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IM-TWIN: from Intrinsic Motivations to Transitional Wearable INtelligent companions for autism spectrum disorder

a European funded project

Exploitation Plan 2

Deliverable 5.1

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Project duration 24 months (November 2020, October 2022), Consortium: Consiglio Nazionale delle Ricerche (ITA), Universiteit Utrecht (NLD), Centre de Recherches Interdisciplinaires (FRA), Università degli Studi di Roma La Sapienza (ITA), Plux-Wireless Biosignals S.A. (PRT).

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Acronyms of partners

CNR-ISTC	Consiglio Nazionale delle Ricerche, Istituto di Scienze e Tecnologie della Cognizione (Italy)
UU	Universiteit Utrecht (The Netherlands)
CRI	Centre de Recherches Interdisciplinaires (France)
LA SAPIENZA	Università degli Studi di Roma La Sapienza (Italy)
PLUX	Plux - Wireless Biosignals S.A. (Portugal)

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1. EXECUTIVE SUMMARY

This deliverable is a first revision of the Exploitation Plan illustrated in the Proposal of the Project, to ensure that the project results are exploited and reused by the different target stakeholders to benefit the wider community. The exploitation strategy plan was developed as a work-in-progress document to weigh and stipulate the gradual development and exploitation of IM-TWIN results from the beginning to the conclusion of the project.

As a brief recall, the project has also a whole work package (WP5) dedicated to exploitation processes.This shows the strong commitment of the Consortium to build a path moving towards the creation of a startup that, by the end of the project, will have the organizational, legal and financial sustainability requisites of a pre-acceleration stage so to access the new EU instruments for SMEs.

The overall aim of the exploitation process is to identify value in the whole IM-TWIN system, and/or some of its components (PlusMe, New Wearable Sensors, AI based Affective detection system) that can be pre-industrialized with the activities of the project for suitable areas of application and related addressable markets.

It is necessary in this phase of the project to assess for each component the TLR achieved or achievable and the related market potential, to start discussing models for IPR management and strategy and the possible business strategies, along with the composition of the possible Team for market exploitation, to consider which competences/areas are covered or need to be found. The aim of the present deliverable is to preliminarily summarize the indications emerged (Tasks 5.2, 5.3, 5.5, 5.6) in order to focus the further exploitation activity on the specific components with potential commercial value.

As clearly emerged during the Review Meeting held on January 21 2022, the high modularity of the components represents both a big opportunity, but possibly also a risk, in view of the exploitation process: indeed, maximum effort must be made to identify the final product to invest in and focus on it, on which specific market to address, and how to formulate the related unique selling proposition, as well. In line with the most realistic opportunities for exploitation that will be identified by the end of the project, this document will be updated in the final Exploitation Plan (D. 5. 2).

Chapter 1 of this document outlines background information, including the type of research and nature of the outputs, for the exploitation of IM-TWIN Project results.

Chapter 2 reviews the exploitation actions already implemented under WP5 and the next actions to come. The work of CNR in this task is supported by the central CNR “Technology Transfer Office”, and by the CNR subcontractor QUANTUM LEAP-INFINITY EDGE.

Chapter 3 presents the current results and discusses first plans for their exploitation on possible markets, taking into account the Innovation Radar and Transition Plan already submitted to EU Services.

Chapter 4 reviews the results of IPR Analysis and Strategy (D 5.9)

Chapter 5 concludes this deliverable highlighting the main criticalities that emerged and the possible strategies that the Consortium is to discuss, share and implement to address them.

The present Plan takes into account the negative impact on the project activities due to the COVID-19 pandemic and also other risks emerged during the first implementation of the project work plan. The difficulties to acquire the electronic components due to the global shortage of semiconductors and microchips, and the impossibility to run the experimental planned activities caused a delay in the research activities that slowed down the development of expected project results and motivated the request for an extension of the duration of the project (Amendment under evaluation).

Chapter 1 - Introduction

The IM-TWIN project aims to develop some of the outcomes of the FET GOAL-Robots project towards market exploitation. The basic-research FET GOAL-Robots project aimed to study how intrinsic motivations (“curiosity”) drive exploration and learning in children, and how such processes can be used to develop innovative autonomous robots. This led to conceive the idea that intrinsic motivations can be used to build engaging interactive robots usable for the treatment of children with developmental disorders, in particular within the Autism Spectrum Disorder (ASD). ASD is a condition with dramatic importance for the well-being of society as it affects about 1 out of 10 newborns in developed countries. ISTC-CNR developed a “wearable companion robot”, usable for the treatment and daily support of ASD, called PlusMe, now at the stage of prototype.

The IM-TWIN project has two sets of objectives. The first is to develop a highly-modular system pivoting on the PlusMe, called the IM-TWIN, addressing the needs of the market segment involving ASD therapy centers and, potentially, families with ASD children: this involves endowing the PlusMe with intelligent behavior, equipping it with additional embedded biosensors and cameras for detecting the child’s affective/emotional state, and integrating all components as a whole IoT system. The second set of objectives aims to validate the device and its components with target stakeholders, and to carry out a number of activities directed to advance the system components to a higher Technological Readiness Level (TRL7 for the PlusMe): this involves identifying the target groups and analyzing ASD-related markets, refining and implementing an effective IPR strategy, planning the steps for individual and collective exploitation of the project outcomes, and finally evaluating the feasibility for the creation of a startup for the exploitation of the IM-TWIN system and its components. IM-TWIN will also foster the development of a lively high-tech research and application ecosystem.

The Consortium, where a leading SME operating in the hardware sector (PLUX) is already present, is strongly committed to capitalize the knowledge developed and the advancements of technology utilized, as well as for bringing the value generated to both open market and society. Specific activities are planned to identify the exploitation potential of the deliverables in different areas of applications.

The exploitation process will be planned not only with the support offered by the technological transfer offices of the Participants’ networks, but also with the specialized support of a subcontractor (QUANTUM LEAP-INFINITY EDGE) involved in the Project by CNR to assist exploitation actions, IPR Analysis and Strategy,market analysis and business model planning, and financial sustainability assessment.

From a technical point of view the IM-TWIN system presents several innovative features: PlusMe Intelligent Behavior (software), Body-contact wearable devices (hardware), Emotion visual detection (software); Overall IoT software for data integration, collection, and processing (Software).

A crucial aspect of the system will be its modularity: the system relies on the development of different components that can potentially be used and exploited individually. In particular, this modularity will involve both the hardware (PlusMe, wearables on the child, wearables on the caregiver) and software (communication with the different components; basic data-analyses related to the data collected by such components before information integration).

Each of the components of the system represents therefore a potential economic value generated by the project, to be tested and exploited for business opportunities in different industrial and SME segments and markets (biosensor and hardware industry, medical device industry, toy industry, etc.).

The modularity represents a big challenge for the definition of the exploitation strategy, because it will be necessary for the new start-up to identify, choose and focus on the commercialization of the project's result that has the best market opportunity as a commercial product, along with the definition of a unique selling proposition in the selected market, which can be formulated only through a deep collaboration with selected target users.

After the first year of Project activities, it is possible to do a first assessment of results and related market potentials that will be presented in Chapter n. 3.

Chapter 2 - Exploitation actions implemented

2.1 Deliverables submitted

D5.3 "IM-TWIN system booklet 1" (CNR, report, public, M3, 31 Jan 2021)

The first IM-TWIN system Booklet is a "CALL TO ACTION" which describes the general aims and objectives of the IM-TWIN project, in order to promote the possible involvement of stakeholders in the implementation of the exploitation activities.

The booklet was edited at the beginning of the project activities with a very **extensive approach**, including all the potential stakeholders identified at the time of the proposal in order to promote through targeted messages (see Table 1) their possible involvement in the implementation of the exploitation activities. The second version of the booklet will be more focused on the specific market that will be identified as the first to be addressed.

Stakeholder category	**Need Addressed**
ASD Therapy Centers	Improve the efficiency of therapy and the quality of life of children diagnosed with ASD with personalized tools for stress detection
Health, Social, Educational Services	Evaluate IM-TWIN research findings on emotion-detection in the framework of neurodevelopment surveillance protocols **(screening programs in primary care for early diagnosis).**
Research Bodies	**Integrated dataset usable for research on ASD**, built on a highly interdisciplinary integration of the last advances in signal processing, cognitive sciences, artificial intelligence, autonomous robotics
Digital health/ Autonomous Robotics, Socially Assistive Robotics Industries	New solutions thanks to the IM-TWIN platform (wearable sensors and software) of **integrated data acquisition for socio-emotional detection and adaptive interaction**, that can be used for a wide range of clinical applications, at lab/clinical environment or at home (for remote monitoring scenarios)
ASD Industry	Research program specifically aimed to collect experimental evidence on the beneficial use of the IM-TWIN system as a basis to monitor **(early detect) ASD and to improve the efficacy of child-customized therapies.**
Intelligent Toy Industry	Transitional Wearable Companion as a new class of interactive/adaptive toys to **develop emotional and social intelligence,** along with the pleasure of making new

	discoveries (curiosity and exploration) combining developmental psychology soft robotics and AI.

Table 1 *IM-TWIN Stakeholders categories and Needs Addressed*

D5.7 "Identification of target groups and relevant stakeholders 1" (CNR, report, confidential, M6, 30 Apr)

As part of the exploitation and dissemination activity, it has been edited a list of 50 selected stakeholders at a UE level (identified in the deliverable D5.7) who will receive a printed copy of the booklet.

During the implementation of this activity, some issues emerged as to be carefully considered in relation to some feedback received by therapists during the tests: a direct message to families of ASD children is extremely delicate; in particular, a non clear message in the video could raise expectations in parents.

Partners agreed that this is a critical point and that addressing directly Families with ASD Children (and Associations of Families) can be premature, before having acquired sound clinical data, and even counterproductive. This kind of considerations led to excluding families as targets for direct dissemination and exploitation activities, with the consequent suppression of the dissemination deliverables specifically addressed to them (D 5.5 - Professional video to families). See indicated in Section 3.2, some activities directed to families will be carried out at the end of the project.

2.2 Further actions undertaken

The following activities have been implemented so far to support the exploitation process

2.2.1 Specific provisions on exploitation have been included in the Section Governance Structure of the Consortium Agreement.

In particular, the Governance Structure of the Consortium includes the following:
Exploitation and Intellectual Property Manager,
- prompting, leading, and monitoring the innovation and exploitation activities;
- coordinating the IPR activities and monitoring the accomplishment of the IPR protection plan.

Local Exploitation and Intellectual Property Managers identified by each Party
- following the exploitation and IPR issues at the level of the Participant,
- coordinating those activities with the Exploitation and Intellectual Property Manager at the project level.

2.2.2 Identification of Beneficiaries IPR Regulations, Offices and Managers

In order to set the legal framework accompanying the creation of a new start-up, and the conditions under which the start-up is granted access to IPR, as well as to prepare the IPR Analysis, a preliminary recognition has been conducted of the different Beneficiaries' Regulations on IPR management, with the identification of the responsible Offices and managers, as follows:

CNR:
Office: Ufficio Valorizzazione Ricerca (UVR) .
Contact Person CNR: Ing. M.Carmela Basile
Contact Person ISTC-CNR: Maria Luisa Di Muzio
Contact Person Quantum Leap (subcontractor): Maurizio Berti
Legal framework: Regolamento per la generazione, gestione e valorizzazione della proprietà intellettuale sui risultati della ricerca CNR (Delibera 338/2019)

UU
Office: Research Support Office (RSO)
Contact persons: Ayla Kruis, Marlene Duijnhouwer
Legal framework: Patent Law (Rijksoctrooiwet 1995)

CRI
Office: Research Digital Project management
Contact Persons: Lionel Deveaux
Legal Framework: negotiable in autonomy

SAPIENZA:
Office: Ufficio Valorizzazione e Trasferimento Tecnologico (UVTT)
Contact Person: Daniele Riccioni
Legal framework: Regolamento brevetti (D.R. n.199/19)

PLUX:
Offices: Management, R&D
Contact Persons: Joana Figueiredo, Pedro Duque
Legal Framework: negotiable in autonomy

2.3 Institution of IM-TWIN Exploitation & Dissemination Committee

Since the Kick-off meeting (201124) IM-TWIN Consortium confirmed the interest in verifying the feasibility of the creation of a new-start up and created a dedicated Committee with coordination, analysis, discussion and proposal functions reporting to the Scientific & Technological Board, composed by the following members:

WP 5 - IM-TWIN Exploitation&Dissemination Committee		
Partner	Department/Institute/Subcontractor	Name

CNR	ISTC	Gianluca Baldassarre
CNR	ISTC	Valerio Sperati
CNR	ISTC	M.Luisa Di Muzio
CNR	ISTC	Massimiliano Schembri
CNR	IPR Office	M.Carmela Basile
CNR	QUANTUM LEAP	Emilia Garito
CNR	QUANTUM LEAP	Andrea Berni
CNR	QUANTUM LEAP	Maurizio Berti
CNR	QUANTUM LEAP	Venceslao Marinaro
CNR	QUANTUM LEAP	Francesca Tosato
PLUX	R&D	Pedro Duque
PLUX	CEO	Rita Cristóvão
PLUX	FINANCIAL DIRECTOR	José Lopes
UU	INFORMATION AND COMPUTING SCIENCES (ICS)	Egon L. van den Broek
UU	RESEARCH SUPPORT OFFICE (RSO)	Ayla Kruis
UU	RESEARCH SUPPORT OFFICE (RSO)	Marlene Duijnhouwer
SAPIENZA	HUMAN NEUROSCIENCE	Vincenzo Guidetti
SAPIENZA	HUMAN NEUROSCIENCE	Carla Sogos
SAPIENZA	HUMAN NEUROSCIENCE	Noemi Faedda
SAPIENZA	HUMAN NEUROSCIENCE	Gioia Cavalli
SAPIENZA	HUMAN NEUROSCIENCE	Federica Giovannone
SAPIENZA	UFFICIO VALORIZZAZIONE E TRASF. TECN.	Daniele Riccioni
	GRANT OFFICE	Emanuele Gennuso
CRI	R&D	Lisa Jacquey
CRI	R&D	Kevin O'Regan
CRI	Research Digital project Management	Lionel Deveaux

Table 2 - IM-TWIN Dissemination and Exploitation Committee Members

The Committee had a first meeting on February 11 2021, indicating the opportunity to start identifying the possible research results that could be patented/protected (see Chapter 3) , analyzing their patentability, and discussing the methods of participation of the partners in the new start-up. Main issues emerged and decisions: (1) To manage the participation of CNR and Universities calls for more complex administrative procedures to deal with (particularly in Italy);

(2) Dissemination/exploitation dilemma: any dissemination (including publications or release of information on web pages) should be delayed until a decision about its possibile protection has been made (trough IPR or trade secrets); the Committee decided that Partners have to inform about any possible publication in advance the Committee, which makes decisions if protecting or publishing. (3) Criticalities on the protectability of expected results: Plus Me Intelligent Behavior (CNR: difficult, unless new improvements, to have a patent for an *i*ncremental improvement of an existing device already public domain; difficult to protect AI based Affective detection and interaction system (UU); there is the possibility of patenting the wearable sensors (PLUX). However, this option needs to be evaluated in more detail, as the costs might outweigh the benefits of filing for a patent. Also, the priority is to get this product to the market quickly and the efforts at this point will be directed towards this goal; too early to consider the overall IoT System. The Committee agreed on relying on EU facilities to evaluate the business potential of project results and appreciated the initiative to participate in the EIC Bootcamp (see Section 2.6).

A new meeting will be scheduled shortly to discuss and approve an IP agreement on the management of the intellectual property generated by the Project, including the definition of criteria for the ownership of joint results.

2.4 Subcontracting

Quantum Leap is the division of Infinity Edge (tech transfer company) specifically specialized to support companies, research centers and innovative startups for the definition of new enhancement paths aimed at the growth and dissemination of innovation produced on an international scale.
Administrative Covid-19 related delays impacted negatively on the duration of the subcontracting procedures: the contract was actually signed on August 11th 2021, for the realization of the following deliverables: D5.9: IPR analysis and strategy (1); D5.10: IPR analysis and strategy 2; D5.11: SWOT analysis, addressable-markets analysis, D5.13: Feasibility study and business model.
Despite the delay in contracting, Quantum Leap-Infinity Edge consultants have started collaborating since before, both participating in the meetings, and collaborating with the central CNR office devoted to the management of intellectual property developed by its Institutes. Actions implemented: assessment of the expected results (see Section 1.4) by the means of individual interviews with each Beneficiary Project scientific coordinator; updating and more precise definition of the Background with respect to the first formulation contained in the Consortium Agreement.

2.6. Participation in the pitching session of the first EIC Pathfinder BootCamp

Project representatives from CNR-ISTC participated as EIC Pathfinder beneficiaries in the first EIC Pathfinder Bootcamp (16 -19 February 2021) to acquire better knowledge and opportunities on how to reach the market. The IM-TWIN Project was presented in the final day dedicated to

pitches in the Health section, collecting important suggestions and feedback by EIC Coaches on the main criticalities of the market strategy proposed.

The Pitch conducted by Gianluca Baldassarre (Project Coordinator) was focused on one of the components of the IM-TWIN System, the PlusMe device, being at that time the component with a more advanced TRL. The PlusMe device was presented both as a toy (Intelligent Toy market) and as a therapeutic tool (Assistive Robotics ASD related market).

The major issues expressed by experts in their feedbacks concerned the necessity:

- to better differentiate the two products (target users/consumers and relative costs);
- to define partners and the persons directly involved in the team;
- to better quantify the effort and the investments needed for the clinical validation of the tool;
- to gather strong evidence of the improvement in the therapy efficacy (in absence of patents, this can be an inappropriable asset);
- to analyze and quantify the SOM for ASD Market;
- to verify the IP potential;
- to more accurately estimate the toy market size, with a warning about its possible restricted size, considering that the case of a mono-product for a small market is not interesting for investors.

The participation in the EIC Bootcamp gave the chance to braden the dissemination activity of the IM-TWIN project within the EIC Community, see the article “Pathfinder Bootcamp: From Lab to Market” at the following link:
https://eic.eismea.eu/community/articles/eic-pathfinder-bootcamp-lab-market

2.7 Scientific Publications

N. 5 Publications (D 6.1)

- **2021) X-8: an experimental interactive toy to support turn-taking games in children with Autism Spectrum Disorders**, B. Özcan, V. Sperati, F. Giocondo, G. Baldassarre, extended abstract presented at *23rd International Conference on Human Computer Interaction, HCI International 2021; p*ublished in Stephanidis C., Antona M., Ntoa S. (eds), *HCI International 2021 - Posters. HCII 2021. Communications in Computer and Information Science,* pp 233-239, vol 1419, Springer, Cham, DOI: 10.1007/978-3-030-78635-9_32

- **(2021) Link between topographic memory and the combined presentation of ADHD (ADHD-C): a pilot study,** N. Faedda, C. Guarilia, L. Piccardi, G. Natalucci, S. Rossetti, V. Baglioni, D. Alunni Fegatelli, M. Romani, M. Vigliante, V. Guidetti, *Frontiers in Psychiatry* 12:647243, DOI: 10.3389/fpsyt.2021.647243

- **(2021) A 1D CNN for High Accuracy Classification and Transfer Learning in Motor Imagery EEG-Based Brain-Computer Interface.** F. Mattioli, C, Porcaro, G. Baldassarre. *Journal of Neural Engineering. https://doi.org/10.1088/1741-2552/ac4430.*

- **(2022) The fast Continuous Wavelet Transformation (fCWT) for real-time, high-quality, and noise-resistant time-frequency analysis**, Arts, L.P.A. and van den Broek, E.L. *Nature Computational Science, 2(1)*, 47–58. *[featured, extended cover article]* DOI: https://doi.org/10.1038/s43588-021-00183-z

- **(2022) The fast Continuous Wavelet Transformation (fCWT) for real-time, high-quality, and noise-resistant time-frequency analysis,** Arts, L.P.A. and van den Broek, E.L. *Nature Computational Science, 2(1),* Code Ocean code repository. DOI: https://doi.org/10.24433/CO.8389373.v1

N. 3 Submitted Publications

- **(2022) A Novel System with a Smart Toy Responding to Child's Facial Expressions: Potential Use in Early Treatment of Autism Spectrum Disorders,** F. Mattei, F. Montedori, M. Schembri, V. Sperati, B. Özcan, G. Baldassarre, *CHI - Conference on Human Factors in Computing Systems, April 30 – May 6, New Orleans, LA.*

- **(2022) Leveraging curiosity to encourage social interactions in children with Autism Spectrum Disorder: preliminary results using the interactive toy PlusMe,** F. Giocondo, N. Faedda, G. Cavalli, V. Sperati, B. Özcan, F. Giovannone, C. Sogos, V. Guidetti, G. Baldassarre, *CHI - Conference on Human Factors in Computing Systems, April 30 – May 6, New Orleans, LA.*

- **(2022) Emotions modulate affordances-related motor responses: a priming experiment,** F. Giocondo, A. M. Borghi, G. Baldassarre, D. Caligiore. *Frontiers in Psychology Emotion Science.*

3. Forthcoming actions

3.1 Rescheduling of deadlines due to covid-related delay

As a results of the 9 months extension AMENDMENT 952095-7 submitted in December 2021 a number of deliverable of WP 5 initially planned by M12 has been postponed and several tasks have been extended, as detailed below:
WP5:

- *T5.1 Presentation of IM-TWIN System* has been extended by 9 months (from 24 to 33 months) and will end at M33 (Jul 2023);
- *T5.2 Customer/user engagement analysis* has been extended by 9 months (from 18 to 27 months) and will end at M33 (Jul 2023);
- T5.4 *IPR Analysis and Strategy* has been extended by 9 months (from 15 to 24 months) and will end at M33 (Jul 2023) The deliverable is among those subcontracted to Quantum-Leap - Infinity Edge, it is currently in draft, and it is planned to be discussed for the final review and approval by the Partners.
- T5.5 *SWOT Analysis and addressable-market analysis* has been moved from M16 (Feb

2022) to M24 (Oct 2022), the duration has been extended by 2 months (from 3 to 5 months) and will end at M28 (Feb 2023);
- T5.6 *Startup feasibility Study and business model* has been moved from M13 (Nov 2021) to M24 (Oct 2022), the duration has been reduced by 2 months (from 12 to 10 months) and will end at M33 (Jul 2023).

3.2. Exclusion of Families as target of direct engagement and dissemination activity

Following the decision not to include families as direct targets of the engagement/dissemination activity, as initially planned, due to ethical reasons of opportunity (see 2.1) (Request for Amendment under evaluation) the "Professional Video directed to families of children with ASD" will not be realized. The same information can be conveyed in the deliverable D6.5,"Professional video on IM-TWIN as therapeutic tool", which will report the project outcomes in a more neutral way based on sound scientific evidence. Families will be engaged in the co-design (test on the acceptability and usability of the devices) and with dedicated "Open days for families" at the very end of the project, when it will be easier to give parents a more reliable overview of the project's concrete outcomes thus avoiding the generation of unfilled expectations

3.3. Participation in EIC Services

To support the development of new competences necessary for managing the whole process of exploitation of the Project results, ISTC-CNR and other beneficiaries' members will be involved in the EU support services initiatives.

Already planned:

- **EIC Women Leadership Programme** (started in October 2021, ongoing, Ozcan is selected as one of the "50 women in science in EU" for the programme)
- **Horizon Results Booster**, Service 1 Portfolio Dissemination & Exploitation Strategy, Module C **Assisting projects to improve their existing exploitation strategy** (planned for March/April 2022, Sperati)
- **Horizon Results Booster**, Service 2 **Business Plan Development** (planned for March/April 2022, Schembri)

3.4 Next deliverables

The Consortium shares a strong commitment to guarantee the full implementation of the planned activities, detailed below, taking full advantage of the extension of the duration of the Project (Request for Amendment under evaluation).

The prosecution of the exploitation strategy is largely based on what was described in the proposal and GA, with the refinements arising from the inputs received during the Review Meeting held on January 21 2022, suggesting an overall refocusing of the Project exploitation strategy on the more realistic achievable commercial exploitation goals (see Chapter 5-Conclusions)

According to the changes requested (Amendment under evaluation), the deliverables of WP 5 have been remodulated as follows:

D5.5 (MS5) End-user engagement questionnaire 1 (July 2022)
Outcome of questionnaire evaluating user-expectation and propensity to use/ purchase (the categories of potential users that will be targeted will be limited to therapy centers, therapist and families, to concentrate the attention on the refocusing of the exploitation process on one single product - the IM-TWIN System as a whole - to build the path-to-market on)
D 5.4 IM-TWIN system Booklet 2. (August 2022)
Final booklet and material for presentation of IM-TWIN system to relevant stakeholders as redefined in line with the need to focus the exploitation strategy on the best marketable product with its specific unique selling proposition.
D 5.8 Identification of target groups and relevant stakeholders 2 (January 2023)
Revised database of target groups and key actors potentially interested in adopting and applying the IM-TWIN system or one of its components.
D5.11 (MS10): SWOT analysis, addressable-markets analysis. (February 2023)
Market analysis on the Im-TWin system in the possible areas of applications (ASD Therapy and early Diagnosis)
D5.12: **Country-based exploitation questionnaire and stakeholder interviews** (March 2023)
Identification and contacts with the relevant country stakeholders and key actors.
D 5.6 End-user engagement questionnaire 2 (May 2023)
Outcome of the questionnaire to evaluate the user-experience (satisfaction, functionality) (selected target groups of primary end users:therapists)
D 5.10 IPR analysis and strategy 2 (M15) (June 2023)
Revised IPR analysis defining a shared IPR strategy to possibly protect any future commercial use of the project knowledge.
D.5.2 Exploitation plan 3 (July 2023)
Exploitation plan reviewed accordingly with the results of the previous activities (Swot Analysis, Market analysis, networking with the stakeholders, assessment of the user-engagement)
D 5.13 (M16) Feasibility study and business model (July 2023)
Study to create a startup aimed at reaching the requisite of a pre-acceleration stage within the period of the project.

Chapter 3 - Current results to be exploited

This chapter reviews the current results achieved during project research activities and discusses how they can be exploited. It is drawn up on the basis of the Innovation Radar Questionnaire and the complementar Transition Plan, already submitted to UE Services, as tools to refine expected pathway(s) to market for identified results, identify hurdles to overcome, Identify potential needs to support the implementation of this plan, during and beyond the lifetime of the funded project.

Two Innovations have been reported so far in the Innovation Radar. For these Innovations “Expected pathways to Market” and “Go to Market Milestones” have been formulated in the Transition Plan, as reported in the following tables.

It is worth underlining that these are the first 2 single components of the IM-TWIN system being developed. As described in the introductory chapter, there are other expected results currently under development (see 3.3). In addition to the first two potential innovations already identified, those other results could have an interesting potential for innovation. The Consortium intends to complete the development of all the research activities already planned and reserves to assess the maturity of results obtained by the end of the project to update the exploitation strategy in line with the inputs received during the first Review Meeting held on January 21 2022 (see Chapter 5 - Conclusions)

3.1 Innovation n. 1 - Interactive soft toy PlusMe

Description: Interactive soft toy PlusMe, for encouraging social skills in children diagnosed with Autism Spectrum Disorders during early therapy. - new product already developed but not yet exploited, obviously innovative with easily appreciated advantages for customers in growing markets (Toy Market and ASD Market), to be introduced as new **to the market in 1-3 years**, with a trademark already registered, with planned market and feasibility study and business plan, and desirable compliance with existing standards, open to the possibility of licensing the innovation to 3rd parties, and for further investments (capital or public fundings):

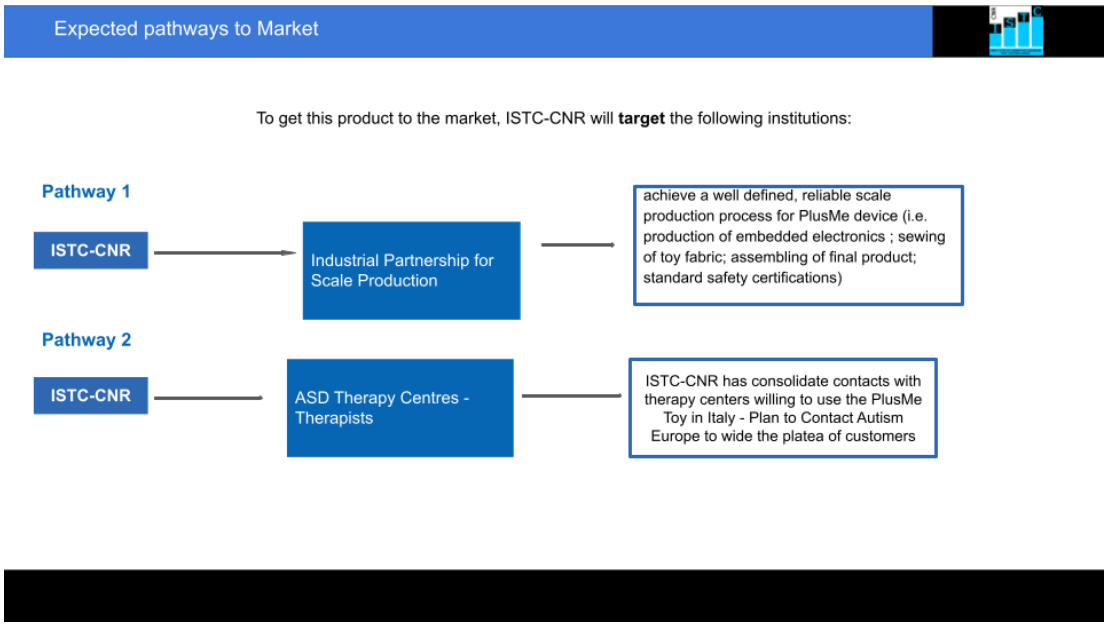

Table 3 - Innovation 1 - PlusMe Interactive Soft Toy Expected pathways to market

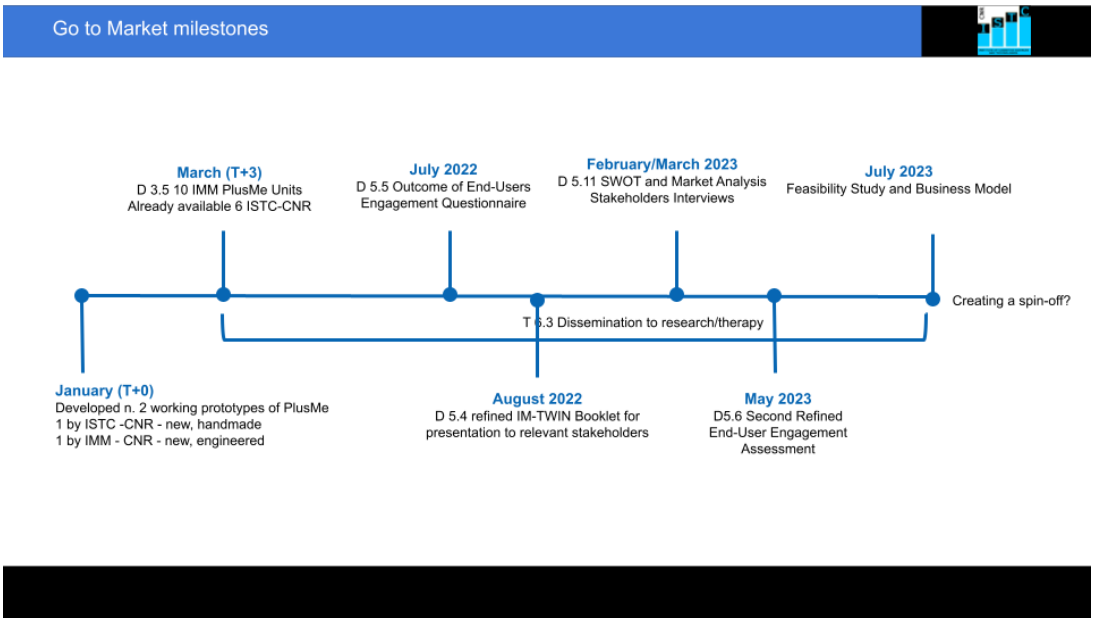

Table 4 Innovation 2 - PlusMe Interactive Soft Toy Go to market Milestones

Registered TradeMark of PlusMe Device

On 11/12/2021 it was registered the PlusMe European Union Trade Mark with the European Union Intellectual Property Office. Trade Mark number: 018509222.

The Trade Mark will be used as a tool to build brand recognition in the market. As established by the law, an EU trade mark must be put to genuine use in the European Union in the five years following its registration. According to the IP Strategy that will be defined by the end of the Project, the Consortium will consider whether and how to seek an extension of the trade mark outside the EU (through an individual application with any non-EU IP Office or an international application via the Madrid protocol).

First Production of PlusMe device

A small production (estimated in 25 samples, planned in the deliverables 3.5 and 3.6), is going to be entrusted – through subcontract – to a high-tech company expert in electronic manufacturing. Such company will be supervised by the Institute of Microelectronics and Microsystems CNR-IMM, the engineering institute – part of CNR – which realized the new prototype within the PlusMe project[1]. It is important to highlight that the new prototype was designed with industrial criteria, which allows a potential larger production.

First use and test of PlusMe device by therapy centers (targeted stakeholders)

The first copies will be made available to interested institutes active in ASD therapy for evaluation. At present, CNR-ISTC made informal contacts with at least 3 structures in Italy, which showed interest in evaluating the device:

- Foundation Stella Maris[2]: healthcare center treating ASD;
- CRC Balbuzie[3]: healthcare center treating ASD and Communication Disorders;

[1] For additional information, please see PlusMe project deliverable D1.1 "Identification of a research partner for engineering +me" at the following link: www.plusme-h2020.eu/deliverables/
[2] https://www.fsm.unipi.it/
[3] https://www.crc-balbuzie.it/

- Institute for Biomedical Research and Innovation, IRIB-CNR: research institute – part of CNR – active in ASD research[4].

Moreover, CNR-ISTC made an informal contact with the international association Autism Europe AE[5], one of the most important associations in Europe active in the field of ASD. Some of the contacts have been described in the deliverable D5.7 “Identification of target groups and relevant stakeholders, version 1”. Such structures could be then introduced to the other technological outcomes developed in the project.

3.2 Innovation n. 2 - Sensorized t-shirt

Description: Wearable physiological sensors in the form of a T-shirt for evaluation of children’s emotional state during therapy sessions - new product under development (demonstrator level) obviously innovative with easily appreciated advantages for customers in growing markets (Biosensors for emotional detection) and possibly to expand to more markets, to be introduced as new to **the market in less than a year**, with planned market and feasibility study and business plan, and desirable compliance with existing standards, open to the possibility of licensing the innovation to 3rd parties, and for further investments (capital or public fundings): - interest to enter Incubation/start-up accelerator.

[4] https://www.irib.cnr.it/en/institute/
[5] https://www.autismeurope.org/

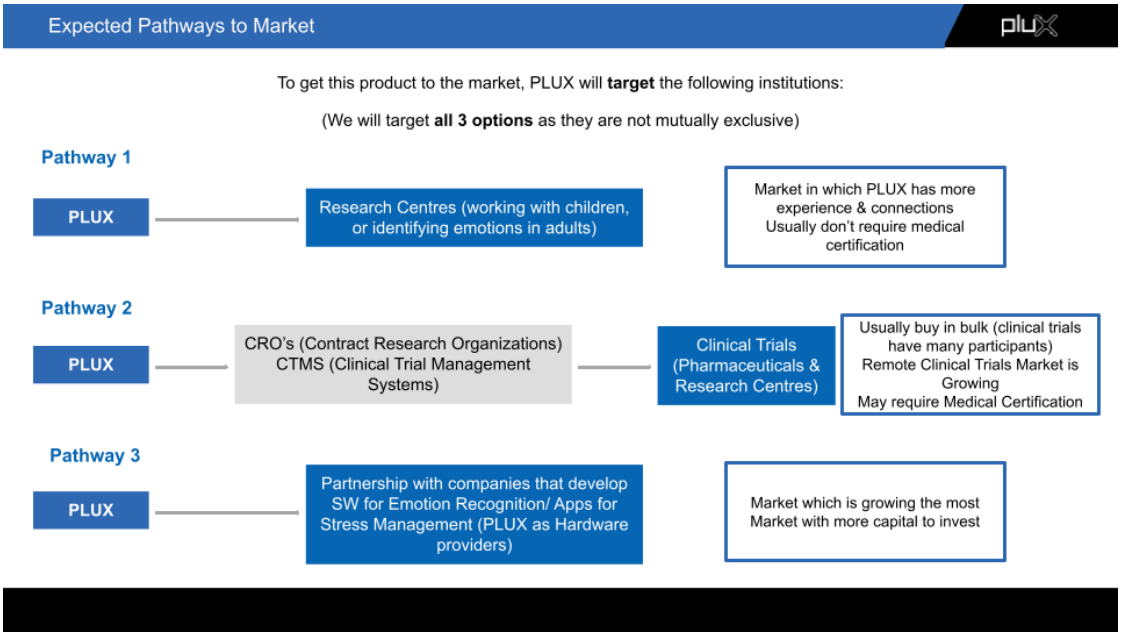

Table 5 - Innovation 2 Sensorized T-shirt Expected pathways to market

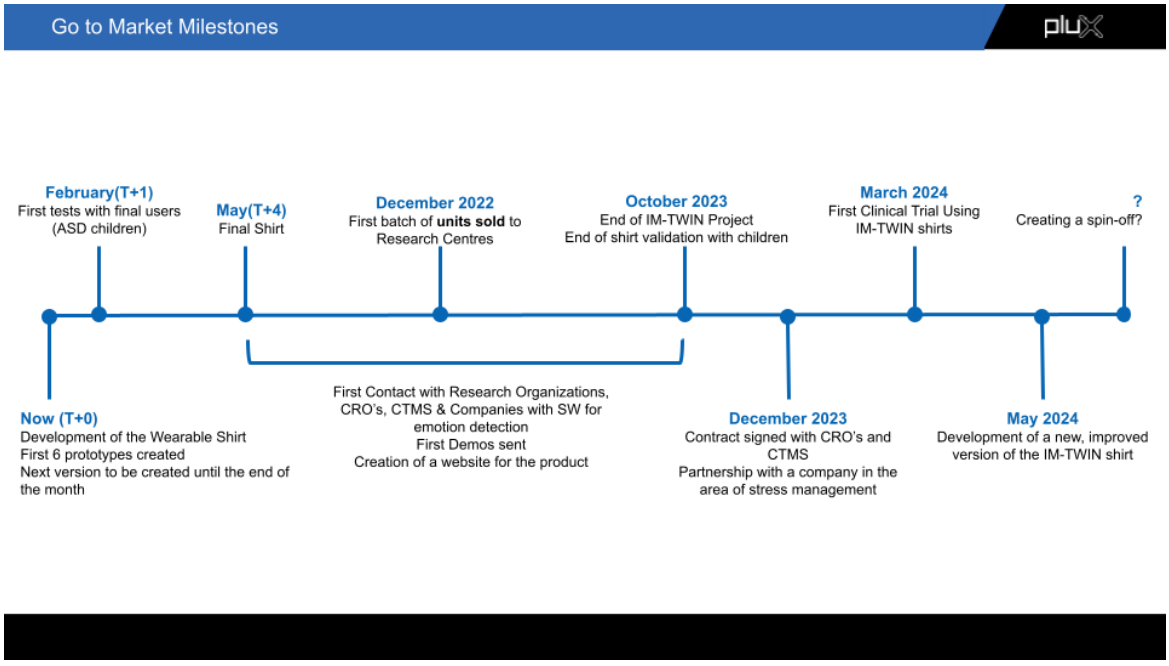

Table 6 - Innovation 2 Sensorized T-Shirt Go to market Milestones

3.3 Other results with potential for innovation

As described in the introductory chapter, the IM-TWIN Project aims at the development of several different components that can potentially be exploited both individually and together, as an overall IM-TWIN System).

At the end of the first year of the project activity, as seen in the sections above, two components have reached a degree of maturity that makes them interesting for exploitation activities, even if the Consortium reserves the right to revise the exploitation strategy, so to concentrate on the more realistic achievable results and related exploitation opportunities.

After Innovation 1 - Plusme Device and Innovation 2 - Sensorized Wearable, already described, the following results still remain interesting as new potential additional innovations that the Consortium can and want to achieve by the end of the Project:

3_ Affective Computing Algorithm
4_ IM-TWIN System

Furthermore, it must be considered that the research is continuing on all the components and since now it is possible to foresee a further upgrading of the Innovation 1 -PlusMe Device.

ISTC-CNR has developed in December 2021 a system that improves the PlusME “intelligence” through new computer vision algorithms and plans to verify the possibility of registering a patent.

Chapter 4 - IPR Analysis and Strategy

This chapter is intended to summarize and make preliminary general considerations about the IPR Analysis and Strategy (Report - Deliverable 5.9).

As a first and indicative summary, the activities implemented so far are the following:

- Analysis of the GA and CA Provisions on IPR management (summary of provisions)
- Provision of suggestion of actions to comply with (attention to protectability, preliminar check before disclosing)
- More detailed definition of Partners background with respect of CA (no rights of third parties are needed for project results)
- Discussion of creating an IP Portfolio and adopting a filing strategy to be discussed within the Consortium in relation to the possible business models of Open Innovation
- Discussion on attribution of joint-ownership in relation to project results (criteria of attribution, terms of the ownership may change according to the activities and the contribution made). Evaluation on the possibility to register one or more patents related to project results.
- Discussion on the possibility to release the code with an Open Source license taking into account the opportunity to identify a suitable license under which to release the software for a possible commercialization, with the possibility of dissemination of the results by the beneficiaries for research or educational purposes. It is advisable to carefully evaluate the case, based on the business model that will be defined.
- Preliminary patent landscape as to Innovation 1 and 2.

Consortium is to agree soon on a common-shared framework for the IPR management, as a tool to maximize the impact of the Project results.

The precise evaluation of the opportunity and the modalities to protect results will be related to the refocusing of the project objectives suggested by the monitors during the Review Meeting.

The IPR strategy, including a possible filing strategy, can then be properly defined only once not only the foreground of the project will be more clear but also once the value of these results is assessed through the identification of a clear business model based on a proper unique selling proposition (see Chapter 5 - Conclusions).

Partners have been engaged in the discussion on how to address the issue of (joint) ownership of results and it is currently under definition an overall IP agreement, including the definition of criteria for the attribution of the IP property. A new meeting of the Dissemination and exploitation Committee is to be scheduled soon to reach such an agreement.

Chapter 5 - Conclusions

The document describes the summary of IM-TWIN Exploitation, on the basis of the progress made during the first year of the Project activities.

The document takes into account the results of the first Review meeting held on January 21 2022, where a deep and fruitful discussion with monitors helped to identify the main criticalities for the exploitation of project results, and possible ways to address them.

Due to its high modularity, the project presents a significant number of current results (Innovation 1_Interactive soft toy Plusme, Innovation 2_sensorized T-shirt) and expected results (Innovation 3_affective computing algorithm, Innovation 4_IN-TWIN System), without considering the unforeseen results that may be further developed.

The Innovation 1 (the IM-TWIN component related to the sensorized t-shirt to detect physiological data related to affective state in children) shows at the moment the best chance to enter the market of wearables thanks to the company partner (PLUX) that can drive the commercial exploitation. The next steps suggested aim to develop a more user-centered design approach, with studies on the acceptability to the users (families and children) and ethical and risk assessment.

The path to the market of the Innovation 2 (the IM-TWIN component related to the interactive soft toy PlusMe) needs to be more carefully focused with a more precise definition of the product itself and its application area. It emerged the need of overcoming the ambiguity between the pedagogical and the therapeutic purpose and the opportunity to focus only on the therapeutic purpose, within the more general framework of the whole IM-TWIN System.

It is clear that once Innovation 3 (IM-TWIN component supporting the effective processing of data) and Innovation 4 (whole IM-TWIN system) are also developed, managing multiple options for commercializations is a big challenge but also represents a potential risk to deal with. The strategy that is to be discussed within the Consortium is to concentrate on the need to focus on the definition of one single marketable product (the whole *IM-TWIN system used as a modular and integrated platform to support therapy of children with developmental disorders*) and on the formulation of its unique selling proposition, once its added value is demonstrate, through a strong and continuous process of end-user engagement to test its acceptability and usability.

The Deliverable is the first of two and it will be updated at the end of the project (D5.2 -July 2023) Other updates will also be necessary as project results mature, and existing market and other conditions outside the project evolve.

To update the strategy, we will consider the results of the Deliverables D5.11: SWOT analysis, addressable-markets analysis (February 2023) and D 5.13 (M16) Feasibility study and business model for the creation of the start-up (July 2023).