions/feedback to the two consortia to go deeper in the commercialization of the robotic solutions for sewer inspection and to analyse areas of synergy between the two teams to mutually strengthen their route to market.

2.3 PDTI Urban Robotics: Progress Phase III

ARSI

It is clear that the ARSI UAV is an early prototype which was completely redesigned from previous solutions. The reviewers doubt whether the chosen approach to develop a new platform is appropriate given commercial availability of COTS (Commercial off-the-shelf) solutions. In addition, a fully commercial solution may require a range of platforms depending on sewer dimensions, with modular payload to accommodate different situations.

The strength of the ARSI solution lies in the data handling. The matching process in real time and post processing is excellent. Classification using multiple methods (heat maps, interpretation by masking surfaces from real pictures) is well developed. However, it needs further integration. The UI (User Interface) of comparing real and simulated image is very effective and well represented. The classification of the objects and singularities works very well and is automatic.

Figure 1 ARSI final prototype

SIAR

The SIAR team has made commendable progress since the last review at the end of Phase II. It is clear from the improvements implemented that they have taken many of the comments from the previous review on board. They have succeeded to develop a prototype which shows a lot of potential for commercialization and is already quite close to a market ready solution. Among the important issues resolved are the addition of a small arm mounted to have better spatial awareness when executing complex manoeuvres and in support of inspection in real time. SIAR prototype needs to further improve postprocessing and reporting workflow in close collaboration with the end user to reach a fully practical field-ready solution, but there is every reason to assume that with some effort this can be achieved.

Figure 2 SIAR final prototype

2.4   PDTI Urban Robotics: Panel Meeting and Outcome

ARSI team would very likely have achieved a better overall result if they had separated the data acquisition and sensoring from the UAV platform and pursued a different strategy for the platform. Alternative solutions in terms of platform should have been investigated and pursued given the fundamental nature of the problem with the flight stability. The reviewers believe that with some help these stability challenges may be resolved within reasonable time to make the otherwise good solution viable for commercialization.

The SIAR team has developed a solution with a high potential for very significant impact on the market. The updated design is a good step towards this market, e.g. due to improved robustness, materials and improved specs (Sensors, image quality, repeaters).

In general terms both consortia are strongly advised to get connected to the international market sooner rather than later, as the international market will be needed to make the commercialization viable and sustainable. The experts recommended to split the technology in individual units, considering bringing different partial solutions to the market and do not concentrate on the robotics technology alone. A lot of interesting technology was developed and/or integrated in the project, which might have separate market potential, such as wireless communications, sensors, data handling and analysis, robotics. Collaboration between the consortia is important as they both face the difficult task of opening up the market. One area of synergy may be market studies to understand which cities have visitable sewers and comparison of technology solutions. By joining efforts ARSI and SIAR consortia can achieve higher targets in terms of product versatility and potential market share.

3   PDTI Healthcare: Major activities and achievements in Phase III

3.1   Overview of the process

PDTI Phase III started on 1st of June 2018 and ended on 31st of January 2019. Phase III started with initial conference calls between the consortia, TUM and BOR to set the goals and tasks for Phase III and confirm the effort and budget. As the monitoring team partly exchanged members (BOR took lead in the monitoring during Phase III), conference calls between the consortia and the monitoring team, the Phase started with identifying the current status of development and commercialization effort. Based on the outcome of the calls and the final evaluation reports of Phase II, the monitoring team worked on the Key Performance Indicators for Phase III. In the first months of Phase III, the consortia continued their work based on the recommendations from the final evaluation of Phase II accompanied by conference calls to discuss the status and potential issues.

It was decided not to organize a kick-off meeting as the consortia still had targets and concreted suggestions from the final evaluation reports and because Phase III started delayed and thus started during summer break. Instead of a kick-off meeting, a midterm testing was organized, which took place in Vilanova i la Geltru, Barcelona Spain, at Hospital Sant Antoni Abat from 17th to 19th of October 2018. At the testing, representatives of the two consortia, of the monitoring team (Blue Ocean Robotics) and healthcare professionals and hospital staff from the public body (hospital Sant Antoni Abat) participated, as well as the patients who tested the solutions. Moreover, two representatives of the European project SCALINGS observed the testing with the purpose of analysing the process of monitoring in ECHORD++. The midterm testing gave the opportunity for the public body and the monitoring team to get a live update on the development progress, give them feedback on their first new prototype of Phase III, discuss the KPIs for the final evaluation and the next steps until the end of the phase (monitoring deliverables, due dates, etc.). In this regard, the midterm testing was also used to organize two workshops in order to go into detail on how to write a business plan and what matters when developing a product. The agenda included general tests with patients for the consortia to collect initial end-user feedback (patient) while planning their small-scale tests, tests with healthcare professionals to also get their end-user feedback.

Furthermore, the agenda included workshops on the business part and product development part of Phase III, both included a feedback session based on first monitoring submissions and on-site tests.

Specific focus was placed on the business workshop as the final evaluation of Phase II showed a critical lack in this area, specifically on the business plan. At the workshop, the plan and guidelines for the business monitoring were presented. The agenda for the workshop included providing a typical business plan structure incl. an example of a business plan; going through the defined business KPIs, plan for the upcoming monitoring and deliverables. Furthermore, at the workshop the teams were introduced to how a business case typically looks like and were given the task of starting up a business case looking at the costs and benefits involved from the customer's point of view. Each team presented their findings, which were discussed and suggestions on how to move forward were given. Lastly, the teams were given brief feedback on their business plans as they were at the time, incl. suggestions on which areas to focus on and how to move forward.

In the following months of Phase III, the consortia and the monitoring team had weekly monitoring calls: technical calls after each submission of a deliverable and update calls in-between. As the business part only included three long deliverables (business plan, business plan presentation and market intelligence report), the monitoring was structured with clear goals according to a workplan that included sub-deliverables and weekly monitoring conference calls.

Both consortia participated in ECHORD++'s booth at the MEDICA fair 2018 and the monitoring team used this opportunity to inspect the updated prototypes and have a physical meeting to discuss the product development progress.

In order to monitor the progress of the user studies, the consortia exchanged information (via mail or conference calls) on the status with the monitoring. Furthermore, César Galvez Barron, healthcare professional from the public body, was in contact with the consortia before they focused on their small-scale tests and visited both teams at the beginning of their test series.

The final evaluation of Phase III took place on 25th of January 2019 in Brussels. Besides the three external reviewers, members from each consortium as well as representatives from the public body and the ECHORD++ core team participated. Also, a representative of the SCALINGS project participated again. Both teams presented their progress during Phase III in form of presentations and demonstrations of their new prototypes, outlining their achievements according to the KPIs set-out for Phase III.

The panel meeting took place on 26th of January with the same participants as on the evaluation day except for the consortia. The results and progress achieved by both teams towards the outlined KPIs was discussed. As ECHORD++ will not find further support for the two teams to continue their route to commercialization, the reviewers carefully discussed during the panel meeting how the reviewer's recommendation can support the final way of the solutions to the market.

3.2   PDTI Healthcare: Progress Phase III

The CLARC team has again been highly motivated in Phase III. They have carried out tests with a large number of patients (more than 400 patients so far), which helped to collect feedback on the new prototype design developed towards the end of Phase II. They have also attended all dissemination events that ECHORD++ invited them to such as Automatica, IROS and Medica Fair.

Early on in Phase III, CLARC focused on preparing the prototypes for the small-scale test series. Their prototype is complex and needs intense development, the delivery of parts can take several months. As they aimed at testing the four prototypes with a larger number of patients at different institutions, they started to prepare their prototypes early. This did not give them the opportunity to make changes in the design of the prototype. The prototype had been re-

designed at the end of Phase II and the next step was to test it. During the prototype development, CLARC also worked on the software and included recommendations from the reviewers and user testing at the end of Phase II. In addition, the technical monitoring team and CLARC investigated how the robot can be prepared better for commercialization e.g. by discussing the bill of material, electrical diagram, user and developer manual. Also, the 3D model design was evaluated. The stability of the prototype needs improvement. The driver wheels are close to the centre of gravity, this could cause the robot to continue rolling in a situation where the robot needs to break.

During the user testing, CLARC collected valuable information on the installation of the system in a healthcare institution. The user studies were conducted by CLARC's team of healthcare professionals without an engineer present. After installing the robot, they instructed the healthcare professionals on how to operate the system. They also created an in-depth user manual for the healthcare professionals to assist them during the user studies. The user tests revealed that the prototype still has a longer path to commercialization. Two of the test sites had technological issues while installing the robot due to the additional software development and updates in the mobile platform. The tests were delayed and are planned to finalize in March 2019. The platform has significant shortcomings such as it is not able to understand the response of the person to the questions asked or record a person during the Get up and Go test. The data representation and management interface was rated very positively during the user testing by César Galvez, the public body's healthcare professional. This is certainly an asset the solution can build on. To this end, strategies for integration into IT-infrastructure should be further developed.

The user studies have been carefully planned by the CLARC team, including well-known work such as the USUS framework[1] for evaluating human-robot interactions (see also section 3.3). In view of the novel uses of robots that are likely to emerge, this may prove a useful addition to knowledge in the field. A number of scientific results have been disseminated in this connection. Even though these rather build scientific impact than actual innovation, they contribute to a user-friendly development within this field that all developers of social robots can make use of.

CLARC has been dedicated to creating a thorough business plan with the business monitoring team. The presented business plan has been well developed and can be feasible when the technology works.

ASSESSTRONIC has again demonstrated an organized approach to their work, with a clear focus on product development and delivering a prototype that is close to market at the end of Phase III.

Just like during Phase II, ASSESSTRONIC's needs, in terms of assistance from the monitoring team, were very different from those of CLARC. One of their greater challenges in Phase II was to create a well-developed business plan as well as high quality manuals for their product. The product related documents have been finalized and represent a good basis for ASSESSTRONIC to go to the market. The 3D model of their prototype design has also been evaluated as stable by the technical monitoring team.

The ASSESSTRONIC team made significant progress since Phase 2. The system is convincingly simple and thus does not represent a high level of risk. The external reviewers evaluated the solution as TRL 6, on its way to a market ready solution. The tablet solution is highly usable for the patient and carer as well as from the healthcare professional's perspective. A portable system has been developed for the Get Up and Go Test, which seems to work robustly and reliably.

The final business plan is solid in the perspective of market expectations, the market approach, and foreseen sales estimates. Especially the involvement of Acetiam as a company who could commercialize the solution, is promising.

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[1] https://www.researchgate.net/publication/313559458_The_USUS_evaluation_framework_for_human-robot_interaction

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Acetiam possesses all infrastructure and knowledge to successfully exploit the results and access the market without need of venture capital.

ASSESSTRONIC independently organized user studies, which had no major technical issues or delays. They planned their study with a smaller sample size but focusing on a more appropriate end-user. Still, the number of patients on which the solution was tested is too few. Further trials are needed to ensure validation, which is essential if a final product is to be marketed successfully.

In Phase III, both teams have clearly benefitted from the PDTI structure, especially the monitoring input from multidisciplinary experts and the definition of clear KPIs. Phase III was shorter than expected and clear monitoring deliverables with deadlines and detailed feedback as well as extensive progress discussions during monitoring calls have assisted them in structuring the way they approached their work, workflow and communication inside the consortium. Both teams have successfully submitted all monitoring deliverables and especially the business plan was evaluated as very convincing by the external evaluators. They have delivered a tremendous amount of work during this short Phase III. This also meant that the teams had to manage their priorities well. Both teams were asked to focus a core part of their work on the business aspects as this was a oblivious downside during their work in Phase II. Besides this, both teams were working on increasing the robustness of their software. They also had to create prototypes for the user studies and develop a final improved prototype by the end of Phase III. All this was done in 8 months, taking into consideration that the first 3 months were influenced by summer vacation.

The teams have different solutions that clearly vary in their go-to-market time. From the beginning of PDTI, ASSESSTRONIC focused on delivering a solution that works for the end-user and is robust enough to be used within the next couple of years. This also meant that their solution did not focus on the mobile part anymore that was requested in the original call documents. CLARC focused on developing a mobile robotics solution as outlined in the call. This meant including more advanced technology and software, but also the risk for less robustness and thus a longer time to market.

In Phase III, both teams have focused on progressing towards market, but according to the time that suits the development of their solutions. ASSESSTRONIC clearly pursued the development of a robust prototype with a TRL of 6 which was achievable within Phase III. CLARC's technology itself is very innovative. There are currently not many socially assistive robots on the market in healthcare applications and those that are on the market are struggling to survive. Thus, CLARC has taken an approach that is focusing on the long-term sustainability of their prototype, which has clearly been approved by end-users in Phase II. As the platform is more expensive, but very adjustable, a main question was also which other application scenarios such a robot can be used in parallel to CGA tests. Thus, they have increased their number of participants with a broader sample. This also gave them the possibility to collect information on the robustness and become sharper on their development plan. Through publications, they have made sure that these valuable experiences, which are still extremely rare in the field of robots for the elderly in the wild with large sample size, will be available for all robot developers. PDTI has helped to develop CLARC's product and innovation mind-set, especially with focus on including the user into the development of robots (as requested at the end of Phase II) and pushing the state-of-the-art in this field, thereby fostering entrepreneurship within academia.

Both teams have delivered a business plan that is feasible and which they can continue to work with in their future activities. It is the monitoring team's belief that the PDTI experience will prove beneficial to both teams, in particular in fostering a product- and innovation- technology-development mind-set that will support them in introducing the product to the market according to the time frame that is appropriate for their individual solutions.

3.2.1 Progress summary by CLARC

Robot and CGAmed redesign

After the second evaluation at Vilanova, the suggestions from reviewers and medical staff who participated in the meeting were integrated into the CLARC framework. The external appearance of the CLARA robot[2] changed in order to integrate the components, which were originally located outside the robot, into the chassis . The adopted elements included the IP camera or the shotgun microphone Other elements such as the touchscreen or the embedded processors were also updated. The new robot is now more compact and robust against unintentional hits that could move one of the cameras or the microphone. As a major open problem, the deprecated Kinect v2 sensor had to be removed and exchanged against a valid alternative. So far, the Orbbec Astra Pro has been identified as the most solid alternative. It can be used to replace the Kinect in nearly all the CLARC use case, including evaluating the Timed Up and Go test. However, this device has lower distance ranges and noisier RGBD outputs, so it is still not able to directly replace (i.e. without algorithmic updates) the Kinect v2 in the more demanding Get Up and Go test.

The CGAmed[3] was also updated. The new interfaces reflect the recommendations from the medical reviewers at the public body. For instance, it is now possible to produce the final report file, which summarizes the results from an automatized CGA session, and can be easily copy-pasted from the CGAmed.

Dissemination

Phase III has meant a great deal of effort in dissemination. In June 2018, the team participated in the Automatica fair in Munich. End of September 2018, the CLARC solution was presented in the II Conference about Ageing and Dependency, held in Jaén (Spain). From there, the robot travelled to Madrid, to participate in the IROS 2018 conference. In November 2018, the robot was again packed to travel to Dusseldorf, to be presented in the Medica 2018 fair. The project has been visible in national and regional television news, but more importantly CLARC could get valuable feedback from direct stakeholders such as healthcare professionals, resellers of healthcare solutions and robotics developers.

In parallel, the CLARC framework was presented in academic forums. In August, a paper was presented in the RO-MAN conference. In September, CLARC was involved in a keynote presentation at the 6th World Convention on Robots and Deep Learning, held in Singapore. In November, another paper was presented in the Workshop of Physical Agents 2018, held in Madrid. A paper has been recently published in the Cognitive Systems Research journal describing part of the software architecture within the CLARA robot. This work aimed at pushing the state-of-the art in this rather innovative application for robotics within healthcare. ´

Pilot at Seville and qualitative testing at Reims

The major aim of Phase III was to pilot the robot solution in real scenarios. To this end, two of the platforms were sent to Seville in December 2018, to be tested in the Nursing Home San Nicolás from Cantillana and the Primary Healthcare Center of Viso del Alcor. Before this, CLARC also worked on designing the entire framework (pre- and post-session questionnaires) to capture the information of the end-users (doctors and patients) and collect valuable information for future deployment of socially assistive robots in these settings. External cameras recorded the whole session, providing additional information about postures or gestures, which will complement the data collected by the robot. By January 25, when the final on-site review took place, the feedback of 45 patients (16 from primary care centre and 29 from the nursing home) was consolidated and already available for evaluation.

A third platform was deployed at the Hospital of Reims, mainly absorbing the qualitative feedback from the medical staff at the care centre. Their feedback was very positive, concerning the performance of the robot, social acceptability, and

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[2] CLARA is the name of the CLARC prototype developed in Phase II
[3] The CGAmed is the interface for the healthcare professional

added value in their practice. This platform travelled to Troyes on January 25, to be deployed in the Hospital of Troyes and in a rehabilitation centre (CRRF Pasteur), to collect data following the same approach as in the Seville test sites.
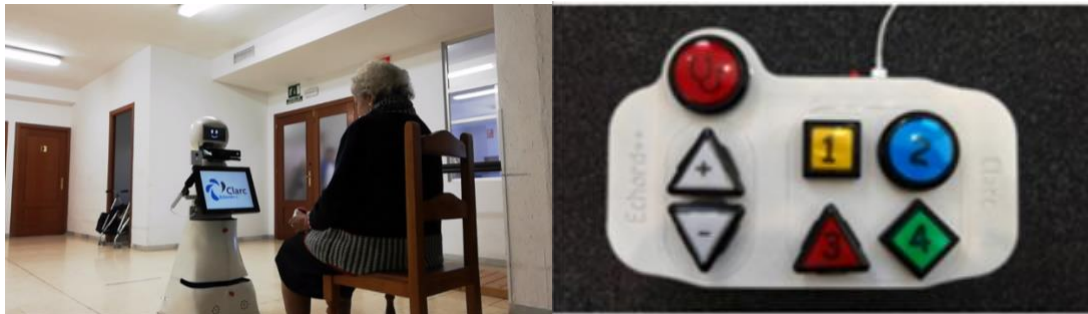

Figure 3 CLARC user testing and new prototype, including new remote control (right)

Scientific contributions

The need to evaluate the platform in such specific environments (hospitals with elderly people) has promoted the definition of a new evaluation framework where accessibility is taken into account as a success factor for integrating robots in society. Therefore, the A+USUS evaluation framework is proposed. It is a methodological framework to evaluate the human-robot interaction between patients and Clara, including accessibility as an evaluation indicator, proposing methods and a methodology to evaluate accessibility and the other factors assessed by USUS: usability, social acceptability, user experience and societal impact. The main characteristics of this methodology are described in a research paper which is currently under evaluation in the Autonomous Robots journal and will help other robotics developers to evaluate their robot during tests with patients. This adds knowledge to a so far less explored field.

3.2.2 Progress update by ASSESSTRONIC

During the mid-term evaluation, the system has been tested with 2 patients. Both the Barthel and the Get Up and Go tests have been performed by them. The first patient completed successfully the Barthel test and the Get Up and Go test with minor help. He seemed interested and quite confident in using the system. The second patient performed the tests with a lot of difficulties and needed major help to complete the Barthel test. He was cognitively deteriorated, so this result was quite expected. The second patient also performed the Get Up and Go test but using a walker. The system failed in collecting the measures of the body movements because of the occlusion of the legs by the walker during the first phases of the test. The system has also been analysed by some health professionals and interesting feedback about potential improvements have been collected.

The feedback collected during the midterm evaluation and during few tests already performed in Phase II, suggested that some improvements were required in order to enhance the usability of the product (especially for the patients). At the beginning of Phase III, the suggested modifications have been applied and, following the user-driven strategy, a small-scale test series of the improved product have been performed in Charles-Foix Hospital (Paris). Additional feedback has been collected and further improvements of the system applied. However, some details still need to be improved. For instance, the results page has to be upgraded to better filter the results based on different criteria (e.g. the type of the test, the date of recording and so on). Also, the page to schedule consultations need some improvements. As discussed with the medical staff, the system should allow to schedule more than one consultation and to modify already planned consultations. It is planned to work on these aspects in the first months subsequent to the end of the project.

Figure 4 ASSESSTRONIC final prototype

During Phase III a big effort has been put into developing the hardware. A completely new prototype of the ASSESSTRONIC box has been designed and fabricated (see picture on the left).

The ASSESSTRONIC box is a compact and portable device used for performing physical-based tests. It embeds a 3D camera which is used to observe the patients' movements during the physical tests, a battery pack to power the camera, an ON/OFF switch and several ports to connect with the camera from outside the box (HDMI, USB and micro USB). The box dimensions have been accurately chosen in order to minimize the encumbrance and to maximize the perception performance simply placing the box on the floor (no need to use external additional support to lift up the box).

During Phase III, the system has been tested in Charles Foix Hospital following a rigorous protocol that was previously agreed with Doctor Barron (public body) and his team. The study has been conducted with 20 patients and their relatives. The usability of the system has been observed and additional interesting feedback collected. Besides, the satisfaction questionnaires filled by the participant after the use of the system, show that the majority of the patients enjoyed the interaction with the system, even though, due to the lack of experience with technology, they sometimes struggled during the tests. Some training and further improvements of the system will make the interaction easier and more effective.

However, the major part of the work done in the last phase of the project was dedicated to market analysis and business plan. Thanks to the help provided by the Blue Ocean Robotics monitoring team, the business issues have been analysed entirely and covered and this helped to understand the potential market of the system and to schedule the next steps to enter the market.

3.3   PDTI Healthcare Phase II and Phase III conclusions on reviewer's recommendation by CLARC

In November 2016, after a first evaluation of CLARC (Phase I of PDTI), the consortium was encouraged to add a new partner for redesigning the solution by including the end-users. They decided to add the team of Dimitri Voilmy (ActivAgeing Living Lab of Troyes University of Technology) - specialised in Participatory and Human-Centred Design for AAL technologies. During the evaluation of Phase III, the reviewers agreed that the additional partner has added great value to the progress of the CLARC consortium with regard to user testing, not only for the development of the product, but also the scientific and dissemination results.

Design process: Iterative, Participatory and Human-Centred

In January 2017, CLARC moved the robot and the teams to Troyes to start working with the end-users, focusing first on a profound analysis of user needs. At that stage, and all through the project, the different stakeholders have been actively involved in the research on the CLARC solution, older adults (both seniors who are informal caregivers and elderlies being cared for) as well as healthcare professionals. The design was created in an iterative process. Hence, the different versions of the prototype were co-designed with the end-users, iteratively evaluated and improved. The benefits of the Human-Centred Design approach were visible in the second and third evaluations at the public body in Vilanova. But they have now been more clearly captured in the pilot at Seville (December 2018 - January 2019) for two of the CLARC prototypes. The design approach - Iterative, participatory and Human-Centred - therefore allowed to achieve the "appropriate design", i.e., a tool that is considered by the users themselves as efficient, usable, accessible and socially acceptable (cf. details of the evaluation framework and results below, captured using post-session questionnaires).

Evaluation criteria 1: Social acceptability

With a technology like a social robot, social acceptability is the most important criterion for use by end-users. Therefore, much focus was put on evaluating this aspect. Table I shows the responses of 16 patients post-session questionnaires to the questions related with social acceptability (Mean Score, with 5 being the maximum score, and Significant Deviation).

Questions (Lickert scale)	Mean score (1-5)	SD
I feel comfortable, motivated and able to do the test with the robot.	4,7	0,75
By interacting with the robot, I felt safe, convinced that the robot will not do anything unpredictable.	5	0
I feel like I'm really interacting with the robot (not just responding to a machine).	4,2	0,92
I was (not) intimidated when I first saw the robot.	5	0
I find it easy to be in the robot's presence and I find its physical appearance not intimidating.	5	0
The robot made me feel comfortable and I communicated easily with it	4,6	0,77

The answers to the questions (Table 2) suggest a very positive attitude of geriatric patients towards the robot: they declare feeling safe, comfortable, not being intimidated, and interestingly, that they have the impression of "really interacting" with the robot (not just responding to a machine). This supports the hypothesis that there is a strong correlation between these positive social acceptability and the usability accessibility criteria. This correlation was further examined in future pilots in Seville and Champagne region, France.

Evaluation criteria 2: Usability

Usability was carefully evaluated during the pilots (results below), and - more importantly - has been subject to careful design, so as to make the interaction as "easy" as possible.

Table 3 Usability (16 respondents - Seville, December 2018/January 2019)

Questions (Likert scale 1-5)	Mean score (1-5)	SD
I was able to understand (hear or read) what the robot was clearly asking for at one point.	4,1	1,06
I think the robot is easy to use in the tests I just passed.	4,2	0,83
The explanations given by the robot on the tasks to be performed are clear and easy to understand	4,5	0,96
I find that the robot behaves in a flexible way in terms of interaction (Voice/TS.RC)	4,1	0,90
I could clearly hear what CLARA was saying at every moment.	4	1,5
I was able to easily identify the buttons on the remote control related to each question (display and remote control report).	4,7	0,75
I was able to answer without any problem using the remote control	4,7	0,85

Indeed, usability was carefully looked into during the design process, considering the specific needs, abilities, and previous use of technology The demographic data collected in the pre-test questionnaire (graphics below) suggest either a complete lack or very limited use of technology. Yet, even if patients are not familiar with technology, Clara has achieved very positive results on: Usability, Social acceptance, UX.
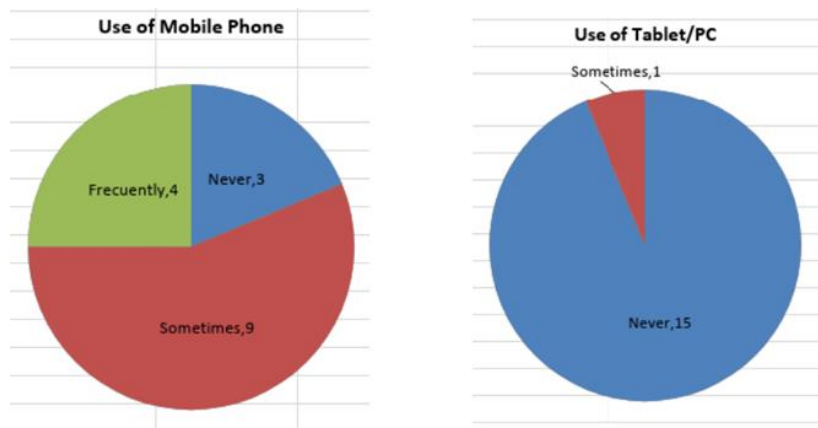
Figure 5 Usability questionnaire results on usage of phone, PC or tablet

Evaluation criteria 3: Accessibility

Last but not least, accessibility was an essential criterion both in the design as well as the evaluation framework. The first user tests revealed the extent sensory impairments (visual and hearing) as well as cognitive impairments of the patients, due mainly to the degeneration which comes naturally with age, which prevented them from interacting efficiently with Clara (or any other technology).

A profound analysis of the barriers to accessibility has been carried out by an accessibility expert. Afterwards, a re-design of the Clara platform was developed to better reflect accessibility aspects, including multimodal interaction: the patients could at any time select the mode of interaction with the robot: by voice, touch screen, written text - captioning-, physical buttons on a remote control, among others. Thus, Clara was adapted to interact with the patients in an inclusive way, regardless of the patients' characteristics, abilities/disabilities, needs and preferences, hence facilitating the interaction.

Moreover, as another inherent contribution to the evaluation framework, the CLARC consortium has added the A+USUS framework. It complements the existing USUS framework, which is the complete framework for HRI evaluation, examining Usability, Social Acceptance, User Experience, Societal Impact. Accessibility was therefore added as the 5th criterion. The AUSUS framework, designed as part of CLARC research, was used as the evaluation criteria of the pilots.

Concluding remarks and Future work

The iterative updates of the way the robot looks / the outer design of the robot, how it approaches the patient, the interfaces and channels employed to capture the responses of the elderly, have allowed to develop a solution which makes the elderly feel comfortable when interfacing with it. It is clear the analysis needs to be based on a larger number of questionnaires to verify the assumptions. Pilots will be continued in Seville and will be complemented by pilots in Champagne region in France, using a comparative approach. However, if the new data collected during these field tests confirm the direction just outlined, then it can be assumed that the major challenge with regard to a viable solution will be solved If the robot is able to engage with the elderly, it will be able to autonomously capture the responses from the Geriatric tests. New tests could then be designed and added to the sessions. The current ones could be refined and improved. But already, the preliminary results pilots in Seville are very promising, both from a technical and user study perspective (cf. for more details about results, including KPIs, see Powerpoint presentations).

Besides, the CLARA robot and its software architecture have demonstrated their robustness during the pilots. For Phase III, the robot was redesigned. This redesign included the outer appearance but also the internal hardware, including the embedded processors. Updating the software remained without any technical problems during the pilot. Set-up problems occurred when the platform was deployed in a clinical environment, but they were mainly provoked by two factors. On the one hand, by not fulfilling the constraints required to the environment. On the other hand, a lack of training of the

Deliverable 5.7 – Small scale test series and user acceptance

deployment teams. Utility, for a complex tool such as the CLARC system, requires the users to acquire the necessary skills to fully use its capabilities. Once the users had acquired those skills, they could work with the framework without further irritations, and the evaluation could run correctly. Therefore, for future deployments, the users should get a training course before working with the platform. It is also important to clearly state the deployment constraints in the User's Manuals.

3.4 PDTI Healthcare: Development of Deliverables and Evaluation Criteria for Phase III

A lesson learned from earlier phases was to start the KPIs development progress as earlier as possible to provide a clear roadmap for the consortia to follow and goalposts to strive for. The KPIs supporting the monitoring process and the definition process of this set of KPIs is crucial and should be performed as transparently as possible. Thus, the KPIs have initially been proposed by the monitoring team after several conference calls on both consortia's status and have then been refined through discussion with the consortia during the midterm testing and the weeks after. Direct inclusion of the consortia within this definition process was intended to further promote transparency and underline inclusiveness and consideration for their input. After that, the KPIs were reviewed by the evaluators and public body to consolidate into a final version towards the end of the phase. The reviewers and public body suggested further specific KPIs concerning the end-users (patients as well as healthcare professional). This interaction proved beneficial as, beyond ensuring selected KPIs provided a fair reflection of the user's need, tests and guidelines (e.g. PUX guidelines (Personal User Experience guidelines) which are recommendations and lessons learned from the EIPonAHA European Innovation Partnership on Active and Healthy Ageing) Action Group C2). The public body could specifically contribute on aspects related to assessing quality of data gathered by the solution, which are fundamental to the ability of the system to be of use to the healthcare professional. These contributions were also discussed with the consortia at the visits of the public body during the test series. Just as in the last phases, it was allowed to detect and adjust the KPIs as appropriate (following verification with the consortia, experts and stakeholders). During the monitoring, adjustments on the financials (from 5 years to 4-5years) and the outreach (strategic partners instead of investors) have been made after feedback from the consortia.

	Category	#	tKPI	Explanation	Importance (1-5; 1 being least important and 5 most important)
Technical Aspects	**Production and deployment** *(setup, installation and reliability)*	1	Average time taken to set up the system [10 times] before the test		4
		2	Average time taken to calibrate the system [10 times] before the test	The set up and calibration time of the system should be fast and easy as to not take time from the HP	4
		3	# of calibration needed on 50 tests		3
		4	The time it takes to install the system	This is about the time between the reception of the system and the moment it is able to be used (if the system does not need any specific installation, the measurment can be 0)	2
		5	# of tests where the HP get involved out of 50 tests		5
		6	# of tests where the developer get involved out of 50 tests	The tests (Barthel, 'Get up Go') should be repeatable, reliable, and autonomous. Moreover, the performances should be the same or similar between the prototypes.	5
		7	Comparing the # of times the HP or the developer needs to get involved between the different prototypes		5
	Ease of use in daily routine *(e.g. portability, mobility, etc.)*	8	Weight, size, form factor	[Non self-driving systems] how portable is the system. This parameter defines practicality in terms of use	4
		9	Average speed	[self-driving systems] How mobile is the system. This parameter defines practicality in terms of use.	2
		10	# of features not available while charging		2
		11	System runtime until battery discharge	The system should be able to perform the tests on battery or while the battery is charging	3
		12	Estimated MTTF (Mean Time To Failure) based on component choices		4
		13	Estimated MTTR (Mean Time To Repair)	Component lifetime and ease of maintenance in terms of modularity	4
		14	Installation manual, user manual, trouble shooting & FAQ sheet	Documentation for end-users on system usage, trouble shooting, etc.	4
	Human-Machine Interaction	15	# of times a message/statement/query from the robot to a patient needs to be clarified by the HP, over all relevant tests performed	Patients ability to understand statements formulated by the robot through whichever modality is used, written text, visual diagrams, synthesized speech, or any relevant combination thereof.	5
		16	# of times patient test-responses captured by the system do not reflect what was expressed by the patient	Robot's ability to capture, understand or interpret test-relevant communication from patients.	5
		17	* Attitude towards technology generally * Trust of the specific technology. * Ease of interaction with the technology.	There is an ethical dimension to the patient acceptability that relates to the person's acceptance of the 'procedure' (perhaps their predisposition towards technologies more generally); their trust in the technology and the ease by which they can interact with it.	5
	Design *(aestetics, supply chain)*	18	Subjective measure from hospital staff	The design of the system needs to suite the situation: no sharp edges nor possibility of pinching, easy to clean (maybe waterproof), material should resist to standard cleaning chemicals, and so on. In addition to that, the looks of the system should suite the users (HP)	4
		19	# of trustworthy suppliers identified for needed components per number of item: is there a trustworthy supplier identified for all items?	In order to bring a product to the market, the manufacturer needs a list of trustworthy suppliers in order to get all needed parts at the right time	3
	Compliance *(TRL 8, standars for medical equipment)*	20	Initial estimation performed by E++ monitoring team, on the faith of monitoring information. Final evaluation performed by external experts on the occasion of the end-of-phase II on-site review and corresponding demonstrations	Using EC scale, expected TRL by the end of Phase III is 8	5
		21	Identified requirements		4
		22	Documentation e.g. system description, design details incl. electrical and safety, workflow, use environment, etc.	In order to bring the system to the market, the system needs to comply with a number of standard (depending on the region).	2
		23	Type test specification		3
		24	List of applicable standards identification		4
		25	Risk Analysis and mitigation plan		4
		26	Certification documentation		4
	Data analysis *(results, integration and data protection)*	27	Ease of viewing test data collected, locally on the system, and remotely	The way the system shows the collected information needs to be intuitif and help the HP take decision, without removing the possibility of looking into each piece of information separatly	5
		28	Compliance with standard hospital softwares	In order for hospitals to use the system, it should be able to easily interface with their already existing system.	4
		29	Data processing capacity		3
		30	Compliance with data collection hospital standards	The data should be protected from external leaks	4
		31	Reliability of punctuations gathered by robot (in terms of test/retest and concordance between punctuations gathered by robot and health professional)	This information is important in order to get health professionals acceptance of the product.	5

Figure 6 Technical KPIs

	Category	#	bKPI	Explanation	Importance (1-5; 1 being least important and 5 most important)
Business Aspects	**Business plan**	1	Viability of business plan	The business plan should seem viable to potential investors, i.e. how sound are the assumptions, does it seem realistic etc. based on an evaluation by a selection of sample investors	5
		2	Quality of business plan	The business plan should be perceived as high quality by potential investors in terms of writing, format and layout, based on an evaluation of the business plan by a selection of sample investors	5
		3	Feasibility of business	The business should be feasible based on a cash-flow analysis (i.e. breakeven within a certain period of time)	5
		4	Coherence with format	How well the business plan measures up to standard according to the *Business Plan Guidelines*	4
		5	Number of spelling / grammar mistakes	The quality of writing should be of high standard	4
	Business Plan Presentation	6	Number of presentation slides	The length of the presentation should be 10-20 slides	3
		7	Number of areas described	The level of complexity will be determined depending on the areas from the template described (e.g. product description, introduction to the problem, etc.)	4
		8	Number of spelling / grammar mistakes	The quality of writing should be of high standard	4
	Market intelligence	9	Number of contacted strategic partners	Number of strategic partners that have been contacted that are relevant for the project, a reasonable number is around 30 contacts	5
		10	Number of established customers	Number of strategic partners that are already engaged in an agreement; letter of recommendation from at least 1 partner that you have been in close dialogue with	5
		11	Number of contacted investors	Number of investors/strategic partners that have been contacted with particular reference to invest in the project; a reasonable number is around 20 contacts	5
		12	Funding applied for / received	Here, the amount of funding will be assessed, hence a higher score will be given if the funding has already been approved	3
		13	Number of calls applied for / accepted	Here, the considered calls will be assessed, hence a higher score will be given if the submission has already been approved	3
		14	Lead Flow	A count of the number of leads that your sales people are working on; a reasonable number is around 10-20 contacts	3
	Data room	15	Present documentation	Amount of documentation present in the data room, according to the *Data Room Guidelines*	4

Figure 7 Business KPIs

The KPIs for Phase III can be found in Appendix a and an overview of the KPIs in Figure 6 (technical) and Figure 7 (business). In order to help the consortia working towards the KPIs and structure the monitoring, monitoring deliverables were presented during the business and product development workshops at the midterm testing and followed afterwards in the monitoring process. For the business monitoring, the teams followed a workplan with sub-deliverables to structure the writing of the business plan and market intelligence report. All the documents are included in Appendix b.

3.5 PDTI Healthcare: On-Site Testing and Evaluation

The final evaluation of Phase III took place on 25th of January 2019 in Brussels. Besides the three external reviewers, around 5-8 members of each consortium as well as representatives of the public body and the ECHORD++ core team participated. Also, a representative of the SCALINGS project was present again. Both teams presented their progress during Phase III in forms of presentations focusing on the following topics:

- Business and commercialization
- User studies and acceptance
- Technology, product development and prototype demo

They also demonstrated their technology to the reviewers in trials, taking participants of the meeting as testimonials. During the preparation of the final evaluation meeting, it was decided that patients will not be involved in the final evaluation as they do not feel comfortable testing the prototypes with strangers in the room. A more realistic evaluation of the usability of the solution was obtained by a visit of the public body (healthcare professional César Galvez Barron) to the consortia during their small-scale test series. A summary of the experience of the user studies and an evaluation with the KPIs in mind was presented at the final evaluation meeting by the healthcare professional.

3.6 PDTI Healthcare: Panel Meeting and Outcome

The panel meeting took place on 26th of January with the same participants as those in the evaluation day (except for the consortia). The results and progress achieved by both teams towards the outlined KPIs was discussed:

CLARC has shown significant progress towards integrating user needs into their design process. There was, for instance, careful attention to the interface between the older person and the system - recognising fears and uncertainties that may have militated against effective 'engagement' with the robot. The attention given to adjusting the design and appearance of the robot was therefore important. Also, the data representation and management was 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), even though the sample as not fully representative. This has helped to better integrate the user perspective in the development.

Deliverable 5.7 – Small scale test series and user acceptance

Overall, though, the system displayed significant shortcomings. The system was frequently not able to understand the response of the person to the questions. For the Stand Up and Go Test, the machine was not able to recognize the person and thus to initiate the test. Due to important deficiencies in the technical implementation, the current offer is not ready for an exploitation path. This is mainly due to the robotic platform that fails to demonstrate the required level of reliability to be operational in an unstructured environment (as found in a hospital).

The presented business plan has been well developed and could be feasible if the technology worked. However, the business is based on assumptions that could not be demonstrated successfully. The business plan foresees the intake of venture capital. The preconditions to successfully pitch in front of venture capitalists, among others, are: 1) market and need; 2) solution and technology; 3) IP; and 4) Implementation. All 4 preconditions need to be more or less met. At the current stage 2), 3), and 4) are not sufficiently developed and/or they pose serious problems. As such, the product still requires a high amount of research, specifically when the envisioned autonomy of the robotic solution should be part of the offering.

A number of scientific results have been disseminated. This builds scientific impact. However, this does not necessarily represent innovation.

ASSESSTRONIC made significant progress. 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. This is the result of some previous technical recommendations of the reviewers having been taken into account carefully. business plan is solid with regards to market expectations, the market approach, and foreseen sales estimates.

The current business plan, however, neglects the fact that a CGA system is a medical product. Therefore, the costs for medical certification are underestimated. There is also a certain risk that the currently chosen alternative to the Kinect camera (no longer available) system still requires R&D - i.e. improvements in its stability to be able to reliably analyse gait patterns for patients. Currently also missing are results from a larger group trial that should be undertaken either sponsored by the commercialising company or through funding schemes, e.g. through innovation programmes like EIT-Health.

As ECHORD++ will not find further support for the two teams to continue their route to commercialization, the reviewers gave the following recommendations:

ASSESSTRONIC has presented a very interesting, scalable solution with an interesting cost-benefit ratio for the end users. The technology needs an additional two years' funding to be mature enough to make it to the prioritization list of Acetiam, a large company groups standing behind ASSESSTRONIC. Going for the next EIT Health call with the hospital and Tecnalia (via Thierry Keller) is an option to generate funds for the further development of the system. The business plan needs more care in terms of certification costs and sales numbers. But the market potential is huge, and the solution finds the approval of the medical staff.

The merit of **CLARC** mainly lies with the scientific knowledge so far. But components of the solution are worth further developing – for instance in additional EU-funded projects which have already been acquainted. The shortcoming lies in the robustness of the platform which needs to be replaced. 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.

4   PDTI Phase III Lessons Learned

Having performed also Phase III of PDTI, the core consortium of ECHORD++ is now able to fully assess the achievements and commercial potential of the different solutions. ECHORD's recommendations to the EC and the

stakeholders involved in developing robotics technology for and with the public sector in the future 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 (which was highly the case in sewer inspection, but less with regard to Comprehensive Geriatric Assessment, where the most viable solution is not purely robotics now).

- 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 development, but it is important to have all stakeholders with their interests on the screen.

- Some of the technologies developed in PDTI, are not mature enough to be commercialized yet in specific service. This became obvious by the use of drones for autonomous sewer inspection. Drones are working very well in open spaces, but not so well in confined spaces as sewer, due to different aspects as air turbulences and the balance between payload and batteries. Air turbulences did not allow to reach a high level of stability of the drone, which creates problems in image processing, while the payload / battery balance put limitations on the allowed number of sensors and thus impaired the autonomy of the drone.

- 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. So, 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 a lot of tests, while ARSI never achieved to set up such an environment. This resulted in hardware solutions, which lacked robustness and reliability until the end.

- The coaching by the tandems business-technical from the core teams was tremendously important to achieve the results outlined in this deliverable. 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.

- 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.

a. **Evaluation Report PDTI Urban**

PDTI Sewer. Final Evaluation PHASE III

Acronym: ARSI

1 Technological Excellence

The strength of the ARSI solution lies in the data handling. The matching process in real time and post processing is excellent. Classification using multiple methods (heat maps, interpretation by masking surfaces from real pictures) is well developed. However, it needs further integration. The UI of comparing real and simulated image is very effective and well represented. The classification of the objects and singularities works very well and is automatic.

The procedure of deployment of the UAV is workable, but the consortium should think about a non-man entry solution, as man entry becomes more and more restricted due to tighter security regulations. The UAV platform itself is still an early prototype, which was completely redesigned from previous solution. The protection against impact was improved, but it is still fragile. The reviewers doubt whether the chosen approach to develop a new platform is appropriate given commercial availability of COTS solutions. In addition, a fully commercial solution may require a range of platforms depending on sewer dimensions, with modular payload to accommodate different situations. The flight stability problems that have dogged the consortium throughout the project have not been satisfactorily resolved and needs to be investigated further. The thrust of the new propellors is very powerful, but results in more turbulence and thus more problems than they had before. In terms of assembly the platform looked like a laboratorium prototype not mature to be used in the sewer environment. There are also deployment safety issues, notably the safety button design which is confusing and not safe. On the positive side the battery life has been extended compared to the previous prototype.

Due to repeated failure of the UAV platform the team was unable to demonstrate a full inspection during the review.

2. Quality and efficiency of the implementation and the management.

The project showed a lack of awareness of appropriate priorities, resulting in a missed opportunity to deliver a complete solution. The project has struggled throughout with the drone platform and the goals of the new platform have not been achieved. A different strategy to solve the stable flight solution with a modular platform would most likely have led to a better outcome. This raises the question whether the right leadership/decision making procedures have been in place to help guide the project in the right direction. As an example: In spite of doubts in the team about the prototype performance, no second prototype was available as back up during the demonstrations.

On the positive side, some upgrades have been implemented tested since the last review, because the available technology has improved meanwhile. The size and technical competences of the team gives confidence that a commercially viable complete solution for a UAV mounted inspection is still achievable.

In Conclusion: The team would very likely have achieved a better overall result if they would have separated the data acquisition and sensoring from the UAV platform solution and pursue a different strategy for the platform. Risk mitigation

was ignored. Alternative solutions in terms of platform should have been investigated and pursued given the fundamental nature of the problem with the flight stability. A modular approach would most probably have led to quicker and more versatile solutions. The team got stuck but didn't change their strategy until it was too late. The good news is that they have only one problem (a stable UAV platform) and the reviewers believe that with some help it may be resolved within reasonable time to make the otherwise good solution viable for commercialization.

1. **Potential Impact through the development, dissemination and use of Project results**

If the flight stability and reliability problem can be resolved the impact can be high and a commercially viable product. The inspection method with a flying platform is quick and versatile and the data handling and interpretation already implemented provides an excellent starting point for a commercial solution. The teams is encouraged to pursue this solution. No information on dissemination was received and it is unclear to the reviewers if a go-to-market strategy is in place.

The data capture and analysis solution has potential to be commercialized even outside the robotic context or with different types of robotic platforms. The presence of FCC as consortium partner should have been leveraged more.

PDTI Sewer. Final Evaluation PHASE I

Acronym: SIAR

1 Technological Excellence

The SIAR team has made commendable progress since the last review at the end of phase 2. It is clear from the improvements implemented that they have taken many of the comments of the previous review on board. They have succeeded to develop a prototype which shows a lot of potential for commercialization and is already quite close to a market ready solution. Among the important issues resolved are the addition of a small arm mounted on small robotic arm to have better spatial awareness when executing complex manoeuvres and in support of inspection in real time. The arm is simple and light, but needs some further industrialization. Also, its protection during launch and retrieval of the robot is a point of attention, as the protective bars on top of the robot do not provide adequate coverage of the arm. Otherwise the launch and retrieval of the robot works well. It is recommended that the launch/retrieval method is further enhanced, so that no man entry in the sewer is needed at all under normal operating conditions.

The Wifi repeater system deployment is very practical and works well, without the need for man entry. A further improvement could be to lower it in the centre of the manhole for optimum line of sight, eg by using an extension rod on the winch.

Gas sensors have been implemented and the symmetry of the robot allow to move and inspect in both directions without problems. Obstacle negotiation was not demonstrated during the review trial, but the inspection run went smooth.

Image processing in real time works well and seems to be correct. Establishing appropriate filters and/or thresholds is a point of further attention as a barrage of indications is automatically generated, surely too many for the damage encountered. Postprocessing has not been demonstrated. It seems they need to further improve postprocessing and reporting workflow in close collaboration with BCASA for end user needs to reach a fully practical field ready solution, but there is every reason to assume that with some effort this can be achieved.

Deliverable 5.7 – Small scale test series and user acceptance

2. Quality and efficiency of the implementation and the management.

The project seems very well managed. The team has the right competences and works well together. It is evident that a tremendous amount of progress has been made as a result. The product has significantly improved with vision of the market (e.g. IP65 now, easily upgradeable to IP67). Also some upgrades have been implemented, because the available technology has improved meanwhile, showing that the team has an open eye to the technological developments in the market.

3. Potential Impact through the development, dissemination and use of Project results

The SIAR team has developed a solution with a high potential for very significant impact in the market. The updated design is a good step towards this market, eg. due to improved robustness, materials and improved specs (Sensors, image quality, repeaters). The close collaboration with BCASA to understand end user needs is clearly paying off. The team has been active in promoting the product e.g at Automatica and Smart City fair. However, the current go-to-market strategy is not clear and needs further attention.

b. Panel report PDTI Urban

ECHORD++ PDTI Urban Robotics, Sewer Inspection, on-site review after Phase III

PANEL REPORT

Version January 6, 2019

1. Introduction and methodology

This report covers *the on-site milestone-review for PDTI, Public end-user Driven Technological*

Innovation, Urban Robotics, Robots for the Inspection and Clearance of the Sewer Network in Cities, after Phase III (Small-scale test series and user-acceptance studies). Two teams – **ARSI** and **SIAR** – had passed Phase II of PDTI Urban Robotics (Phase II: Feasibility studies and prototypes) and were thus entitled to continue their technology development till the end PDTI.

Both teams – **ARSI** and **SIAR** – demonstrated their technology in an on-site test in the sewer of Barcelona. The methodology of testing and the evaluation criteria are set out in the following document:

PDTI SEWER PHASE III. Evaluation criteria and monitoring,

The on-site testing was structured according to the following agenda:

PDTI, Sewer Phase III - final tests 13th dec

The performance by both teams – **ARSI** and **SIAR** – was reviewed by two independent experts (reviewers) in the area of maintenance and inspection in robotics:

Tjibbe Bouma: Chairman at SPRINT Robotics, which aims at achieving field use of robotics for inspection and maintenance of capital intensive infrastructure assets on a very large scale within the next 10 years (https://inspection-robotics.com/sprint-robotics-collaborative/), now also involved in the DIH network on Maintenance and Inspection (RIMA) **Ivan Olivella:** Programme Manager at GUTMAR. He is an engineer specialized in aeronautic and civil robotics with a very strong background in project engineering development and production.

Subsequent to the on-site testing, the two independent experts exchanged their perception of the performance of the two teams in a physical panel meeting. The objective of this panel meeting was:

- to discuss the perceived performance of the two teams based on the pre-defined assessment criteria,
- to reach a consensus on the performance
- to generate evaluation reports for both teams
- and to analyse the gap to commercialization for both teams.

The evaluation reports should give concrete recommendations to both teams on how to proceed with their route to commercialization beyond the funded runtime of ECHORD++.

The panel meeting was attended by:

- Ivan Olivella – Reviewer
- Tjibbe Bouma – Reviewer
- Marie Luise Neitz (Project Manager, TUM, ECHORD++)
- Maria José Chesa (public body, BCASA)
- Lina Martínez (public body, BCASA)
- Ana Puig-Pey (leading PDTI sewer inspection in ECHORD++, UPC)
- Herminio Martinez (UPC)
- Carlos Cuevas García (TUM, independent internal observer, SCALINGS project)

This on-site review revealed very interesting technology in both prototypes with complementary strengths The reviewers saw two competing concepts which both have their place. **SIAR** presented a much more advanced prototype (TRL 6-7) which shows weaknesses, though, in the area of communication technology, data collection and data imaging. The strong point of the **ARSI** technology lies exactly in these areas, but is very poor in terms of hardware (TRL 6 at best). **ARSI** is convincing in terms of data imaging (it takes only half an hour from the moment of data collection to developing the report), but the **ARSI** team has never managed (even after four years) to present a stable prototype. And even if PDTI was not about providing a final solution, it is problematic that **ARSI** has not been able to provide a stable platform after 4 years. It is perceived by the reviewers that this is due to a lack of guidance (poor project management), not due to a lack of effort. **ARSI** has managed to improve the hardware since the on-site review after Phase II (SIMTEC, the original provider of the drone within the ARSI consortium was no longer part of the effort in Phase III), but not enough (the switch to an external drone provider came too late in the project and was triggered by the wrong reasons, i.e. to make the drone more flexible, not to provide the right harsware solution). Due to this lack of project management, **ARSI** has missed an opportunity to extend their business portfolio: Four years ago, there was no off-the-shelf solution to address this application area with a drone, but now there are several solutions on the market. Good project management would have spotted them and adjusted the project plan accordingly.

One possible reason for the poor performance of **ARSI** might be that they have gone too late to test the platform down in the sewer (again a sign of lacking project management). To achieve stability, the **ARSI** team should have constructed a mock tunnel. The **ARSI** platform has a problem with the turbulence, therefore it was stopping and going backwards.

SIAR does have a muck up at the Universidad Pablo de Olavide. It has no roof, but in their case they don't need it. To the **SIAR** team it was interesting and valuable to have different prototypes, but, in contrast, to **ARSI** it was a huge problem, because this prevented them to spend most of their time on the prototypes rather than on developing the software which is the basis of their (service) solution. Taking an off-the-shelf drone, the solution can be close, but only if **ARSI** goes for a different management (agile project management rather than waterfall method) which is triggered by milestones.

The reviewers point out, though, that 30 months of development time are too short to bridge the many TRL step increases necessary to provide a commerciable product. This is a very important lessons learned for future PDTI-like projects and should also have an impact on PCP (which works with exactly the same development time frame).

The competence of the **ARSI** team is in software development, while **SIAR** is much stronger in hardware development. The strong software focus of the **ARSI** team might be due to the fact that **ARSI** wants to develop a service (to be integrated in the service portfolio of the serive provider FCC they have on board for commercialization), while **SIAR** wants to commercialize a product (not just a service). It seems that FCC (with a huge budget in Phase III) was not supporting the ARSI team in the right direction. Merging the software solution developed by **ARSI** with the hardware platform provided by **SIAR** can make a very valuable product.

Both platforms did no more than 200m during the on-site review, but before they did some 400m.

The evaluation of both teams has been summarized in the individual evaluation reports herewith attached as annex I.

3. Recommendations by the reviewers

Imagining that ECHORD++ could not find further support for the two teams to continue their route to commercialization, the reviewers give the following recommendations:

- **ARSI** would need an investor to bring the technology on the market. In addition to this, the ARSI team would need a performant and focused, agile project management, leadership and someone with a market-focus to guide the next steps of the project. Once **ARSI** has a stable drone (off-the shelf solution, stable flight and response to turbulences are key features), they should have at least three different drones in their portfolio to cover different solutions in the sewer as well as to extend their business case to other inspection and maintenance tasks. **ARSI** needs to scan the market of drones to do an educated selection. There are examples from inspection in the petrochemical industry in which drones are much more advanced. **ARSI** has at least another two years to go. And a budget of between 500.000 – 1.000.000 € (by external investors, business angles, seed money etc.). More important even than the capital is external guidance. The market is there – and **ARSI** is not too far off the market. The monitoring of the coming phases should be done by a pair of two advisors: a technical advisor and a market advisor. The role of FCC is not clear – their ambitions need to be analyzed more clearly. Maybe they have already spotted a solution for the drone and are now just interested in the software.

- In case of **SIAR** the envisaged route to commercialization is not clear after this review day since commercialization was not discussed enough during the on-site review. SIAR claims to have a lot of business contacts, but it is not clear to the reviewers what will happen after the funded runtime of ECHORD++

To sum up: Both solutions are very close to each other (and could complement each other in fact), and they are also close to the market. However, a cultural change is needed, because people and city councils are not familiar with robots in inspection service. The two projects need each other and depend on each other because that cultural change can come by exposing people to different technologies that could be used in inspection service.

The situation is positive for both teams because a program on Digital Innovation Hubs for inspection is coming out. Also the call ICT-09-2019 is for projects on inspection and maintenance. The team could go for any of these calls. In that sense, on the EU side there's ways to keep support coming, but both teams (**ARSI** and **SIAR**) also need somebody to push from the market side.

4. Next steps – finding the way to the market

It is agreed that an additional day of in-person feedback This additional review day should comprise separate meetings with both consortia to give them feedback and then to have a joint meeting with both consortia to explore communalities that could mutually reinforce them to get to the market using each others support.

The role of the reviewers in this additional meeting would be to give frank feedback to the two teams on their findings, the positives, the concerns and opportunities for commercialization. The reviewers should get a better understanding of the plans of the two consortia to commercialize and explore how their efforts could be optimized for success.

Exploring communalities, but also possible ways to find investors will be an objective of this additional in-person meeting with both teams. First approaches to investigate could be:

- FCC is willing to invest into the technology. FCC has also a large competitor which might join or take over.

- The EC calls mentioned above could be an option

- For BCASA investing would be difficult (there are elections next year, and "nobody will do anything until after"). The city council is very keen to go into applying robotics technology. They have actually launched other challenges and Paulo Alvito has got another two projects. BCASA could provide contracts for a very short time in order to keep people working closely to the project: the reviewers stress that there are always ways to do it.

- The teams become start-ups (in case of SIAR this has already been done). ARSI's business case is clear, but that in contrast their plan is not. The plan, he noted, is not rocket science, but somebody has to help them.

- BCASA can motive the interest of additional cities (via the water and sewer association) to invest and to turn PDTI into a joined effort Five cities should be enough to make it happen.

The current problem is that the ECHORD++ money runs out end of January. The evaluators, end user and ECHORD++ coordinators need to know what the plans of the two consortia are. So far it is not clear. Also it would be expensive to transfer the project to somebody else. In order to "estimate the appetite" of the teams, that the evaluation panel should come one day with the teams and see what their thoughts are. Both reviewers agree that it will be important to talk with both teams and with the decision makes, and that this should be done in short notice.

After the evaluators saw their agendas, it was established that the meeting will take place on the 14th of January.

5. Insights for 14th January 2019

- Not the entire teams are expected to be there but only the key managers.

- Representatives of the highest levels of the organizations should be there, including FCC. In case of FCC the call should come from BCASA. There was, however, a little bit of discussion regarding who is needed, decision makers only, or high up people who don't have a clue of what's going on.

- the purpose is to talk, not to have a presentation. The purpose is rather to listen about the team's plans, their intentions, and what they think went wrong.

- There are two stages: The first is to find out what the teams are interested, to find out their motivation, the second stage is the more future oriented objective of bringing other cities on board. When inviting cities, commitment is key: The cities involved should really be interested in the technology and willing to invest in it.

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Tjibbe Bouma advertised an event held in Amsterdam on the 7th of February in which public end-users will bring challenges that projects should target. This is an open invitation for BCASA.

c.   Commercialization meeting report PDTI Urban

ECHORD++ PDTI Urban Robotics Challenge, Sewer Inspection

Feedback meeting and planning session to prepare

the route for commercialisation after Phase III

MEETING REPORT

Federica Pepponi (TUM)

Marie-Luise Neitz (TUM)

Version   4

Delivery date   31.01.2019

1. Introduction and methodology

This report covers the in-person meeting to explore and discuss possible routes for commercialization for the technology developed within the challenge on Urban Robotics PDTI[4] on *Robots for the Inspection and Clearance of the Sewer Network in Cities* by the two teams – **ARSI** and **SIAR** – that completed all three phases[5] of the PDTI process and had passed Phase II of PDTI Urban Robotics (Phase II: Feasibility studies and prototypes) and were thus entitled to continue their technology development till the end of PDTI.

As outlined in the panel report on the on-site testing and review after Phase III, dated 06-01-19, the independent experts (hereinafter referred to as "reviewers") – **Tjibbe Bouma[6]** and **Ivan Olivella[7]** – agreed with all attendees of the panel meeting (Barcelona, December 13th 2018) on having an additional meeting to provide in-person feedback to both teams – **ARSI** and **SIAR** – as well as discuss possible new sources of funding to support further development of their technology.

The objective of this additional meeting was to:

- Provide personalized feedback after the on-site review of Phase III and discuss how to overcome the current shortcomings;

- Explore each team's current motivations and future plans and current sources of funding;

- Collectively discuss possible directions and strategic opportunities to further develop their technology;

- Collectively examine possible strategies to secure the commitment of relevant stakeholders (public bodies or current service providers) and obtain new sources of funding to support the development of the technology.

Concrete recommendations were provided to both teams during the in-person and round-table sessions.

This exceptional in-person feedback session was attended by:

- Ivan Olivella (External reviewer);

- Tjibbe Bouma (External reviewer);

- Marie-Luise Neitz (Project Manager, TUM, ECHORD++);

- Federica Pepponi (Assistance Project Manager, TUM, ECHORD++);

- Lina Martínez (Environmental services and External Relations, BCASA);

- Alberto Sanfeliu (leading the Urban Robotics challenge for PDTI, UPC, ECHORD++);

- Ana Puig-Pey (leading the Urban Robotics challenge for PDTI, UPC, ECHORD++);

- Carlos Cuevas García (Independent internal observer, TUM, SCALINGS project);

- Daniel Fernandez Serrano (Head of Autonomous Systems, Eurecat, ARSI);

- François Chataigner (Senior Researcher, Eurecat, ARSI);

- Fernando Marzo Gonzalez (Head of Sewer Services, FCC, ARSI);

- Ivan Ibanez Garres (Inspection supervisor, FCC, ARSI);

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4 Public end-user Driven Technological Innovation.

5 PhaseIII: Small-scale test series and user-acceptance studies; Phase II: Feasibility studies and prototypes; Phase I: Solution design.

6 Chairman at SPRINT Robotics, which aims at achieving field use of robotics for inspection and maintenance of capital intensive infrastructure assets on a very large scale within the next 10 years, and also involved in the DIH network on Maintenance and Inspection RIMA.

7 Programme Manager at GUTMAR, he is an engineer specialized in aeronautic and civil robotics with a very strong background in project engineering development and production.

- Paulo Alvito (CEO/CTO, IDMind, SIAR);
- Fernando Caballero (Associate Professor, University of Seville, SIAR).

The evaluators believe that the solution developed by ARSI has a very high commercialization potential but efforts in that sense need to be optimized. For this reason, the evaluators want to understand and discuss how the consortium evaluates its own results.

A plan to solve some pending technical issues needs to be put in place, in particular regarding the second design of the platform with regard to the control system, the engines, and the physical dynamics of the drone. Some off-the-shelf options have been explored, but the consortium couldn't find a solution that fits the requirements of the challenge, especially in terms of payload, size, and autonomy. For this reason, they decided to work with a professional drone manufacturer that could build a system that fits the requirements, but they didn't plan a collaborative phase with the manufacturer specifically dedicated on the system integration. As a result, the current platform works well in the lab, but has stability issues when tested in the sewer.

In order to prepare commercialization, the reviewers encourage the consortium to look for an off-the-shelf drone supplier who could provide a better design solution for the platform and to set up a realist mock-up of the sewer environment within the lab where the platform is tested, which should be used to test different solutions from multiple suppliers in order to select the one that works better in that environment. Once the most suitable platform has been selected, an iterative development process with manufacturer needs to be put in place in order to get support when the system is further developed. When revising the platform, the consortium should start working on optimizing the sensor package only when the platform works without major issues in the testing environment.

FCC – the partner currently providing the inspection service in the sewer of Barcelona – supported ARSI in logistics and data processing, but was not involved in the drone design phase. FCC is extremely interested in the technology because of its potential to completely change the approach to sewer maintenance and inspection. Currently, a corrective process is in place and resources are mostly spent on cleaning the entire system, even the parts that might not need it, and intervene where some damage is found. The availability on the market of ARSI's software solution would enable service providers to shift most of their resources to inspection tasks for the early detection of problematic areas allowing intervention before actual damage happens, thus spending less funds on major repairs. FCC employs 200 operators in Barcelona's sewer network daily, with 20 of them working on inspection tasks. The ARSI system would allow FCC to reduce this effort to 10 staff members, who wouldn't need to enter the sewer. However, at the current stage they cannot support the further development of the system with their own funds.

To maximize the commercialization potential of ARSI's solution, the reviewers advise the consortium to build a business case that goes beyond selling a "small" number of drones only to FCC. FCC is helping with this by disseminating this new approach to sewer inspection in different locations worldwide and by including this service in the offers they make for new tenders. FCC is very satisfied with the current level of image processing. In general, they are in agreement with BCASA – the public body who proposed the challenge – that an aerial solution is very suited for the sewer environment, despite the challenges imposed by the hardware, for it can adapt to different sewer architectures (diameters, shapes etc.). Moreover, in order to operate, a drone would not require the sewer to be be cleaned in order to adequately perform. However, different sewer architectures would require different drone

solutions. In order to be really able to reach the market, ARSI needs to investigate and develop different solutions and then combine those with the software that has already a very high quality level.

ARSI is considered a flagship project for Eurecat. Therefore, they are still committed in further engage in the development of the drone also through other third-party funded projects. However, bringing ARSI to the market would entail investments to increase their manpower. Because of regulation within their organization, Eurecat cannot commercialize the product directly but they are exploring different solutions, from licensing to selling the solution to a company. Their preferred option would be licensing to FCC, who could then sell an additional service to their customers. They have also received many contact requests from potential competitors, thus confirming the market potential for this technology.

The reviewers suggest building an international business case, which would increase sustainability on the long term, and introducing, in parallel, the commercialization of a wearable solution of the sensor package 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. A spinoff company of Eurecat, launched with the support of national funds or professional investors, could easily transfer this solution to FCC. This would also allow the consortium to access the interesting instruments that DIH[8], like the RIMA[9] network, will make available to SMEs.

5   3. In-person feedback to SIAR

IDMind considers the approach proposed by the PDTI instrument quite interesting, for it enabled the consortium to distribute the development effort into different phases allowing them to concentrate on the main issues within each phase. The ECHORD++ project gave them access to several events allowing them not only to expand their network, but also to collect several new contacts relevant for the commercialization of SIAR. In order to be ready for commercialization, the system needs additional testing to (i) improve the technical features of the platform (e.g. in terms of autonomous navigation), (ii) package the software modules and improve its usability, and finally (iii) obtain the CE mark. The platform is suitable also for the inspection of other environments, such as underground galleries, which most of the time require an easier setting than the sewer network. The target price of the platform is 50k Euro. The target unitary cost given by BCASA in the challenge requirements was 0,50 Euro/m on inspection tasks. The SIAR system could reach 0,20 Euro/m.

Their future plans include building a B2B model and continuing the long-standing collaboration with the University of Seville, with which they already have an IP agreement to continue the development of the software. Different setups are currently discussed to guarantee the continuous update of the software and the transfer of the technology between the University of Seville and IDMind.

IDMind is willing to commercialize the product but is currently looking for a company that can provide maintenance and inspection services. Currently IDMind doesn't have the setup to face commercialization, but the company is planning an internal reorganization to employ resources that will be devoted to commercial tasks. What they currently lack and are looking for is the additional funding to support two additional small pilot projects, which can inform the next steps of the platform development and advance the commercialization of their solution. Their approach so far has been to avoid narrowing down the fields of application of the platform too much, even though they are aware

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[8] Digital Innovation Hubs, ecosystems that consist of SMEs, large industries, startups, researchers, accelerators, and investors. They aim to create the best conditions for long-term business success for all involved.

[9] RIMA aims to establish a network of 13 DIHs on robotics to facilitate uptake of inspection and maintenance technologies.

Deliverable 5.7 – Small scale test series and user acceptance

that this has an impact on the effort they can devote to looking for financial support or potential end-users.

The reviewers advise the consortium to start a more in-depth market analysis to understand the current demand of the market, also in terms of system characteristics, before proceeding with further RTD activities. They need to understand what is missing from the current solution for it to be a higly acceptable product for a specific segment of the potential customer base. In order to facilitate the entrance of this technology in the inspection market, the Barcelona City council, through BCASA, could include additional constraints to their tenders, such as limiting the number of operators allowed for certain tasks this favouring the application of autonomous solutions. This can be problematic for the City Council, in any case and has to be very well explained to citizens, as such decisions imply a translation of the work force from sewer inspection to other tasks but on the other hand safety concerns for operators in the sewer are increasing and thus also need to be taken into account.

The acceptance of robotic technology for maintenance and inspection is changing dramatically. A new market with very interesting opportunities is opening up, and the consortium should make the right choices to benefit from this situation.

Finding a professional investor seems to be quite difficult because of the high degree of specification of the solution. Furthermore, a critical mass of potential clients needs to be reached for investors to pay attention. In the meantime, applying to calls issued by the RIMA network can be a good opportunity. The consortium is also working with the [Lisbon Robotics Cluster](), which includes the Lisbon City Council and promotes the local application of robotics technology. In Lisbon the inspection of the sewer is directly made by the city, without external providers, but the sewer network is quite different from the one in Barcelona and only 20-30% of it is accessible.

It is proven to be very difficult to find information about other sewer networks as most of the plans are still on paper only, and cities are not really aware of the specifications of their tunnels. BCASA is trying to collect this kind of information through the participation in a project about the quality of water. BCASA will also participate to an important meeting with other companies and cities managing sewer systems in Europe, this could represent a good opportunity for both teams to present their solutions, showcase their prototypes, and find additional support. BCASA is willing to support the consortia by establishing a first contact with other City councils potentially interested in the platforms through the association [Aqua Publica Europea]()[10].

There are also multiple valuable modules of the software developed by SIAR that could easily be integrated with other systems. IDMind is trying to commercialize the communication system developed and they are already receiving request for quotations. Most providers use 360-degree cameras that don't have image processing. Hence, there will already be a market for the image processing software. This solution would also limit potential issues of acceptance, because it won't have an impact on the current number of operators employed but it would pave the way for the introduction of incremental solutions.

The reviewers also suggest collecting information on what kind of manoeuvres inspectors are currently able to perform and which new ones they could do by using the SIAR system. They encourage IDMind to find a partner that understands the sewer inspection market and is ready to make offensive moves on the market by introducing an alternative solution that could substitute the current standard.

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[10] Aqua Publica Europea (APE) is the European Association of Public Water Operators. It unites publicly owned water and sanitation services and other stakeholders working to promote public water management at both European and international level. APE is an operator-led association that looks for efficient solutions that serve public interests rather than corporate ones.

IDMind already has a business plan to exploit the current solution and is motivated to validate it by getting in touch with different stakeholders, as advised by TUM. Additional support can come from small contracts (for Barcelona the limit is 15k Euro) for the supply of limited services that can leverage the interest of larger investors, also allowing IDMind to provide services to city councils without having to participate in tender processes. BCASA could further stimulate the dissemination among current providers of inspection services by including a series of trials for procurers to prepare upcoming tenders.

4. Plenary session and reviewers' feedback

The reviewers consider the PDTI instrument and the solutions developed for the Urban Robotics challenge to be quite relevant. A lot of interesting technology has been developed and/or integrated in the projects and that might have separate market potential, 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 counterbalance the immaturity of the platforms and 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 they are developing and be ready to accept an improved product.

BCASA and FCC can play a very important role in facilitating the introduction of these solutions on the market. Both consortia are, therefore, advised to use the contacts with BCASA and FCC to get in touch with smaller municipalities that might be more open to offer further pilots for the products and services that are ready for market uptake. Contracts, even if for small services or technology packages that remain below the tendering threshold, may have big leverage if they can prove to investors that there is viability in the market. A quick way for FCC (and potential future partners of both SIAR and ARSI) to get return on investment is deploying the sensors and a data solution without the robot. Enabling them to provide 3D mapping to BCASA and other municipalities can immediately represent a very valuable service, thus generating the momentum to enable the introduction of robotics at a later stage. This will also contribute in showing investors that there is a potential market for these technical solutions.

Moreover, both consortia should start preparing the material to present the state of the art of marketable products (not the entire platforms) at the general assembly of public operators suggested by BCASA.

Further opportunities are:

- RIMA network:
  - Attend the user seminar in Amsterdam on February 5th, 2019 to create visibility for sewer inspection solutions, get insights on other opportunities in different sectors, and make sure that the sewer inspection becomes part of the call texts for the RIMA calls;
  - Submit proposals for the Technology Demonstrators and Technology Transfer experiments calls;
  - Get advice and contacts as a service from the RIMA digital innovation hub network;
  - Use the project to get in contact with other parts of Europe and also in other continents.
- WssTP that can provide access to a lot of European network operators for sewer inspection.

- French capital fund that will be active soon looking for possible investments in the market of robotics maintenance and inspection and that could be particularly interested in the ARSI and SIAR platforms.
- Get in touch with the American service provider for sewer networks (potential competitor for FCC) that has already expressed interest in the results of the Urban Robotics challenge.

ARSI and SIAR need to join forces and build synergies at the current stage, in order to fill the gap with the market and further improve their prototypes, which can provide enough benefits for both consortia. Some of the responsibility for the current gap lies with service providers and end-users not being interested in holding any IP, but who will need to look forward soon to become early adaptors of autonomous solutions, thus helping these solutions to reach the market. The knowledge produced by the two projects is quite complementary; a strength that should be used to increase the market size and introduce novel standard to current procedures, in terms of e.g. safety, operations, etc.

Both consortia are currently facing the same problem, the lack of a commercial partner to vehicle their platforms to the market. One area of synergy may be that of conducting market studies to understand which cities have accessible sewers and might need comparable technical solutions. By joining efforts, ARSI and SIAR consortia can achieve further targets in term of product versatility and in term of potential market share. The reviewers strongly advise the consortia to get connected to international markets sooner rather than later, as a larger market will be needed to make the commercialization viable and sustainable.

The ARSI and SIAR consortia are willing to find marketable solutions within their software packages, keeping the same paradigm, but also coming up with a kit that can eventually work with both the aerial and the terrestrial solutions.

All attendees consider this meeting as quite helpful and as an important step in the right direction. Both reviewers gladly give their availability to continue their interaction with the consortia as external facilitators. The ARSI consortium also expressed their appreciation for the cascade funding mechanism employed by ECHORD++ because it represents a very good alternative for small research groups and young researchers, who have increasing issues in accessing funding.

d. KPIs PDTI Healthcare

	Category	#	tKPI	Explanation	Importance (1-5; 1 being least important and 5 most important)
Technical Aspects	**Production and deployment** *(setup, installation and reliability)*	1	Average time taken to set up the system [10 times] before the test	The set up and calibration time of the system should be fast and easy as to not take time from the HP	4
		2	Average time taken to calibrate the system [10 times] before the test		4
		3	# of calibration needed on 50 tests		3
		4	The time it takes to install the system	This is about the time between the reception of the system and the moment it is able to be used (if the system does not need any specific installation, the measurment can be 0)	2
		5	# of tests where the HP get involved out of 50 tests	The tests (Barthel, 'Get up Go') should be repeatable, reliable, and autonomous. Moreover, the performances should be the same or similar between the prototypes.	5
		6	# of tests where the developer get involved out of 50 tests		5
		7	Comparing the # of times the HP or the developer needs to get involved between the different prototypes		5
	Ease of use in daily routine *(e.g. portability, mobility, etc.)*	8	Weight, size, form factor	[Non self-driving systems] how portable is the system. This parameter defines practicality in terms of use	4
		9	Average speed	[self-driving systems] How mobile is the system. This parameter defines practicality in terms of use.	2
		10	# of features not available while charging	The system should be able to perform the tests on battery or while the battery is charging	2
		11	System runtime until battery discharge		3
		12	Estimated MTTF (Mean Time To Failure) based on component choices	Component lifetime and ease of maintenance in terms of modularity	4
		13	Estimated MTTR (Mean Time To Repair)		4
		14	Installation manual, user manual, trouble shooting & FAQ sheet	Documentation for end-users on system usage, trouble shooting, etc.	4
	Human-Machine Interaction	15	# of times a message/statement/query from the robot to a patient needs to be clarified by the HP, over all relevant tests performed	Patients ability to understand statements formulated by the robot through whichever modality is used, written text, visual diagrams, synthesized speech, or any relevant combination thereof.	5
		16	# of times patient test-responses captured by the system do not reflect what was expressed by the patient	Robot's ability to capture, understand or interpret test-relevant communication from patients.	5
		17	* Attitude towards technology generally * Trust of the specific technology * Ease of interaction with the technology.	There is an ethical dimension to the patient acceptability that relates to the person's acceptance of the 'procedure' (perhaps relating to their predisposition towards technologies more generally); their trust in the technology and the ease by which they can interact with it.	5
	Design *(aestetics, supply chain)*	18	Subjective measure from hospital staff	The design of the system needs to suite the situation: no sharp edges nor possibility of pinching, easy to clean (maybe waterproof), material should resist to standard cleaning chemicals, and so on. In addition to that, the looks of the system should suite the users (HP)	4
		19	# of trustworthy suppliers identified for needed components per number of item: is there a trustworthy supplier identified for all items?	In order to bring a product to the market, the manufacturer needs a list of trusthworthy suppliers in order to get all needed parts at the right time	3
	Compliance *(TRL 8, standars for medical equipment)*	20	Initial estimation performed by E++ monitoring team, on the faith of monitoring information. Final evaluation performed by external experts on the occasion of the end-of-phase II on-site review and corresponding demonstrations	Using EC scale, expected TRL by the end of Phase III is 8	5
		21	Identified requirements	In order to bring the system to the market, the system needs to comply with a number of standard (depending on the region).	4
		22	Documentation e.g, system description, design details incl. electrical and safety, workflow, use environment, etc.		2
		23	Type test specification		3
		24	List of applicable standards identification		4
		25	Risk Analysis and mitigation plan		4
		26	Certification documentation		4
	Data analysis *(results, integration and data protection)*	27	Ease of viewing test data collected, locally on the system, and remotely	The way the system shows the collected information needs to be intuitif and help the HP take decision, without removing the possibility of looking into each piece of information separatly	5
		28	Compliance with standard hospital softwares	In order for hospitals to use the system, it should be able to easily interface with their already existing system.	4
		29	Data processing capacity		3
		30	Compliance with data collection hospital standards	The data should be protected from external leaks	4
		31	Reliability of punctuations gathered by robot (in terms of test/retest and concordance between punctuations gathered by robot and health professional)	This information is important in order to get health professionals acceptance of the product.	5

	Category	#	bKPI	Explanation	Importance (1-5; 1 being least important and 5 most important)
Business Aspects	**Business plan**	1	Viability of business plan	The business plan should seem viable to potential investors, i.e. how sound are the assumptions, does it seem realistic etc. based on an evaluation by a selection of sample investors	5
		2	Quality of business plan	The business plan should be percieved as high quality by potential investors in terms of writing, format and layout, based on an evaluation of the business plan by a selection of sample investors	5
		3	Feasibility of business	The business should be feasible based on a cash-flow analysis (i.e. breakeven within a certain period of time)	5
		4	Coherence with format	How well the business plan measures up to standard according to the *Business Plan Guidelines*	4
		5	Number of spelling / grammar mistakes	The quality of writing should be of high standard	4
	Business Plan Presentation	6	Number of presentation slides	The length of the presentation should be 10-20 slides	3
		7	Number of areas described	The level of complexity will be determined depending on the areas from the template described (e.g. product description, introduction to the problem, etc.)	4
		8	Number of spelling / grammar mistakes	The quality of writing should be of high standard	4
	Market intelligence	9	Number of contacted strategic partners	Number of strategic partners that have been contacted that are relevant for the project, a reasonable number is around 30 contacts	5
		10	Number of established customers	Number of strategic partners that are already engaged in an agreement; letter of recommendation from at least 1 partner that you have been in close dialogue with	5
		11	Number of contacted investors	Number of investors/strategic partners that have been contacted with particular reference to invest in the project; a reasonable number is around 20 contacts	5
		12	Funding applied for / received	Here, the amount of funding will be assessed, hence a higher score will be given if the funding has already been approved	3
		13	Number of calls applied for / accepted	Here, the considered calls will be assessed, hence a higher score will be given if the submission has already been approved	3
		14	Lead Flow	A count of the number of leads that your sales people are working on; a reasonable number is around 10-20 contacts	3
	Data room	15	Present documentation	Amount of documentation present in the data room, according to the *Data Roo*	4

Chapter	Criteria	Explanation	Content Measurement
Front Page	Front Page	Include a picture and a telling title for what the business plan is about	1 page with a title and picture that tells what the business plan is about
Key Figures and Achievements	Status	Status in bullet points on what has happened in the project and main achievements (how much funding has been received, what has been developed)	5-10 bullet points on the main achievements in regards to your product
	Product Status	Status in bullet points on where you are with the product (is it a prototype, a concept, etc.?)	1-2 bullet points on where you are with the product in terms of is it a concept, is it a prototype, is it a finished product?
	Investment Status	Status in bullet points on how much capital has been used so far on this product, and how much moeny you are seeking now, and thus, what is presented in the business plan	2-10 bullet points on how much capital you have used so far, and how much capital you need now (this number should be found in your budget). Inlude a cap-table showing the ownership percentages (how much does the investor get, how much do you get, and specify the "you")
	IPR Status	Status in bullet points on where you are with IPR (do you have any patents, trademarks, etc.?)	1-5 bullet points on what you have done in terms of IPR and what you intend to do
	Projected Business Plan Highlights	State in bullet format what the next steps are if you get the money you are seeking? This is a short bullet point timeline	5-10 bullet points on the main next steps you will go through when you get the capital
Introduction	The Problem	What is the problem today that you are addressing with your robot, how big is the problem (how many have this problem?). This should be like an appetizer for the reader that will make her/him want to read more about the actual solution you have for this problem.	1 page description of the problem the product addresses (incl. specific numbers on how many have this problem
The Product	Product description incl. break-down of main elements/components	A description of the product incl. illustrations of the product. The description of the product should include the what the purpose of the product is, who it is aimed for, what it can do, what features it has. If the product consists of significant components (for example a UV system and a navigation system that together forms a UV-Disinfection Robot), these components should have a sub-section in "The Product" section. This section should make an investor understand your product and what it does.	Min. 1 page (max. 2 pages) description of the product (incl. its purpose, who it is aimed for, what it can do.
			Min. 1 picture of the product
	Workflow description and illustration	A description of the workflow of your product, from the user's perspective i.e. what is the step-by-step process when the user uses your product.	Easy-to-understand illustration of the workflow with figures and icons (no simple boxes with text inside and arrows)
			0.5-1.5 page description of what happens in each step in the workflow
	Key Selling Points	In a bullet format list your 10 key selling points. This will be the last section under "The Product" so this will be kind of a conclusion or summary of what you have written in this section.	8-12 key selling points listed in a bullet format
Market Analysis	Size	Description of the market size. Should incl. a clear introduction to how you will come to the final number so the reader knows what to expect to read and the path to the final number.	1.5 - 3 pages description of the market potential incl. numbers
			1-2 tables (max. 2) in the main business plan (rest in appendix)
			State your market potential in number of units AND how much revenue that means
	Competition	A description of the main competitors. Should incl. a table with the main ones incl. your own solution, and a list of parameters to the left side in the table, and a rating of all the solutions incl. your own on these parameters.	A table that incl. a list of parameters to compare the competition on. The table must incl. min. 4 competing solutions, and a rating (either with numbers or using a low-medium-high rating) of these min. 4 solutions and your own solution based on the parameters you identify.
			1-2 page description of your competitors and why you have rated them the way you have in the table.
Business Case	Business Case	A description of your business case, i.e. what is the setting, what are the assumptions, who has the business case been made for (is it based on a specific case, or just an example?). The business case should look at what the customer gets from using your product. It should include the costs of having your product, the benefits of having your product, and the difference between these two, i.e. the payback time stated in months or years. The cost: It should include the costs of having your product The benefits: The business case should look at what the customer gets from using your product. It should include the benefits of having your product. Will they save time? If so, what is the value of this time. The payback: The payback time is the difference between the costs and benefits.	1-3 pages description of the business case, which should include a description of the setting (i.e. who the business case has been made for, are there any assumptions?)
			A number that states what it will cost your customer to implement the robot
			A number that states what the customer will gain in benefits by implementing the robot (benfits include (1) average hospital stay, (2) treatment cost, (3) patient satisfaction, (4) costs by payer, and (5) staff cost reduction.)
			A number of payback time measured in months or years, that states when the customer will have gotten their investment back
Go-To-Market	Go-To-Market	A description on how you will bring the robot to the market. Include a timeline, what will happen, when, and who will do it?	1-2 pages description of how you will bring the robot to the market.
Organization	Organization	Illustrate the organization behind, i.e. who has been part of bringing this product to life, and who is going to bring the product to market?	Illustration of your organization.
		Describe your organization based on the illustration	0.5-1.5 page description of your organization
	The Team behind	Describe the specific people who are going to work on the product (technical side and business side) when you get the investment on board. Please remember that investors invest in people!	0.5-1.5 pages description of the team behind incl. title, education and what they will do.
Financials	Cost Structure	Describe price and your profit	Price and margin of robot
	a 4-5-year budget	Create a budget and a short description of it.	Number of expected robots sold pr. year over next 4-5 years. (can be in a table)
			Expected revenue pr. year over next 4-5 years. (can be in a table)
			Expected costs pr. year over next 4-5 years. (can be in a table)
			Expected profit pr. year over next 4-5 years. (can be in a table)
			Expected cash-flow pr. year over next 4-5 years that states investment need (the capital required from investors). (can be in a table)
			2-3 page description of your budget incl. tables.
	Valuation	Describe the valuation of your business	0,5-1 page description of the valuation of your business. You should end up with a table that shows your valuation and how many % of the company the investor will get for his investment.
Intellectual Property Rights	Intellectual Property Rights	A description of any IPR you have in relation to your product. Have you done a freedom-to-operate analysis? If yes, what are your conclusions? How do you intend to protect your product?	0.5-2 page description of what has been obtained on IPR so far, and what plans you have for obtaining further IPR
Risk Overview	Risk Overview	A description of risks incl. your contingency plan. You should group your risks into at least two groups: product risks and market risks.	1-2 page description of 5-10 risks incl. contingency for each of them.

Business Plan Guidelines

	Criteria	Explanation	Content measurement
Data Room Guidelines	Presentations	The business plan presentation	10-20 slides present in .pdf format (y/n)
	Business plan	The business plan, incuding older versions and iterations, should be available in pdf format. The business plan should meet a generic format of a business plan, including sections such as problem, product, market, business case, organization, financials, intellectual property, risks	Present in .pdf format (y/n)
	Business case and data	A business case, including the data and references it is based on	Present (y/n)
	Market, competitiors and patents	Documentation regarding the market, competitors (products, technical sheets etc.) and relevant patents	Number of present documents
	Research and field studies	All research and field studies should be documented, e.g. interviews with users, relevant articles demonstrating user needs and workflows, pictures and videos etc.	Min. 3 user interviews
			Min. 10 pictures illustrating major issues, pains and gains of patients, nurses, relatives etc.
			Video material of the typical workflow of a geatric assement
	Budgets	A detailed five-year budget, including a calculation of monthly cashflow and when breakeven is expected	Present (y/n)
	Planning and milestones	An updated time shedule, including important milestones and how they will be reached	Present (y/n)

e. Midterm testing report PDTI Healthcare

Mid-term testing PDTI Healthcare

Blue Ocean Robotics
Hospital Abat
PDTI Consortia Assesstronic and Clarc

Table of Contents

6 Introduction

PDTI Phase III started on 1st of June 2018 and runs until 31st of January 2019. Phase II started with initial conference calls between the consortia, TUM and BOR to set the goals and tasks for Phase III and confirm the effort and budget. As the monitoring team partly exchanged members, conference calls between the consortia and the monitoring team started to identify the current status of development and commercialization effort. Based on the outcome of the calls and the final evaluation reports of Phase II, the monitoring team worked on the Key Performance Indicators for Phase III. In the first months of Phase III, the consortia continued their work based on the recommendations from the final evaluation of Phase II accompanied by conference calls to discuss the status and potential issues. The midterm testing gave the opportunity for the public body (hospital Sant Antoni Abat) and the monitoring team to get a live update on the development progress, give them feedback on their prototype, discuss the KPIs for the final evaluation and the next steps until the end of the phase (monitoring deliverables, due dates, etc.). In this regard, the midterm testing was also used to organize two workshops in order to go into detail on how to write a business plan and what matters when developing a product.

6.1 Location and date

The testing of PDTI Healthcare took place in Vilanova i la Geltru, Barcelona Spain, at Hospital Sant Antoni Abat, 17th to 19th of October 2018.

6.2 Participants

At the testing, representatives of the two teams, Blue Ocean Robotics, healthcare professionals and hospital staff participated, as well as the patients who tested the solutions. Moreover, two representatives of the European project SCALINGS observed the testing with the purpose of analyzing the process of monitoring in ECHORD++.

Table 4 Participants Midterm testing PDTI Healthcare

Organization / Project	Representatives
Blue Ocean Robotics	• Franziska Kirstein • Mamoun Gharbi • Ana-Maria Macovetchi • Mermia Cikotic
CLARC	• Fernando Fernández Rebollo • Cristina Suarez Mejias • Rebeca Marfil • Adrián Romero • Ana Iglesias • Andreas Bley (Skype)
ASSESSTRONIC	• Consuelo Granata (Skype) • Etienne Dupuy
Hospital Sant Antoni Abat	• César Galvez Barron
Healthcare professionals	• Frida Bockel - Psychologist • Alejandro Rodriguez - geriatric doctor • Social worker
European project SCALINGS	• Kyriaki Papageorgiou • Benjamin Lipp

6.3   Agenda

The agenda included general tests with patients for the consortia to collect initial end-user feedback (patient) while planning their small-scale tests, tests with healthcare professionals to also get their end-user feedback. Furthermore, the agenda included workshops on the business part and product development part of Phase III, both included a feedback session based on first monitoring submissions and on-site tests. The agenda can be found in Appendix A.

7   Patient testing Clarc

7.1   Testing procedure

For this testing session, CLARC has performed two tests: Barthel and Get-up-and-Go for each of the patients.

Barthel Test:

1. Intro:
    * The patient goes into the room, and sits on a chair in front of the robot
    * The patient is given a remote control with buttons
    * The robot introduces itself and offers a description of what will happen
2. Trial:
    * The robot performs a trial session with 3 questions to make the patient feel comfortable during the actual session.
3. The test:
    * The prepared test was formed by 10 questions about the daily activities of the patients
    * The patients were presented 2 options to answer questions: by speaking or by pressing the specific button on the remote control.
    * In case there was no answer / the robot did not understand an answer, it would repeat the question one more time.
4. Final:
    * The robot thanks the patient and informs the test was over

Get-up-and-Go Test:

1. Intro:
    * The robot introduces itself
    * The robot introduces the test and shows an explanatory video of the test
2. The test:
    * The robot invites the patient to follow to the test designated area, next to a chair
    * The robot tells instructions for how the patient should move
    * The robot waits for the patient to reach the chair again
3. Final:
    * The robot thanks the patient and informs the test was over

7.2 Patient profile

Initially, there were three elderly male patients, who have been asked to sign a consent agreement in order to be able to perform the testing. As one of the patients refused, the testing took place with two subjects, as following:

Subject 1

- 85 years old
- He walks by using a cane
- He suffers of dementia
- He can hear and see well

Subject 2

- 82 years old
- Suffering of a light form of Alzheimer
- He can walk without any help
- He has a small hearing problem

7.3 Testing outcome

Barthel Test:

1. Intro:
   - The introduction of the robot is too fast
   - Too much time between the intro and the actual test
2. The test
   - The robot did not hear the answer → the answer from the patient was delayed and the robot did not wait enough, thus it confused the patient
   - There is too much time between presenting the options of response and the time to give the response
   - The speech recognition does not work properly if the patient uses lower voice
   - The patient needed help with pressing the buttons → might be a good idea to have an intro session where the patient is shown how to press the buttons, to get used with the remote control
   - In general, the robot is going too fast, does not wait enough for the answers
3. Final:
   - The test did not reach the final questions
   - The patient was too intimidated by the people in the room

Get-up-and-Go Test:

1. Intro:
   - The patient listened to the robot and it raised when the robot said so
2. The test:
   - There are too complex instructions → the robot gave all instructions at once and the patients could only fulfill half of them and then was waiting to receive more instructions

- The patients needed assistance to be able to complete the test.
- There should be shorter commands so the patients can easily follow them.

3. Final:
   - The test went better than the Barthel, as there were vocal instructions and the patients seemed eager to listen to them
   - The patients shown interest in following what the robot was saying and doing.

7.4 Technical feedback

During the session, multiple topics concerning the technical feedback were discussed. The first part of the feedback concerned the deliverables: What are the documents needed, such as the Hardware architecture, CAD files, Electrical schematics, PCB layout, remote repositories, list of materials, HMI design, and user manuals.

The second part of the feedback concerned the robot on site. It is to be noted that the prototype presented in Barcelona was a soon to be changed version, so the feedback was more generic and did not focus on small details of that specific prototype.

The first topic concerned the remote, and how to enhance it for the usage. A draft of a possible design was also transmitted to the team. This draft includes a more human friendly design enabling the user to hold the remote easily but also to place it on a table or on his laps.
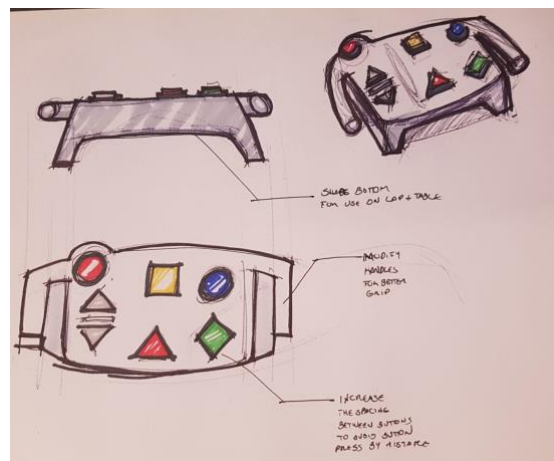
Table 5 User-friendly design suggestion for remote control

The second topic that was discussed with the team concern the Barthel test, more specifically the communication modalities. The timing was a bit of in certain cases, a bit too fast between questions, or between instructions. Also, the waiting time of the answer may be too fast, but it depends on the patient, which means that the duration should be adjustable by the healthcare professional easily.

The third topic of feedback was about going from a prototype to a product, which includes taking care of a number of things, such as:

- how to do updates on the robot once it is deployed,
- how to disinfect the robot,
- is there a complete supply chain for the robot,
- how to maintain and service the robot.

The final topic discussed with the team was how to start the certification process, by preparing the list of applicable standards, and then extract from it the list of compliance for the hardware and the software.

7.5 Conclusion by Clarc

After Phase II, the CLARC framework has been seriously redesigned according to the suggestions captured in focus group meetings and small-scale tests. The interfaces with the clinicians included now the suggestions from previous meetings. It seems to be a mature item. With respect to the robot, it is able to move in the care centre and engage with patients by itself. We put the emphazis on a robot that is able to drive the sessions in an automonous way, with additional functionalities such as being able to go to the charging station by itself or to detect that the patient is getting up from the chair and call the doctor.

In general, there were positive feedback from the people attending to the meeting. The remote control device was considered a good alternative to other interfaces (touchscreen or Tablet device) for dealing with the elderlies. The suggestion coming from BOR for changing its external appearance was welcome, and we will update it for the pilot at Sevill and Reims. In fact, the touchscreen was not proposed as an alternative in the tests at Vilanova, and the general opinion is that this eases the Barthel test to the patient. On the other hand, we have the impression that the doctors need a tool that they can customize according to their personal opinion. For instance, the clinicians from Vilanova think that the patient should answer a question on the Barthel test although all alternative responses were not presented. But our experts from Seville defend a different opinion: all responses must be presented and, then, the patient can choose one of them. Similar feelings can be reported with respect to other issues such as the speed on unfolding the test, the instructions to be given to the patients in the GetUp & Go test, etc. Our main conclusión is that our proposal should provide the tools for allowing the end-users to configure the way the system works.

8 Patient testing Assesstronic

8.1 Testing procedure

For this testing session, Assesstronic has performed two tests: Barthel and Get-up-and-Go, for each of the patients.

Barthel Test:

1. Intro:
   - The patient goes into the room, and sits on a chair in front a table, the tablet is on the table
   - The doctor introduced the patient to the tablet and the test
2. The test:
   - The prepared test was formed by 10 questions about the daily activities of the patients
   - The patients were presented 2 options to answer questions: by speaking or by pressing the specific button on the remote control.
   - In case there was no answer / the speech recognition did not understand an answer, it would repeat the question one more time.
3. Final:
   - The software on the tablet thanks the patient and informs the test was over

Get-up-and-Go Test:

1. <u>Intro:</u>
   - The doctor introduces the patient to the sensor box
   - The doctor introduces the patient to the test
2. <u>The test:</u>
   - The doctor tells instructions for how the patient should move
   - The doctor waits for the patient to reach the chair again
3. <u>Final:</u>
   - The doctor thanks the patient and informs the test was over

8.2 Patient profile

8.3 Technical feedback

The prototype presented in Barcelona was a soon to be changed, thus the feedback was in a more general level then focused in the details of that prototype. Different subject were discussed:

- **Moving from a prototype to a product**, which involves planning on how to execute a number tasks, such as updating the tablet and the camera box (and making sure both have compatible versions), servicing the machine and maintaining it, having a supply chain for both parts, and how to disinfect both, especially the tablet as it is manipulated by the patients.
- **Starting the certification process**, which includes finding the list of applicable standards, extracting the list of compliance, for both hardware and software.
- **Minute changes on the app**, such as button placement, speech speed, adding going back button, maybe including another tablet for the hospital professional to get notification and/or follow the test remotely.

8.4 Conclusion by Assesstronic

The system has been tested with 2 patients and both the Barthel and the Get Up and Go tests have been performed by them.

The first patient completed successfully the Barthel test and the Get Up and Go test with minor help. He seemed interested and quite confident in using the system. The second patient performed the tests with a lot of difficulties and needed major help to complete the Barthel test. He was cognitive deteriorated, so this result was quite expected. The second patient also performed the Get Up and Go test but using a walker. The system failed in collecting the measures of the body movements because of the occlusion of the legs by the walker during the first phases of the test.

The system has also been analysed by some health professionals and interesting feedback about potential improvements have been collected.

9 Test session with healthcare professionals

9.1 Alejandro Rodriguez, healthcare professional in the field of geriatric assessment

9.1.1 Clarc

I liked it a lot (I already knew it), it is especially remarkable the portal for doctors, which is intuitive to handle and also presents the information and results very well. It can also be consulted from any type of device.

The main problem is the speed of Barthel administration. Listening to all questions and not being able to answer until the robot finishes talking, makes it too long and there may even be falls of attention and false answers at the end. We have explained to the designers that most of the time these questionnaires are answered by a family member in practice. The robot should have a faster and easier way of interacting with the family member who responds (like responding tactilely on the screen, without the robot reading anything). In short:

- the predetermined option for patients must be the one by which the robot reads sentences, but patient should keep option for changing to respond tactilely and quickly; and
- the default option for family should be the quick response on screen without reading, but with an option to switch to reading mode by the robot if they prefer.

We have commented that the patient should have a pause button at his disposal, in case he wants the robot to stop for a moment while doing something else (look for a handkerchief, go to the bathroom ...), or if the robot simply goes too fast. Voice recognition is a problem, but they are considering removing it.

After the Up & Go it is not defined what action is done with the patient. We have suggested that the patient follows the robot back to the waiting room where you found it (and also the robot will be there for the next patient or test). Anyway, there is a problem with the specification that the robot can perform this test autonomously because human supervision is necessary for this type of tests to prevent falls (in addition the robot does not detect or warn if the patient falls).

9.1.2   Assesstronic

They have worked much more with the interface compared to months ago (last evaluation). They have a couple of failures that we have commented (e.g. it is blocked if a response option is not selected ...).

They show buttons to the patient that do not have a specific function or utility for them. We have suggested that neither the patient nor the family member can edit the identification data or the results of the tests. We have suggested that the doctor can edit previous test results, with a temporary limit to do it (for example 7 days ago).

The graphics are intuitive, but the search for a specific answer requires more work, because you have to navigate backwards in time, test by test. To improve this a bit, we have suggested that the presentation of the answers, in addition to being ordered by date, as it is now, can be ordered by type of test (in case you want to see only the Barthel ...).

Through this system, answering the questionnaires is much faster, although it requires that the patient and / or the family member be able to handle the tablet.

9.2   Frida Bockel, psychologist

9.2.1   Clarc

Displacement: it would be interesting if the displacement of the platform was self-adaptable according to the movement of the patient. I know it can be complicated, although a speed range of ¾ which could be adjusted.

Voice tone: I understand that a standard voice was incorporated (as it is the most economical), but perhaps adjusting some tonality would be a way to give a more rhythmic sense to the sentences and therefore help adding more meaning and clarity to the information.

The information gathered by the robot: the way of combining and arranging the words and expressions from the robot speech does not seem very appropriate. However, I did not observe the interaction with patients, so I believe that the

sentences were too long and included too much information within the same sentence. I would simplify them in short, simple and more precise sentences.

Patient - robot interaction: I do not know if the platform is expected to repeat the indication to the patient if he does not respond, I could not observe that situation in the test.

Physical aspect: the face of the robot is important; I mean eyes and mouth. The eyes seemed a little expressionless. Could you give some kind of expression? Perhaps warmer eyes, not imitating humans but having more expressiveness. You can look at images. Or perhaps by that closes and opens the eyelids? The same about the mouth.

Regarding the size, it seems appropriate, neither too high nor too wide. He is handsome.

9.3 Assesstronic

In general, I found it quite simple and "clean". Very suitable for professionals and perhaps also for families (most of them are used to mobile phones).

For the use by patients, I have more formal issues/recommendations: adjust the sizes of the letters, the bars with the indications and organize some icons so that they do not cause confusion at the time of answering the questions. I also think it is important to consider the possibility of some "reaction" of the tablet in the absence of a response from the patient.

Questions discussed:

- Does the robot repeat the question again?
- How much time is considered for an answer?
- If the patient rushes and responds (verbally) before the information ends, the tablet, if I correctly remember, was blocked?
- And finally, if the patient wants to stop the test, is there an option?

10 Business feedback

At the workshop in Barcelona, the plan and guidelines for the business aspect were presented. The agenda for the workshop included providing a typical business plan structure incl. an example of a business plan; going through the defined business KPIs, plan for the upcoming monitoring and deliverables. Furthermore, at the workshop the teams were introduced to how a business case typically looks like and were given the task of starting up a business case looking at the costs and benefits involved from the customer's point of view. Each team presented their findings, which were discussed and suggestions for how to move forward were given. Lastly, the teams were given brief feedback on their business plans as they were at the time, incl. suggestions on which areas to focus on and how to move forward. The presentation used at the workshop can be found in Appendix B. Also, the teams were presented a workplan to structure the monitoring of business plan writing and market intelligence work (Appendix C).

10.1 Clarc

The CLARC team was encouraged to improve their structure, and specific sections like the market analysis, existing solutions, business case etc. were talked about and improvements were suggested based on the provided guidelines. Much of the data that already existed in the business plan could be used moving forward with additions and revisions, as well as including more visuals to make it more appealing and interesting to read for potential investors. The team was

encouraged to focus on the product section to begin with to better explain what their offering is, as this was quite unclear to someone who had never heard of the project before.

10.2 Assesstronic

Due to time limitations, the Assesstronic team did not get an individual session in Barcelona, so it was agreed to do this over Skype the following week. At the Skype meeting the Assesstronic team was encouraged to put some heavy effort into the business plan as it was somewhat short and could follow a clearer structure and more detailed explanations. The team was encouraged to follow the suggested structure and guidelines, and include more visuals, as well as explain their product in a better and more thorough manner including workflows and illustrations. At the meeting here, it was also discovered that the product would be commercialized through Acetiam, and they will invest time and resources in bringing this product to the market. The team was asked to be specific on how that would happen in the go-to-market section, and include overall time estimates and action plan.

11 Key Performance Indicators (KPIs) and monitoring deliverables Phase III

A lesson learned from earlier phases was to start the KPIs development progress as earlier as possible to provide a clear roadmap for the consortia to follow and goalposts to strive for. The KPIs support the monitoring process and the definition process of this set of KPIs is crucial and should be performed as transparent as possible. Thus, the KPIs have initially been proposed by the monitoring team after several conference calls on both consortia's status and have then been refined through discussion with the consortia during the midterm testing and the weeks after. After that, review by the evaluators and public body will follow to consolidate into a final version towards the end of the phase. Just as in the last phases, it should be allowed to detect and adjust the KPIs as appropriate (following verification with the consortia, experts and stakeholders). The KPIs presented at the midterm testing can be found in Appendix D. In order to help the consortia to work towards the KPIs and structure the monitoring, monitoring deliverables (Appendix E) were presented during the business and product development workshops.

Appendix

Appendix A

Agenda

E++ PDTI Healthcare, Phase II midterm on-site monitoring, 17.-19.10. 2018

Participants

Hospital Sant Antoni ABAT: César Galvez Barron, Esther Valldosera Dorado, Antoni Yuste Marco

AQuAS: Jean Patrick Mathieu

Blue Ocean Robotics: Mamoun Gharbi, Merima Cikotic, Ana Maria Macovetchi, Franziska Kirstein

Clark: Cristina Suarez Mejias, Fernando Fernández Rebollo, Rebeca Marfil Robles, Adrián Romero, Ana Iglesias

Assesstronic: Etienne Dupuy, Consuelo Granata (Skype), Jean-Louis Baudet (Skype)

Schedule of the meeting

E++ PDTI Healthcare, Phase II mid-term on-site monitoring

Meeting Address: **Hospital Sant Antoni ABAT**

Carrer de Sant Josep,21-23

08800 Vilanova I la Geltrú, Barcelona

https://goo.gl/maps/QeTkyU6giW22

Mobil number for emergency cases: 0049.178.1965348

Wednesday, 17 October 2018

Please note: we would like to take video recordings of the testing and sound recordings of some of the sessions for reporting. In case you do not agree with being recorded, please let us know.

09:00 - 12:00	Patient Test Clark
Tuesday	Set-up Clark
09:00 - 09:15	Welcome & introduction of participants
09:15 - 09:45	Patient 1: • Barthel & get up and go test performance • Feedback by patient & monitoring team • Short monitoring discussions
09:45 - 10:15	Patient 2
10:15 - 10:45	Patient 3
11:00 - 11:45	Long monitoring discussion and on-site feedback
11:45 - 12:00	Wrap up of discussion: identify key follow-up points for monitoring
12:00 - 13:00	Lunch
13:00 - 15:30	Afternoon workshop: Technical focus
	Presentation: Examples of technical KPIs and deliveries
	Individual discussion points
	Monitoring deliverables and dates
	Additional requests: please let us know until lunch time

Thursday, 18 October 2018

09:00 - 12:00	Healthcare Professional Test Clark
09:00 - 09:30	Healthcare Professional 1, incl. discussion on results, feedback from monitoring team
09:30 - 10:00	Healthcare Professional 2, incl. discussion on results, feedback from monitoring team
10:00 - 10:30	Healthcare Professional 3, incl. discussion on results, feedback from monitoring team
10:30 - 12:00	Healthcare Professional Test Assesstronic
09:00 - 12:00	Set-up Assesstronic
10:30 - 10:45	Welcome & introduction of participants
10:45 – 11:15	Healthcare Professional 1
11:15 - 11:45	Healthcare Professional 2
11:45 - 12:15	Healthcare Professional 3
12:15 – 13:00	Lunch
13:00-16:30	Afternoon workshop: Business focus
	Presentation: Example of a good business plan
	Presentation & discussion of business KPIs
	Monitoring deliverables and dates (30min)
	Business case activity (1h)
	Individual business plan discussions (1h, 30min each)

Friday, 19 October 2018

09:00 - 12:00	Patient Test Assesstronic
09:00 - 09:30	Patient 1: • Barthel & get up and go test performance • Feedback by patient & monitoring team • Short monitoring discussions
09:30 - 10:00	Patient 2
10:00 - 10:30	Patient 3
10:30 - 11:15	Long monitoring discussion and on-site feedback
11:15 - 11:30	Wrap up of discussion: identify key follow-up points for monitoring
11:30 -	Possible individual technical discussion on site or via Skype if needed

Appendix B

We **Create** and **Commercialize** Robots

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Overview

1. Business Plan and Example
2. Business KPIs
3. Plan for Monitoring and Deliverables
4. Business Case Work
5. Individual Business Plan Discussions

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2

Business Plan
and
Example

Typical Investor Process

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
Business Plan & ICP + Other	Investor Reach-Out	Investor Meeting	Access to Data Room	Individual Investor Negotiations	Contracts in Place	Incorporation/ Operations

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
- Business Plan is written - Presentation is created - Other Material that adds value to the case is prepared.	- Investors are contacted and notified about the case a. Private investors (business angels) b. Strategic partners c. Other	- Investor meeting with the interested investors is held, where the investment case is presented and where they can ask questions about the case	- After the investor meeting, the investors who are still interested, get access to a Data Room with material to study: BZ, ICP, budgets, reports, pics, vids. etc	- Individual meetings in person and phone are held with interested investors, where more questions are discussed, investor share is negotiated, etc.	- Investor agreement, statues of company, (updating) shareholder's agreement, transfer of shares, confidentiality, (ownership agree.)	- The Spin-Out/In starts/continues its operations - Set-up of Board of Directors, and BOR is involved a lot in the beginning - CEO support

The Business Plan
The Structure

1. Legal Disclaimer
2. Summary
3. Key Figures & Achievements
4. Introduction
5. Product Description
6. Market Analysis
7. Business Case
8. Go-To-Market Plan
9. Organisation
10. Financials
11. Intellectual Property Rights
12. Risk Analysis

25 pages (roughly)

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5

The Investment Case Presentation
The Structure

1. Problem
2. Product
3. Market
4. Business Case
5. Organisation/The Team
6. Financials
7. Partnership & Contributions / Valuation

10-20 slides

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6

The Data Room
The Structure

1. Investment Case Pitch/ Business Plan Presentation
2. Business Plan
3. Business case incl. references
4. Market, competitors, patents incl. references
5. Research and field studies
6. Detailed Budgets
7. Plans and milestones (Gantt-chart)
8. Marketing Material
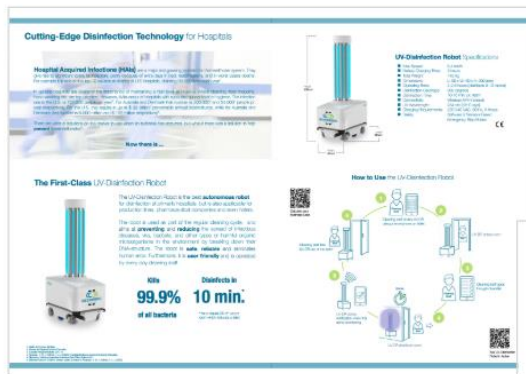9. (other relevant folders and material)

The Data Room
The Structure

Example of Business Plan

[Go to Business Plan](#)

The Ideal Case

1. **Product**
   a. The product is interesting; has been developed, and ready to be on the market
2. **Team**
   a. The **team has already been defined, or at minimum, the CEO/CTO has been found**, however, optimally, additional team members should have already been identified and found as well.
3. **Customers**
   a. Already closed sales, or at a minimum have a lead list of customers, or signed letters-of-intent or similar.
4. **Business Case**
   a. A clear business case that is realistic and based on facts
5. **Business Model**
   a. A clear business model explaining how the company makes money (hardware/software sales, RAAS, leasing etc.); how will the company bring the product to the market.
6. **Market**
   a. A clear need in the market justifying why anyone would be interested in the product, and a great market potential.
7. **IP**
   a. Already hold patent or other IP rights, or at a minimum have a clear plan on how to obtain IP.
8. **Risks**
   a. If all of the above criteria have been met, this will "lower" risk for investors, which in essence makes the case more investor ready.

Financials
Valuation - Rule of thumb

1. Experience from investor talks
    a. For spin-outs that have not sold any robots yet, the valuation is rarely above **1 mio. EUR (pre-money).**
    b. Typically the investor invests 150.000 EUR, which results in 1,15 mio EUR (post-money)
    c. The investor share is then 150.000/1.150.000 = **13 %**
2. Discounted Cash-Flow Method
    a. A mathematical way of calculating valuation, which is often up for debate.
    b. Good tool to use in your discussions with the investors
3. Semi-Public Innovation Environments (in DK) work with a rule of thumb of:
    a. They will invest **3-3.5 mio. DKK (400K-466K EUR) and expect 25%.**
    b. This means that post-money is: 3.5x4 = 14 mio. DKK (1.9 mio. EUR) and **pre-money** is 14-3.5 = 10.5 mio. DKK (**1.4 mio. EUR**)

2

Business KPIs

Business KPIs

Go to Business KPIs

13

3

Plan for Monitoring & Deliverables

14

Plan for Monitoring & Deliverables

BLUE OCEAN ROBOTICS
- for humans

Four business deliverables
1. Business plan   20th of November
2. Business plan presentation   27th of November
3. Data Room   3rd of January
4. Market intelligence report   15th of January

Go to Monitoring Plan

Go To Deliverable Overview

4

Business Case Work

Business Case Work

A business case typically consists of three things
1. Cost
2. Benefit
3. Payback (difference between cost and benefit)

Business Case Work

Costs
1. Initial cost
   a. Hardware (how many robots will 1 customer buy?)
   b. Installation cost
2. Operation cost
   a. Service and maintenance fee
   b. Are there any additional cost that they will have using your robot that they don't have today?

Business Case Work

Benefits

1. Reduction in time spent on a task? (quantify this time)
2. Fewer admissions (quantify this)
3. Other benefits that you can quantify?

You may not have all the numbers today, however, you should know what numbers to look for after today

Business Case Work

Payback

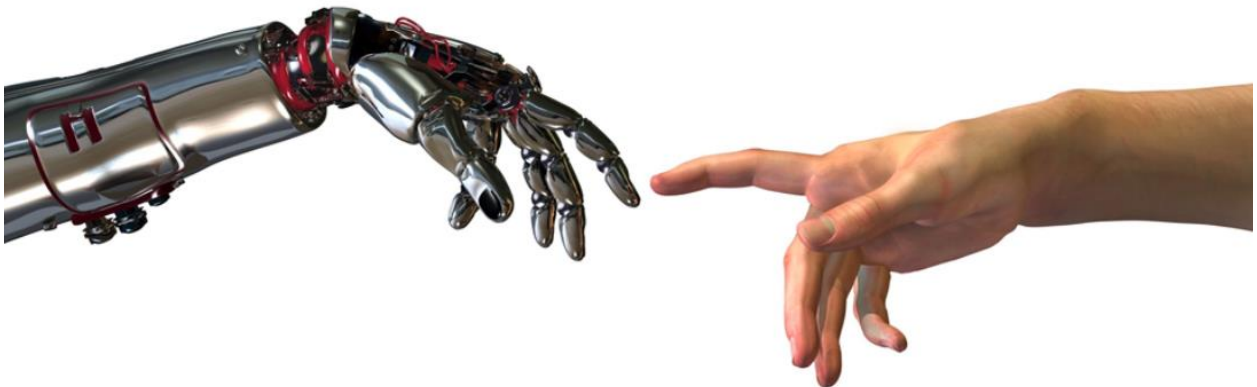Initial Investment / Monthly Cash Inflow = XX months

5

Individual Business Plans

21

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- for humans

Thank you for your attention

Appendix C

Work Plan

Deliverable		Deadline
Create data room		30/10-18
Business plan	The problem	09/10-18
	The product	09/10-18
	Market Analysis	16/11-18
	Business Case	16/11-18
	Go-To-Market	23/11-18
	Organization	23/11-18
	Financials	23/11-18
	Intellectual Property Rights	30/11-18
	Risk Overview	30/11-18
	Executive summary	30/11-18
Business plan presentation		07/12-18
Identification of investors and strategic partners		14/12-18
Contact investors and strategic partners		21/12-18
Identification of potential funding calls or follow-up projects		11/01-19
Market Intelligence Report (report on work done regarding investors, strategic partners and funding)		18/01-19

Skype meetings									
	November				**December**			**January**	
	06/11-18	13/11-18	19/11-18	28/11-18	03/12-18	11/12-18	19/12-18	08/01-19	22/01-19
CLARC	10.30-11.30	11.00-12.00	10.00-11.00	10.00-11.00	10.00-11.00	10.00-11.00	10.00-11.00	10.00-11.00	10.00-11.00
Assesstronic	-	12.00-13.00	11.00-12.00	11.00-12.00	11.00-12.00	11.00-12.00	11.00-12.00	11.00-12.00	11.00-12.00

Appendix D: KPIs Phase III

	Category	#	tKPI	Explanation	Importance (1-5; 1 being least important and 5 most important)
Technical Aspects	**Production and deployment** *(setup, installation and reliability)*	1	Average time taken to set up the system [10 times] before the test	The set up and calibration time of the system should be fast and easy as to not take time from the HP	4
		2	Average time taken to calibrate the system [10 times] before the test		4
		3	# of calibration needed on 50 tests		3
		4	The time it takes to install the system	This is about the time between the reception of the system and the moment it is able to be used (if the system does not need any specific installation, the measurment can be 0)	2
		5	# of tests where the HP get involved out of 50 tests	The tests (Barthel, 'Get up Go') should be repeatable, reliable, and autonomous. Moreover, the performances should be the same or similar between the prototypes.	5
		6	# of tests where the developer get involved out of 50 tests		5
		7	Comparing the # of times the HP or the developer needs to get involved between the different prototypes		5
	Ease of use in daily routine *(e.g. portability, mobility, etc.)*	8	Weight, size, form factor	[Non self-driving systems] how portable is the system. This parameter defines practicality in terms of use	4
		9	Average speed	[self-driving systems] How mobile is the system. This parameter defines practicality in terms of use.	2
		10	# of features not available while charging	The system should be able to perform the tests on battery or while the battery is charging	2
		11	System runtime until battery discharge		3
		12	Estimated MTTF (Mean Time To Failure) based on component choices	Component lifetime and ease of maintenance in terms of modularity	4
		13	Estimated MTTR (Mean Time To Repair)		4
		14	Installation manual, user manual, trouble shooting & FAQ sheet	Documentation for end-users on system usage, trouble shooting, etc.	4
	Human-Machine Interaction	15	# of times a message/statement/query from the robot to a patient needs to be clarified by the HP, over all relevant tests performed	Patients ability to understand statements formulated by the robot through whichever modality is used, written text, visual diagrams, synthesized speech, or any relevant combination thereof.	5
		16	# of times patient test-responses captured by the system do not reflect what was expressed by the patient	Robot's ability to capture, understand or interpret test-relevant communication from patients.	5
		17	* Attitude towards technology generally * Trust of the specific technology * Ease of interaction with the technology.	There is an ethical dimension to the patient acceptability that relates to the person's acceptance of the 'procedure' (perhaps relating to their predisposition towards technologies more generally); their trust in the technology and the ease by which they can interact with it.	5
	Design *(aestetics, supply chain)*	18	Subjective measure from hospital staff	The design of the system needs to suite the situation: no sharp edges nor possibility of pinching, easy to clean (maybe waterproof), material should resist to standard cleaning chemicals, and so on. In addition to that, the looks of the system should suite the users (HP)	4
		19	# of trustworthy suppliers identified for needed components per number of item: is there a trustworthy supplier identified for all items?	In order to bring a product to the market, the manufacturer needs a list of trusthworthy suppliers in order to get all needed parts at the right time	3
	Compliance *(TRL 8, standars for medical equipment)*	20	Initial estimation performed by E++ monitoring team, on the faith of monitoring information. Final evaluation performed by external experts on the occasion of the end-of-phase II on-site review and corresponding demonstrations	Using EC scale, expected TRL by the end of Phase III is 8	5
		21	Identified requirements	In order to bring the system to the market, the system needs to comply with a number of standard (depending on the region).	4
		22	Documentation e.g, system description, design details incl. electrical and safety, workflow, use environment, etc.		2
		23	Type test specification		3
		24	List of applicable standards identification		4
		25	Risk Analysis and mitigation plan		4
		26	Certification documentation		4
	Data analysis *(results, integration and data protection)*	27	Ease of viewing test data collected, locally on the system, and remotely	The way the system shows the collected information needs to be intuitif and help the HP take decision, without removing the possibility of looking into each piece of information separatly	5
		28	Compliance with standard hospital softwares	In order for hospitals to use the system, it should be able to easily interface with their already existing system.	4
		29	Data processing capacity		3
		30	Compliance with data collection hospital standards	The data should be protected from external leaks	4
		31	Reliability of punctuations gathered by robot (in terms of test/retest and concordance between punctuations gathered by robot and health professional)	This information is important in order to get health professionals acceptance of the product.	5

Category	#	bKPI	Explanation	Importance (1-5; 1 being least important and 5 most important)
Business Aspects				
Business plan	1	Viability of business plan	The business plan should seem viable to potential investors, i.e. how sound are the assumptions, does it seem realistic etc. based on an evaluation by a selection of sample investors	5
	2	Quality of business plan	The business plan should be percieved as high quality by potential investors in terms of writing, format and layout, based on an evaluation of the business plan by a selection of sample investors	5
	3	Feasibility of business	The business should be feasible based on a cash-flow analysis (i.e. breakeven within a certain period of time)	5
	4	Coherence with format	How well the business plan measures up to standard according to the *Business Plan Guidelines*	4
	5	Number of spelling / grammar mistakes	The quality of writing should be of high standard	4
Business Plan Presentation	6	Number of presentation slides	The length of the presentation should be 10-20 slides	3
	7	Number of areas described	The level of complexity will be determined depending on the areas from the template described (e.g. product description, introduction to the problem, etc.)	4
	8	Number of spelling / grammar mistakes	The quality of writing should be of high standard	4
Market intelligence	9	Number of contacted strategic partners	Number of strategic partners that have been contacted that are relevant for the project, a reasonable number is around 30 contacts	5
	10	Number of established customers	Number of strategic partners that are already engaged in an agreement; letter of recommendation from at least 1 partner that you have been in close dialogue with	5
	11	Number of contacted investors	Number of investors/strategic partners that have been contacted with particular reference to invest in the project; a reasonable number is around 20 contacts	5
	12	Funding applied for / received	Here, the amount of funding will be assessed, hence a higher score will be given if the funding has already been approved	3
	13	Number of calls applied for / accepted	Here, the considered calls will be assessed, hence a higher score will be given if the submission has already been approved	3
	14	Lead Flow	A count of the number of leads that your sales people are working on; a reasonable number is around 10-20 contacts	3
Data room	15	Present documentation	Amount of documentation present in the data room, according to the *Data Roo*	4

	Chapter	Criteria	Explanation	Content Measurement
Business Plan Guidelines	Front Page	Front Page	Include a picture and a telling title for what the business plan is about	1 page with a title and picture that tells what the business plan is about
	Key Figures and Achievements	Status	Status in bullet points on what has happened in the project and main achievements (how much funding has been received, what has been developed)	5-10 bullet points on the main achievements in regards to your product
		Product Status	Status in bullet points on where you are with the product (is it a prototype, a concept, etc.?)	1-2 bullet points on where you are with the product in terms of is it a concept, is it a prototype, is it a finished product?
		Investment Status	Status in bullet points on how much capital has been used so far on this product, and how much moeny you are seeking now, and thus, what is presented in the business plan	2-10 bullet points on how much capital you have used so far, and how much capital you need now (this number should be found in your budget). Inlude a cap-table showing the ownership percentages (how much does the investor get, how much do you get, and specify the "you")
		IPR Status	Status in bullet points on where you are with IPR (do you have any patents, trademarks, etc.?)	1-5 bullet points on what you have done in terms of IPR and what you intend to do
		Projected Business Plan Highlights	State in bullet format what the next steps are if you get the money you are seeking? This is a short bullet point timeline	5-10 bullet points on the main next steps you will go through when you get the capital
	Introduction	The Problem	What is the problem today that you are addressing with your robot, how big is the problem (how many have this problem?). This should be like an appetizer for the reader that will make her/him want to read more about the actual solution you have for this problem.	1 page description of the problem the product addresses (incl. specific numbers on how many have this problem
	The Product	Product description incl. break-down of main elements/components	A description of the product incl. illustrations of the product. The description of the product should include the what the purpose of the product is, who it is aimed for, what it can do, what features it has. If the product consists of significant components (for example a UV system and a navigation system that together forms a UV-Disinfection Robot), these components should have a sub-section in "The Product" section. This section should make an investor understand your product and what it does.	Min. 1 page (max. 2 pages) description of the product (incl. its purpose, who it is aimed for, what it can do.
				Min. 1 picture of the product
		Workflow description and illustration	A description of the workflow of your product, from the user's perspective i.e. what is the step-by-step process when the user uses your product.	Easy-to-understand illustration of the workflow with figures and icons (no simple boxes with text inside and arrows)
				0.5-1.5 page description of what happens in each step in the workflow
		Key Selling Points	In a bullet format list your 10 key selling points. This will be the last section under "The Product" so this will be kind of a conclusion or summary of what you have written in this section.	8-12 key selling points listed in a bullet format
	Market Analysis	Size	Description of the market size. Should incl. a clear introduction to how you will come to the final number so the reader knows what to expect to read and the path to the final number.	1.5 - 3 pages description of the market potential incl. numbers
				1-2 tables (max. 2) in the main business plan (rest in appendix)
				State your market potential in number of units AND how much revenue that means
		Competition	A description of the main competitors. Should incl. a table with the main ones incl. your own solution, and a list of parameters to the left side in the table, and a rating of all the solutions incl. your own on these parameters.	A table that incl. a list of parameters to compare the competition on. The table must incl. min. 4 competing solutions, and a rating (either with numbers or using a low-medium-high rating) of these min. 4 solutions and your own solution based on the parameters you identify.
				1-2 page description of your competitors and why you have rated them the way you have in the table.
	Business Case	Business Case	A description of your business case, i.e. what is the setting, what are the assumptions, who has the business case been made for (is it based on a specific case, or just an example?). The business case should look at what the customer gets from using your product. It should include the costs of having your product, the benefits of having your product, and the difference between these two, i.e. the payback time stated in months or years. The cost: It should include the costs of having your product The benefits: The business case should look at what the customer gets from using your product. It should include the benefits of having your product. Will they save time? If so, what is the value of this time. The payback: The payback time is the difference between the costs and benefits.	1-3 pages description of the business case, which should include a description of the setting (i.e. who the business case has been made for, are there any assumptions?)
				A number that states what it will cost your customer to implement the robot
				A number that states what the customer will gain in benefits by implementing the robot (benfits include (1) average hospital stay, (2) treatment cost, (3) patient satisfaction, (4) costs by payer, and (5) staff cost reduction.)
				A number of payback time measured in months or years, that states when the customer will have gotten their investment back
	Go-To-Market	Go-To-Market	A description on how you will bring the robot to the market. Include a timeline, what will happen, when, and who will do it?	1-2 pages description of how you will bring the robot to the market.
	Organization	Organization	Illustrate the organization behind, i.e. who has been part of bringing this product to life, and who is going to bring the product to market?	Illustration of your organization.
			Describe your organization based on the illustration	0.5-1.5 page description of your organization
		The Team behind	Describe the specific people who are going to work on the product (technical side and business side) when you get the investment on board. Please remember that investors invest in people!	0.5-1.5 pages description of the team behind incl. title, education and what they will do.
	Financials	Cost Structure	Describe price and your profit	Price and margin of robot
		a 4-5-year budget	Create a budget and a short description of it.	Number of expected robots sold pr. year over next 4-5 years. (can be in a table)
				Expected revenue pr. year over next 4-5 years. (can be in a table)
				Expected costs pr. year over next 4-5 years. (can be in a table)
				Expected profit pr. year over next 4-5 years. (can be in a table)
				Expected cash-flow pr. year over next 4-5 years that states investment need (the capital required from investors). (can be in a table)
				2-3 page description of your budget incl. tables.
		Valuation	Describe the valuation of your business	0,5-1 page description of the valuation of your business. You should end up with a table that shows your valuation and how many % of the company the investor will get for his investment.
	Intellectual Property Rights	Intellectual Property Rights	A description of any IPR you have in relation to your product. Have you done a freedom-to-operate analysis? If yes, what are your conclusions? How do you intend to protect your product?	0.5-2 page description of what has been obtained on IPR so far, and what plans you have for obtaining further IPR
	Risk Overview	Risk Overview	A description of risks incl. your contingency plan. You should group your risks into at least two groups: product risks and market risks.	1-2 page description of 5-10 risks incl. contingency for each of them.

	Criteria	Explanation	Content measurement
Data Room Guidelines	Presentations	The business plan presentation	10-20 slides present in .pdf format (y/n)
	Business plan	The business plan, incuding older versions and iterations, should be available in pdf format. The business plan should meet a generic format of a business plan, including sections such as problem, product, market, business case, organization, financials, intellectual property, risks	Present in .pdf format (y/n)
	Business case and data	A business case, including the data and references it is based on	Present (y/n)
	Market, competitiors and patents	Documentation regarding the market, competitors (products, technical sheets etc.) and relevant patents	Number of present documents
	Research and field studies	All research and field studies should be documented, e.g. interviews with users, relevant articles demonstrating user needs and workflows, pictures and videos etc.	Min. 3 user interviews
			Min. 10 pictures illustrating major issues, pains and gains of patients, nurses, relatives etc.
			Video material of the typical workflow of a geatric assement
	Budgets	A detailed five-year budget, including a calculation of monthly cashflow and when breakeven is expected	Present (y/n)
	Planning and milestones	An updated time shedule, including important milestones and how they will be reached	Present (y/n)

Appendix E: Monitoring deliverables Phase III

	List of deliverables ECHORD++ Oct '18 to Jan '19			
#	**Topic**	**Deliverable Description & Templates**	**Submission Format**	**Deadline**
1	*Final design*	The following points should be highlighted: - *Environment overview* - the environment in which the system will be run (could be presented as scenarios). - *System Architecture* - a high-level description of the system architecture. You could use a few block diagrams to show the major components and their interaction - *Design explanation* - explanation of the design you chose, explaining how your system is structured. This section may also include design justification, including specific rationale for the decisions made in the design (e.g., why your design may be better than another or why you chose to implement a specific design). - *Constrains* - mention the major design constrains. *NOTE!! You can touch these points in any order you want. Also, you can either combine videos / presentations and pictures OR choose just one to deliver the work.*	Pictures / Sketches / Video / Presentation	4-Jan-2019
2	*HMI demonstration*	For this deliverable you should have into account the following: - *System interfaces* - the interfaces provided to users and/or other external systems - *Description* - describe the interfaces which use graphics and descrive the human interaction	Presentation / Video	19-Oct-2018
3	*Functional prototype*	A demonstration of the prototype & how does it work. You can choose a specific feature / scenario to create a video or presentation.	Video / Presentation	2-Nov-2018
4	*Documentation - User Manual*	Create a User Manual Document, explaining every feature the user might need when using your system. As an example, you can use *THIS* template http://www.arbowebforest.com/android/ArboWebForestUserManual.pdf	Report	16-Nov-2018
	Certification	Description of certification preparation and timeplan	Report	14-Dec-2018
5	*Data handling description*	Describe how the data gathered by the robot is handled. The description should include: - *Data collection* - how the data is collected - *Data processing & analysis* - how is the data collected processed & analyzed by the system - *Data stores* - where is the data stored - *Outcomes* - which are the outcomes from data handling - *Privacy issues* - how do you handle privacy *NOTE!! You can choose if you want to write a report or make a presentation. You can choose a specific scenario to record or you can create diagrams / pictures / sketches to show the data workflow throughout the system. Choose what best fits your project!!*	Presentation / Video / Description	30-Nov-2018
6	*Business plan presentation*	Create a presentation of the Business Plan, including the following topics: 1. Executive summary 2. Introduction to the problem 3. The product 4. Market Analysis 5. Business Case 6. Organization 7. Financials 8. Organization 9. Intellectual Property Rights 10. Risk Overview *NOTE!! This should be just a presentation of your business plan. You will receive feedback on it, which should serve you to create the Business Plan Report!*	Presentation	27-Nov-2018
7	*Business plan*	See business plan guidelines in KPI Sheet	Report	20-Nov-2018
8	*Market Intelligence Report*	Report on your market intelligence efforts. Should include your method and results for investor search and contact, strategic partner search and contact, as well as funding opportunities search and conclusions.	Report	15-Jan-2019
9	*Data Room*	Include relevant documentation as described in Data Room guidelines.	Folder	3-Jan-2019

PDTI Healthcare Final Evaluation Phase III

Panel Report

CONTENTS

Glossary of Terms

ECHORD++: European Coordination Hub for Open Robotics Development Plus Plus (E++ for short)

1   Introduction and Methodology

This report covers the final evaluation of Phase III (Small-scale test series and user-acceptance studies) of PDTI, Public end-user Driven Technological Innovation, in Healthcare Robotics, which focuses on the development of a solution to support a healthcare professional during Comprehensive Geriatric Assessment. Two teams – Assesstronic and Clarc – had passed Phase II of PDTI Healthcare Robotics (Phase II: Feasibility studies and prototypes) and were thus entitled to continue their technology development till the end of PDTI.

Both teams presented their progress during Phase III in forms of presentations focusing on the following topics:

- Business and commercialization
- Technology and product development
- User studies and acceptance

They also demonstrated their technology to the reviewers in trials with participants of the meeting. During the preparation of the final evaluation meeting, it was decided that patients will not be involved in the final evaluation as they do not feel comfortable testing the prototypes with strangers in the room. A more realistic evaluation of the usability of the solution was obtained by a visit of the public body (healthcare professional César Galvez Barron) to the consortia during their small-scale test series. A summary of the experience of the user studies and an evaluation with the KPIs in mind was presented at the final evaluation meeting by the healthcare professional.

The KPIs for Phase III, which were used durinf the evaluation are set out in the following document:

PDTI Healthcare Phase III_KPIs, dated 01/19 (updated version, first version 09/18) (see Appendix a)

The on-site testing was structured according to the following agenda:

PDTI, Healthcare Phase III – final evaluation - agenda, dated 18.01.2019 (see Appendix b)

The performance by both teams – Assesstronic and Clarc – was reviewed by three independent experts (reviewers) in the area of healthcare robotics, more specifically business, technology development and user centered design:

Andreas Müller (Univ.-Prof. Dr.-Ing. habil.), head of Institute of Robotics at Johannes Kepler University Linz, Linz (JKU) with expertise in: Mechanical Engineering and Control Systems Engineering and Aerospace.

Malcolm Fisk (Dr.) from the Centre for Computing and Social Responsilibity, De Montfort University. He leads the European Commission funded PROGRESSIVE project that addresses standards for ICT and 'Active and Healthy Ageing'.

Thierry Keller (Dr.), director of the rehabilitation department at Tecnalia, with expertise in Biomedical Engineering, Electrical Engineering and Commercialization of early stage technology.

Subsequent to the final evaluation, the three independent experts exchanged their perception of the performance of the two teams in a physical panel meeting. The objective of this panel meeting was:

- to discuss the perceived performance of the two teams based on the pre-defined assessment criteria,
- to reach a consensus on the performance
- to generate evaluation reports for both teams
- and to analyse the gap to commercialization for both teams.

The evaluation reports should give concrete recommendations to both teams on how to proceed with their route to commercialization beyond the funded runtime of ECHORD++.

The panel meeting was attended by:

Andreas Müller – Reviewer

Malcolm Fisk – Reviewer

Thierry Keller – Reviewer

Marie Luise Neitz (Project Manager, TUM, ECHORD++)

Franziska Kirstein (Project Manager, BOR, ECHORD++)

César Galvez Barron (public body, Hospital Sant Antoni Abat)

Kyriaki Papageorgiou (independent observer, SCALINGS project)

2 Analysis of the performance of Assesstronic and Clarc

2.1. Assestronic

Assesstronic made significant progress. The system beneifts 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. The tablet is highly usable for the patient, but also for the care staff (particularly the doctors themselves). The portable Assesstronic system works reliably and robustly, but the 3D camera and the processing functionality for the human motion tracking system still display some shortcomings. The portability of the system offers the "extra benefit" of "parallel" operation, i.e. enabling a clinician or health practitioner to assist (if needed) an older person to undertake the Barthel Test at the same time as a relative (carer) can respond to the same test or related questions pertaining to the older person's capabilities.

From the user perspective, many good elements are demonstrated. This is the result of some previous technical recommendations of the reviewers having been taken into account carefully.

The presented business plan is solid in the perspective of market expectations, the market approach, and foreseen sales estimates. Sales numbers and market access for the market segment basically does not yet exist and needs to be developed. With Acetiam, the project has a good business partner that possesses all infrastructure and knowledge to successfully exploit the results and access the market without need of venture capital. An estimated development time of about 2 years are still required to push the system to a level which would motivate Acetiam to put this product on their priotity list for commercialization. If this happens, though, the market potential is huge. ASSESTRONIC – together with the hospital and the reviewer, Thierry Keller, - strongly consider to submit a proposal under the umbrella of the next EIT Health Call to close the gap which is still there.

In the presented business plan, however, the fact that a CGA system is a medical product has not been considered. Therefore, the costs for medical certification are underestimated. There is also a certain risk that the currently chosen alternative to the Kinect camera (no longer available) system still requires R&D - i.e. improvements in its stability to be able to reliably analyse gait patterns for patients. Missing are currently results from a larger group trial that should be undertaken either sponsored by the commercialising company or through funding schemes, e.g. through innovation programmes like EIT-Health.

2.2. CLARC

From the user persepective, some good elements were demonstrated. There was, for instance, careful attention to the interface with the older person - recognising fears and uncertainties that may have militated against effective 'engagement' with the robot. The attention given to adjusting the design and appearance of the robot was therefore important. Also the data representation and management was rated very positive by the medical experts. To fully exploit the potential offered by this feature, strategies for integration into IT-infrastructure should be further developed.

Another positive element in the CLARC protject is the large number of patients with whom tests have been carried out (more than 400 patients so far), even though the sample as not fully representative. This has helped to better integrate the user perspective in the development.

The range and form of presentation of data to clinicians is good. Linked work relating to this was noted as including considerations (and an extension through attention to accessibility) of the USUS framework for evaluating human-robot interactions. In view of the novel uses of robots that are likely to emerge, this may prove a useful addition to knowledge in the field.

Overall, though, the system displayed significant shortcomings. The system was frequently not able to understand the response of the person to the questions. For the Stand Up and Go Test, the machine was not able to recognize the person and thus to initiate the test.

Due to important deficiencies in the technical implementation, the current offer is not ready for an exploitation path. This is mainly due to the robotic platform that fails to demonstrate the required level of reliability to be operational in an unstructured environment (as found in a hospital).

The number of communication modalities with the robotic platform is too broad for a patient (voice, buttons, touch screen). The touch screen on the robot cannot be easily operated by the user due to the distance between robot and user. Possibly, it is better to focus on the push button solution, and improve the voice recognition.

The voice recognition system is too restricted and understands only a small subset of keywords compared to natural language.

This leaves the well implemented remote control as only working communication solution. So why offer all those modalities given the likely costs relating to reliability and the potential price of the solution?

The presented business plan has been well developed and could be feasible when the technology works. However, it is based on assumptions that could not be demonstrated successfully.

The business plan foresees obtaining of venture capital. The preconditions for a successful pitch for venture capital, among others, are: 1) market and need; 2) solution and technology; 3) IP; and 4) Implementation. All 4 preconditions need to be appropriately met. At the current stage 2), 3), and 4) are not sufficiently developed and/or they pose serious problems. As such, the product still requires a high amount of research, specifically when the envisioned autonomy of the robotic solution should be part of the offering.

A number of scientific results have been disseminated. This builds scientific impact. However, this does not necessarily represent innovation.

3   Recommendations by the reviewers – steps after ECHORD++

Imagining that ECHORD++ could not find further support for the two teams to continue their route to commercialization, the reviewers give the following recommendations:

- **ASSESSTRONIC** would has potentially an investor on board with Acetim. In order to be put on the priority list fro commercialization of this complay group, ASSESSTRONIC needs to further develop the technology (mainly interpretation of 3D point cloud data, implementation of a laster pointer to track walk path, lack of precision in the description of the protocol, minor refurbishment of the interfaces, accessibility of data reported to clinicians etc.). The reviewers estimate that it will take about two additional years to tackle these issues. Adressing the upcoming EIT Health Call would be one way to generate the funds for this exercise. In addition, it will be necessary to increase the number of tests (with patients, relatives and clinicians).

- Further trials are needed to indicate where the primary market/markets is/are in relation to these specific tests and would (depending on outcomes) enable validation to take place. Such validation (preferably through an independent agency) is essential if a final product is to be marketed successfully. It is important that the offer is made attractive to health professionals with sufficient functionalities, i.e. a sufficiently large number of clinical tests, possibly in the future going beyond CGA tests only. Last but not least the business plan needs to be reworked in terms of costs for medical certification, sales numbers and market access for the market segment.

- In case of **CLARC** the mobile platform has still significant shortcomings which need to be addressed. CLARC has already received several new EU-funded projects to further develop the hardware. The project suffers from the selected mobile platform which would need to be changed in order to make CLARC an interesting business partner, for instance for Blue Ocean Robotics to go into proposals together or further optimize the commercialization perspectives of the team. The major merit of the CLARC project lies in the scientific result which have been disseminated. These build scientific impact.

To sum up: **ASSESSTRONIC** has presented a very interesting, scalable solution with an interesting cost-benefit ratio for the end users. The technology needs an additional tow years' funding to be mature enough to make it to the prioritization list of Acetim. Going for the next EIT Health call with the hpositfal and Tecnalia (via Thierry Keller) is an option to generate funds for the further development of the system. The business plan needs more care in terms of certification costs and sales numbers. But the market potential is huge and the solution finds the approval of the medical staff.

The merit of **CLARC** mainly lies with the scientific knowledge so far. But components of the solution are worth further developing – for instance in additional EU-funded projects which have already been acquainted. The shortcoming lies in the platform which needs to be replaced.

Deliverable 5.7 – Small scale test series and user acceptance