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Ministero dell'Università e della Ricerca

FIT4MEDROB

D4.7.2

REPORT ON THE MAPPING OF STAKEHOLDERS' NEEDS AND ACTIONS #2

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David Natali (SSSA), Ivan Galligani (SSSA), Andrea Chiappetta (SSSA), Elena Vivaldi (SSSA)

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History of Changes

VERSION	SUBMISSION DATE	CHANGES
1	31/10/2023	Deliverable D4.7 First version
1.1	02/11/2023	Deliverable D4.7 Full version sent to external referees
1.2	21/11/2023	Feedback from the external referees
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1.4	12/11/2024	Feedback from the external referees (recommending publication)
2	09/12/2024	Submitted version

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1 EXECUTIVE SUMMARY

The present report explores the attitudes, expectations, concerns, and needs of the main stakeholders who are expected to be involved in the diffusion of robotic applications in healthcare and social care (with particular emphasis on home care). The report also provides evidence of some promising good practices for the implementation of robotics and digital technologies in in the field under scrutiny.

The work is fully in line with the reference Activity as it aims to investigate the approach of operators and stakeholders to robotic instrumentation, as well as the ways in which robotic services can be provided as an alternative to the nomenclator mechanism.

Through mixed methods – i.e. desk research literature review, interviews and focus groups – the report sheds light on the main roadblocks to and enablers of the diffusion of AI and robotics in health and social care. Compared to first and preliminary reconstruction of stakeholders' needs and actions, *Deliverable 4.7* (*Report on the Mapping of the Stakeholders' Needs and Actions*) submitted by November 2023, the present work is based on a further round of interviews with stakeholders; and the results of two focus groups carried out in the context of Mission 1: the first focus group 'TECHNOLOGICAL INNOVATION, ROBOTICS, AND HEALTHCARE: TUSCAN EXPERIENCES AND THE NATIONAL DEBATE' that took place the 5th of April 2024; and the second focus group 'ATTEMPTS TO SIMPLIFY ACCESS TO ROBOTIC DEVICES: THE INAIL EXPERIENCE' that took place the 17th of June 2024.

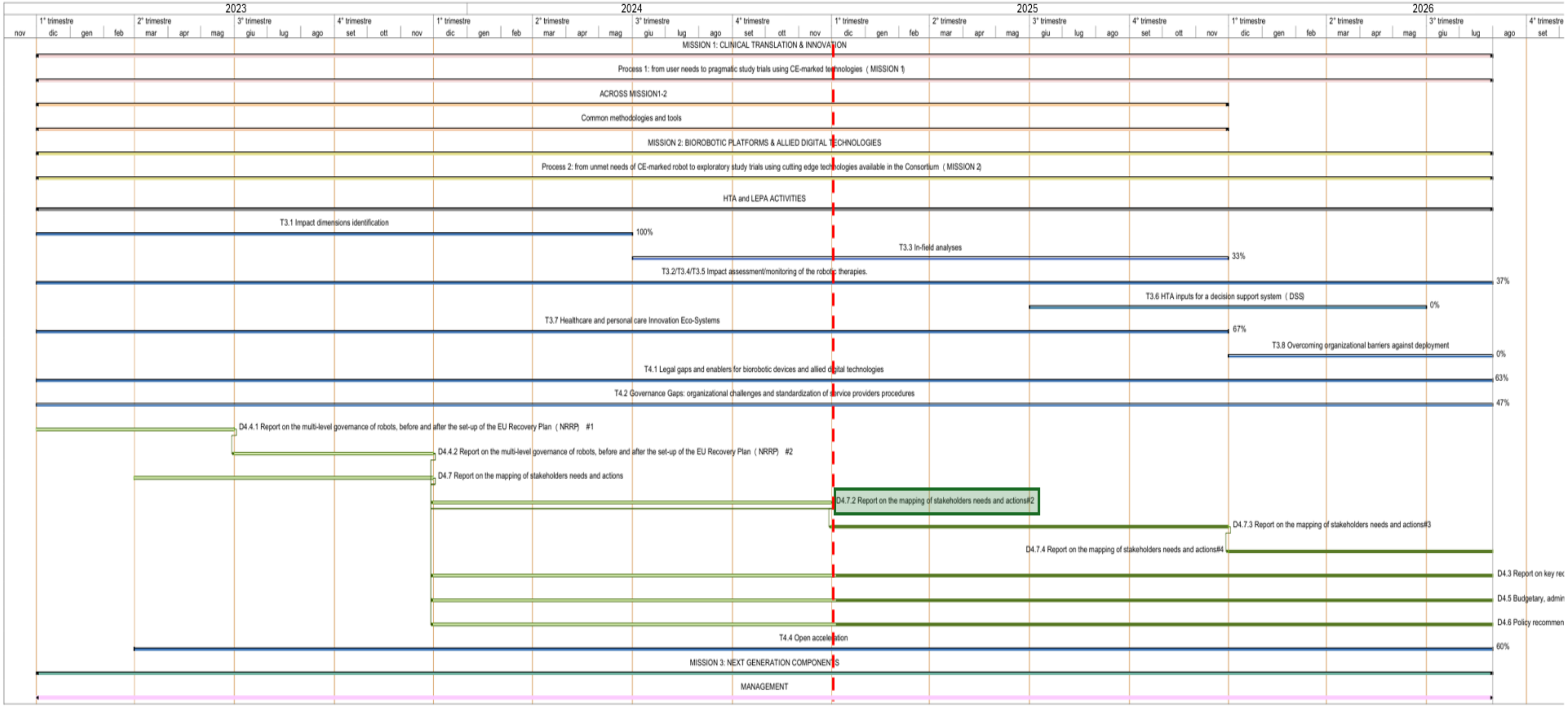
The present deliverable largely confirms the first results of our review (the one provided by *Deliverable D4.7*). Information collected so far prove the target groups of the study (like care workers, managers, and the same final users) have mixed attitudes about robotics.

Evidence provided by the report shows that while the attitudes of the public opinion are often positive, the three groups at the core of the analysis show different and mixed positions. Professional care workers tend to be sceptical about the diffusion of robots and new technologies. Negative opinions are based on the fear to be substituted by robots, and on the supposed need for additional training with the consequent risk of increased workload. Further worries are related to the risk of a deterioration of care services (e.g. due to the de-humanization of the same care activities) and the complexity of the interaction of machines and human beings.

Managers (including clinicians) and final users show mixed positions. Positive attitudes (based on the potential of innovative technologies for more effective care) are paralleled by negative attitudes. The latter are based on the supposed costs of skill-formation and re-training of the labour force, on regulatory challenges (protection of the patients' privacy and the responsibility for injuries and malfunctioning of new technologies), and problems of accessibility to robots and new devices.

The report proves that the more effective diffusion of information on the added value of new technologies and more open forms of coordination of the different stakeholders can improve the recognition of the potential value of robots and AI in care activities. Good practices (evidence referred to in the paper and listed in the annex), represented by seminal research projects that involved many of the target groups mentioned above, show the potential progress related to innovative strategies for the set up and diffusion of robotic technologies.

The present deliverable contributes to the main objectives of *Mission 1 (Clinical Translation and Innovation)* and to *Activity 4* dedicated to *Legal, Ethic and Policy Acceleration*, and it is submitted in line with the timeline of FIT4MEDROB (according to the GANTT in the next page). The deliverable D4.7.2 provides an update of the previous deliverable D4.7 with additional information on both roadblocks and enabling factors for the diffusion of robotics in the field, further evidence of good practices, and take stock of the reconstruction of the regulatory context provided by *D4.2 Report on awareness and regulatory gap analysis* with *stakeholders* and its recent integration (D4.2.1). At the same time it contributes to the next deliverables *D4.7.2* (further integration of the *Report on the Mapping of Stakeholders' Needs and Actions* due by Month 36) and *D4.3* (*Report on key recommendations for the effective governance of robots* due by Month 44). These further deliverables take into account the feedback provided by the anonymous reviewers who outline that the legal and administrative constraints that limit active participation of stakeholders are a promising field to focus on in the next steps of our analysis.


2023
2024
2025
2026
MISSION 1: CLINICAL TRANSLATION & INNOVATION
Process 1: from user needs to pragmatic study trials using CE-marked technologies (MISSION 1)
ACROSS MISSION1-2
Common methodologies and tools
MISSION 2: BIOROBOTIC PLATFORMS & ALLIED DIGITAL TECHNOLOGIES
Process 2: from unmet needs of CE-marked robot to exploratory study trials using cutting edge technologies available in the Consortium (MISSION 2)
HTA and LEPA ACTIVITIES
T3.1 Impact dimensions identification
100%
T3.3 In-field analyses
33%
T3.2/T3.4/T3.5 Impact assessment/monitoring of the robotic therapies.
37%
T3.6 HTA inputs for a decision support system (DSS)
0%
T3.7 Healthcare and personal care Innovation Eco-Systems
67%
T3.8 Overcoming organizational barriers against deployment
0%
T4.1 Legal gaps and enablers for biorobotic devices and allied digital technologies
63%
T4.2 Governance Gaps: organizational challenges and standardization of service providers procedures
47%
D4.4.1 Report on the multi-level governance of robots, before and after the set-up of the EU Recovery Plan (NRRP) #1
D4.4.2 Report on the multi-level governance of robots, before and after the set-up of the EU Recovery Plan (NRRP) #2
D4.7 Report on the mapping of stakeholders needs and actions
D4.7.2 Report on the mapping of stakeholders needs and actions#2
D4.7.3 Report on the mapping of stakeholders needs and actions#3
D4.7.4 Report on the mapping of stakeholders needs and actions#4
D4.3 Report on key rec
D4.5 Budgetary, admin
D4.6 Policy recommen
T4.4 Open acceleration
60%
MISSION 3: NEXT GENERATION COMPONENTS
MANAGEMENT

2 INTRODUCTION TO STAKEHOLDERS' NEEDS AND ACTIONS IN THE FIELD OF ROBOTICS AND DIGITAL TECHNOLOGIES

In the context of MISSION 1 of FIT4MEDROB, one of the objectives of the project is to identify the needs of the target groups and of healthcare practitioners, while inquiring the candidate robots and allied digital technologies addressing those needs. Objective 3 of the project has to do with the identification of the technical requirements to be used as references for the implementation of the activities. The aim is to contribute to identifying the main roadblocks that may hinder the diffusion of AI and robotics in healthcare and social care activities.

The present report contributes to these objectives with the review of stakeholders' needs and actions in the field. For stakeholder we mean a person, group, or organization involved in or affected by a course of action [1]. In the field of health and social care, this broad category includes patients, communities, providers, researchers, advocacy groups, and policy makers. Investigating their attitudes, needs and concrete actions in the field of AI and robotics is crucial in that it allows to shed light on societal demands and broad attitudes and positions towards new technologies. The diffusion of the latter is often shaped by stakeholders' needs and actions. In what follows we thus provide an up-to-date review based on desk research, two rounds of pilot interviews, and the information collected through two focus groups carried out by the Sant'Anna research team.

A preliminary qualification of the research strategy and methods used here is needed. As shown by the first literature review included in *Deliverable 4.7,* much of the analysis is focused on the sub-field of home care. The latter is a critical case in that it is a field where the number of stakeholders is particularly high. Patients, their relatives, and home care givers represent key target groups of the new technologies. At the same time, care activities at home are complex due to the need for interaction of different actors. Thus, their coordination is crucial for the services to address effectively medical, and assistance needs. For those reasons, in what follows we thus mainly refer to home care cases.

As for the target groups to review, FIT4MEDROB refers to four main categories: clinicians, representatives of scientific organisations, final users (i.e. patients and caregivers) and policymakers. The literature, especially from northern Europe, tends to simplify the same targets and refers to three main groups: professional care workers (like nurses, and physicians), managers (including clinicians), and final users. In what follows we refer to these simplified types of targets.

As for the exploratory interviews and focus groups, we have involved mainly clinicians and Third Sector Organisation (TSO) representatives. Clinicians are extremely relevant at the actual stage of diffusion of AI and robotics. As we show in the next pages, in Italy and many European countries, robotics and digital technologies are not particularly widespread. Much of the evidence collected so far refers to pilot experiments and exploratory projects that test new technologies – especially robots – to address critical health conditions. The same new technologies are thus emerging but still need to be further spread. In this context, the role of clinicians is crucial. They drive experimental projects. They participate in the first diffusion of new technologies while observing the needs of the users and the potential limits to the further diffusion of new practices. Consequently, this category is extremely important to be investigated through the collection of a few exploratory interviews.

Regarding TSO, their involvement is justified by the strategic role they play in the provision of social and health services in Italy. Although the uptake of robotics in this operational field is even lower than in the clinical sector, these organisations will inevitably represent key players in the spread of these technologies in home care. In our research we opted to also involve representatives of organisations that have already tested robotic and related technologies in their daily activities, to gather their opinion on the factors that represent a barrier to greater adoption.

The report is structured as follows. Section three provides a first grid for the analysis of social and technical issues related to AI and robots in health and social care. We stress that the diffusion of new technologies depends on the right match between supply and demand. Research and technological innovations must meet the demand of the potential users to improve the opportunities for their further diffusion. Users' demands are influenced by needs but also perceptions and attitudes. Section four provides evidence of the first mapping of stakeholders' needs and actions. Desk research is the first source of information with additional information collected through further pilot interviews and the two focus groups organized in Aprile and June 2024. Section five summarises good practices on both needs and actions. The latter are taken from the literature and from pilot projects we present in more detail in the Annex. Section six concludes.

3 Socio-technical issues regarding AI and robots in welfare and healthcare

As we show below, stakeholders' enthusiasm for investing in robotics for the welfare and healthcare sectors is growing rapidly. Yet, limits in the diffusion of new technologies are evident. The latter are often related to the lack of preparedness of stakeholders in dealing with the same technologies in the field of health and social care. This reminds us of the importance of needs (things that are important for a satisfactory life) and users' perceptions (i.e. attitudes and feelings regarding opportunities and risks related to the instruments intended to address these needs).

As for the potential for the spread of new technologies in the fields under scrutiny here, the global market of socially assistive robots was predicted to grow from 321 million USD in 2018 to 836 Mn. in 2025 [2]. Following the actual and expected tendencies of growth rate, the global market is expected to reach a size of 1.7 billion dollars in 2030. [3]. Furthermore, Europe is a leading market for general robotics technologies (behind only the Asian market), and the healthcare sector is one of the main vectors of this growth [4].

Therefore, the European Union (EU) institutions consider such investments as highly strategic for the future of healthcare systems of the Union, as demonstrated by its investment of at least 235 million € in the 2004-2019 period [5]. This commitment is pushed not only by the potentialities offered by the exponential advancement of digital technologies, AI, and robotic applications, but also by macro-dimensional processes related to demography, healthcare, and welfare systems. European societies are characterised by population ageing and growing care needs for chronic diseases. At the same time, the size of the formal and informal healthcare workforce is in shortage [6]. Thus, applications of *welfare technologies* [7], and, specifically, *assistive robots*, are seen as valuable solutions to cope with the growing need for care for the elderly [8].

The research in the field has detected many innovative applications [9],[10],[11],[12],[13]. In this regard, some distinctions are to be made. The first is between robots applied in surgical and hospital contexts or in home-care arrangements. Regarding the latter – which are the main object of this review – we can identify three different main functions: the monitoring function (related to telemedicine solutions), socially assistive functions, and physically assistive functions. Robots with socially assistive functions provide direct support to users by ensuring companionship or basic assistance (e.g., handling objects). Robots with physically assistive functions (e.g., exoskeletons, orthoses, prostheses, etc.) can be well employed both for rehabilitation purposes and/or long-term continual assistance for prolonging older adults' independent living.

Despite these promises, the actual diffusion of home care robots outside the experimental and pilot settings – that is, solutions available in the ordinary practices of welfare services – is still very limited, with the exception of few local context in the Nordic countries (e.g., for Finland [13][14]; for Sweden [15]; for Denmark [16]).

The literature has so far provided evidence of many roadblocks. The first reference is to *low technological readiness* of robotics applications, especially in home-care settings rather than in hospital structures [18], and to the *incomplete social preparedness*. Further challenges derive from the complexity of the organizational context of the home-care services. This complexity can be represented by the multitude of impacts that the introduction of these technologies may have on consolidated work practices, financial and regulatory frameworks, professional cultures and identities, and, for these reasons, the barriers, pitfalls and resistances that they may encounter [19].

In other words, in the field of health, social and home care, the implementation of new technologies and, specifically robots, requires not only technological innovations but also *socio-technical* ones [20]. This means that technologies are not inserted *in a vacuum*, but in social and organisational environments in function of which the former need to be adapted. Since social environments too are inevitably shaped by technological instruments, there is consequently a need for time and efforts to promote *co-adaptation* and *co-evolution* processes between instruments and their users to permit the consolidation of the innovation [21].

An additional source of complexity stands from the heterogeneity of the stakeholders involved in this process [22]. This broad network in need for effective coordination may include researchers and companies that experiment and develop robots, manufacturers and selling companies, care services administrators and managers, care workers, as well as informal caregivers and final users. For this network, intensive knowledge exchanges in the development process, and active collaboration in the implementation phases, are essential for the effective adoption of robotics-based services. Nevertheless, these collaborations are frequently weakened by a lack of shared vision and common language, boundaries between disciplines and sectors (the so-called "silos logic"), and lack of mutual working experiences [21], [23].

Deliverables 4.2, Report on awareness and regulatory gap analysis with stakeholders and its integration (*D4.2.1*) as well as the focus group organized by the Sant'Anna research team in June 2024, provided evidence of these organizational roadblocks. A compelling illustration of the 'silos logic' associated with the introduction of robotics in healthcare, along with its wider implications, can be observed in the Italian context, particularly in the current state of access to advanced technological prostheses (including robotic prostheses). In Italy, prostheses are provided either by the National Health Service (NHS) or by the Italian National Institute for Insurance against Accidents at Work (INAIL), depending on the cause of the disability. The two public bodies have different administrative procedures. The NHS has more limitations since its prescriptions must stick to the nomenclature: the official list of health services and medical devices covered by the Basic Levels of Care (BLC), that must be guaranteed by the Italian NHS. INAIL is free from both quantitative and qualitative restrictions, which gives it the flexibility to offer robotic devices even if they are not included in the latest BLC nomenclature.

As emerged from a focus group led under component D.4.2, the decision-making process for the distribution of such equipment is based solely on criteria of effectiveness and appropriateness: if a robotic device is considered essential for a patient's clinical situation, INAIL provides it, regardless of its inclusion in the rehabilitation services listed in the nomenclature. Thus, it can be asserted that INAIL operates 'beyond' the BLC, providing cutting-edge devices while the NHS remains constrained by the nomenclator and associated tariff schemes. Notably, the nomenclator makes no explicit reference to robotic devices, except in the case of Item 93.11.G, which addresses 'Motor rehabilitation through high-technology, robot-assisted devices for serious pathologies secondary to lesions of the central nervous system, excluding neurodegenerative conditions.' As a result, the NHS's operational scope is much narrower compared to INAIL's greater flexibility. Since INAIL's services are exclusively available for work-related injuries, this creates a dual pathway: individuals with amputations resulting from workplace accidents have relatively straightforward access to robotic prostheses, whereas access is significantly more challenging for victims of non-work-related accidents.

A twofold reflection regarding the organizational frameworks governing health services emerges, with particular focus on healthcare and robotics. Firstly, it is evident that variations in the structuring of these services lead to substantial disparities in outcomes for individuals requiring support. Specifically, the omission of broader classifications for robotic prosthetics within the existing nomenclature has resulted in significant inequities in access, contingent upon the nature of the injury—whether sustained in the workplace or otherwise. Furthermore, the expertise acquired by INAIL in this domain has been almost unnoticed, failing to play a role in the revision of services listed in the BLC nomenclature. According to what emerged in the focus group, INAIL representatives has been regularly called to present their insights to the Commission tasked with updating BLC services, but these hearings have consistently failed to yield tangible outcomes. A more open form of governance, managing to functionally integrate stakeholders' insights and knowledge into the existing legislative framework might thus contribute to the enhancement of the diffusion of robotics in healthcare.

Eventually, there is also a possible misalignment of interests and motivations between the actors at stake [24], [25]. For that reason, it becomes strategic to promote the motivations and the commitment of all involved actors to strengthen and consolidate the implementation of robotic innovations in healthcare: «People do not automatically start using technology or robots; individuals' behaviors and actions towards any technology will be affected by each person's priorities and assumptions, expectations and understandings of the technology in question, such as perceptions about whether a technology can help them attain their goals or not» (p.312: [26]).

To achieve the further diffusion of AI, robotics and new technologies in health and social care, a key prerequisite is thus the prior assessment of the attitudes, expectations, and interests of stakeholders towards assistive care robots, with the aim to promote the match between these expectations and the potentialities offered by technological innovations. In this perspective, an exploratory mapping of the needs and actions of the relevant stakeholders will be conducted in the next paragraphs.

4 Exploratory Mapping of Expectations, Concerns and Needs of the Most Involved Actors

The exploration and mapping of attitudes (expectations, concerns), and needs of the main stakeholders who are expected to be involved in the implementation of robots in home care settings is conducted below through a review of relevant literature and few explorative interviews with experts.

A substantial body of studies has investigated the attitudes of actors in terms of 'robot acceptance' [27], [28], while the studies of people evaluation of existing experience are quite scarce, due to the still innovative feature of robotic applications in non-pilot contexts [24]. For the scope of our investigation, the discussion will mention large surveys [29] only when needed, while will be prioritised 'implementation experiences in real context' (e.g., [17], [30], etc.), or, at least, evaluations provided by professionals with direct experience of robot implementation (e.g., [21][26], etc.).

The literature review is also integrated by evidence collected in field research: we conducted six interviews with distinguished experts in health robotics at a national level (three of them are university professors). Afterwards, a focus group was carried out involving other seven experts: four representatives of the Third Sector with experience in the implementation of robotics; two trade union representatives of the medical and nursing sector; and a local manager of the RHS with great experience in robotic rehabilitation.

This kind of information is obviously not intended as sources to refute or confirm literature findings – which are, moreover, mainly related to non-Italian context – but rather to concur to the mapping of expectations, needs, and good practices. Finally, an extensive picture of the identified relevant issues, which will be analysed in depth in the subsequent Fit4MedROB research activities.

To approach the topic, field-based literature has put the attention predominantly on the different types of stakeholders: professional care workers (e.g. nurses), managers of care services and, most frequently, final users (e.g. elderly; children, etc.). Accordingly, our discussion will be organised in relation to these three different categories of actors.

4.1 Professional care workers

Due to the large potential impact on frontline services of the introduction of robots in healthcare, and the key role of professional workers in the implementation of these technologies (such as nurses, home-care operators, etc.), many researchers have put the attention to attitudes of this workers towards care and socially assistive robots.

Studies based on attitudinal surveys show that while the disposition towards robots in the broader public is often positive, opinions tend to be more negative in regards of the use of robots in care services [29],[31]. Focusing more on variations in attitudes in relation to specific professional fields, research shows that care workers are among those with the most negative attitudes, even when workers have little or no experience in using robots [24], [32], [33], [34]. However, the same studies emphasise that actual knowledge of care workers regarding robots is often scarce, and that, for care workers as just for the general population, positive attitudes tend to increase proportionally with the amount of direct experience in the use of robotic devices.

These facts highlight the importance of information, orientation, and direct training of professional care workers [35],[36],[36bis], as well as the need to take in consideration concerns, expectations, and needs of these strategic actors for care robot implementation [26].

One of the main referred concerns of care workers is the fear of being substituted by robots, and so lose their job [28],[29],[32],[34],[37]. That worry derives from a misinterpretation of the intended role of robots in care practice, as well as an overestimation of actual and future robotic potentialities (also related to the lack of effective knowledge on robotics application: [21]). In any case, care robots are not aimed as a replacement for professional workers, but rather to complement their work [24]. As vividly represented by one of our interviewees:

Nobody wants to substitute professionals with robots. Somebody has estimated the amount of economic savings obtainable with that substitution, but I think it is just an academic exercise. No one believes that robots are going to be more effective in therapeutic settings than humans. The right perspective is to conceive technology as a complement of the work of professionals. The question is the maximization of the therapeutic advantage offered by *technologies. Home care robots could assure promptness and continuity of assistance when doctors are (temporarily) not available. They could monitor physical parameters and transmit information to the doctor, and so on. Moreover, robots could conduct some standardised and simple therapeutic practices to free time for professionals to work more on practices with therapeutic added value (and even for more users). In other words, I conceive robots similarly to a medication, which is an instrument available for therapists, but which does not substitute them (Int.#1).*[1]

Under this perspective, care workers might envisage also positive practical consequences on their daily work from the introduction of robots, such as support for physically intensive tasks (e.g., heavy lifts[2]), and correlated work injuries, as well as the reduction of the work burden for simple operations (e.g., cleaning, cooking, etc.) [29],[30]. This aligns with findings from two Finnish studies, showing higher appraisal by healthcare professional for using robots only in indirect nursing care situations compared to employing them in tasks involving direct interaction with the patient [36bis], [37bis].

However, even setting aside the worst concerns (i.e., the substitution of workers), the professionals' perceptions remain characterised by a prevalence of potential negative issues. Parvianien, Turja and Van Aerschot [37bis], found that the majority of the 3800 professional care workers involved in their attitude survey did not consider the use of robot in healthcare consistent with their personal values.

In terms of everyday practices, the introduction of robots will determine, at least at the beginning, a need for intensive training to know how to manage the instruments. This is seen like a problem not only because of the strain of re-skilling but also as a cause of loss of control over the conditions of working practices. For example, the qualitative exploration of Blond [17], and Frennert and colleagues [26], both reported the insecurity of frontline workers about their capacity to master and use care robots and, even more, in face of potential malfunctions. What is more, the general concern of practitioners regards the effect of these instruments for patients, in terms of safety and quality of care.

Moreover, many studies report concerns of professionals towards uncertain and otherwise undesirable reconfiguration of care work. The most frequent apprehension regards the dehumanisation of the processes [19],[29],[38]. This threat is represented like a reduction of direct human contact, "cold" operationalisation of assistive and therapeutic practices ('mechanised care') and a subordination of professional practices under the technological necessities (rather than the contrary), determining a substantial loss of professional autonomy [26] [39], [40]. A representative example of the latter outcome is carried out by the ethnographic study of Wright regarding the implementation of two different robots in residential care settings in Japan [39]. For the workers participating in the study, the use of those devices, rather than replacing them, has determined a displacement of them to other tasks, in order to face requirements of robots' operativity. For the participants, this paradoxically implies an increase in tasks and workloads, which are redirected from human care recipients to the robotic device and consequently pushes workers to perceive themselves as 'machine babysitters' [39], [41].

In other words, what is at stake are the professional prerogatives of care workers, not only as service providers while as people committed in a care relationship, that it is what that robot (obviously) cannot be [26]. Workers perceive themselves as committed in interpreting changing care situations and circumstances, thus adapting practices accordingly to the specific needs of the patient. Moreover, care implies mutual trust, respect, consideration and understanding between care recipients and caregivers, whereas care robots symbolise standardised practices. Finally, for professional care workers, the issue with robots is the perceived threat that these changes may mean a depreciation of their work [41].

A common denominator of all three studies was that healthcare professionals might need an introduction to social robots and vocational courses should be organized.

To sum up, the different contributions in the contemporary literature outline that together with investments in training, the design of robots and the related organizational practices are crucial to enable the diffusion of robotic technologies in health and social care. The latter should be carefully designed in line with the needs of care workers. This strategy seems promising in changing the attitudes and perceptions of care workers. These instruments could consequently be considered as useful for workers themselves, and not as a threat for their professional prerogatives.

[1] The referred text of the interviews, in Italian in original, has been translated in English by the Authors of the report.

[2] See the good practice described in Box 4 and Box 5 below.

4.2 The management

The extent and multiplicity of potential impacts of the diffusion of robots in organisations means that the management level should play a crucial role in the technological transition of home-care services.

In terms of general attitudes, managers often show more positive attitudes toward care robots than frontline workers [25]. In comparison to the latter, managers clearly have less apprehensions about the possible negative impact of robots in their work practices and also in their role prerogatives. On the contrary, they see the introduction of robots as a valuable opportunity to improve quality of care and time and cost efficiency [16][26][32]. Furthermore, in terms of 'professional identity', the acquisition of robot technology can sometimes also be perceived by managers as an opportunity to assume the role of 'innovator' and acquire professional status [25]. This can sometimes lead to conflicts with their frontline workers, when these introductions of new technologies are perceived by the latter as merely top-down initiatives, disjointed by the actual necessities of care practices [42][43].

Nevertheless, managers also perceive several problems of preparedness for robot implementation. The most cited is the concern about the lack of skills of their frontline workers [25],[36], as well as possible workers insufficient active participation, or even worse, resistances [19],[21]. Moreover, in accord with their leadership position, managers are also frequently concerned about issues of legal responsibility for the operativity of robots [26]. Due to the novelty of these applications in welfare settings, there is a need for a new regulatory framework that clearly defines the share of responsibility between robot producers and (professional and informal) users in case of malfunctions and injuries [20]. There is also a need to reconsider therapeutic protocols due to the potential problems of liability of workers and their organisations in the case of experimentation of robotic-led therapeutic and assistive practices. In highly bureaucratic environments such as welfare and healthcare, the stringency of legal requirements could inhibit the large use of robots for liability purposes. Two interviews highlight the challenges that bureaucratic procedures bring to the development process:

An important problem is with the ethics committee, which are very restrictive, but even more very slow to give their consent. In general, the regulatory framework is still inadequate for these innovative fields of experimentation. For example, we have to ask the informed consent of our patient to involve them in the trial. If we are trying to change something in the protocol (even small changes in the use of the same instrument) we have to obtain their consent and of the committee. Moreover, for each experimentation that lies outside the consolidated protocol the companies want patients to be insured. In sum, all these legal requirements are legit and useful, obviously. But this means that every experimentation has substantial costs and an arduous bureaucratic burden. This clearly does not ease research (Int. #2).

Each time an instrument is approved for specific therapeutic use, if it has to be tested on another, even if it is very similar, or even simpler and less risky, a new protocol approval must be sought for each new applications, and this process can take months, sometimes a year! This is a truly nightmare for any researcher (Int. #3)

Therefore, there are also issues regarding data management and privacy. The implementation of robotics in healthcare triggers many questions about the confidentiality of collected data by clinicians as well as by the robots themself (and so possibly transmitted to the related company) and raises a question about data ownership and use [26]. As reported by the interviewed clinician:

As clinicians who do research, we have a huge problem with the data we produce. We have a constant fear of doing something bad (breaking privacy rules, sharing data inappropriately, etc.), when in fact we are just trying to help our patients. Data collection and security are our constant apprehension. As clinicians we are not trained for this complex and constantly changing privacy regulations. Moreover, this results in a considerable burden that is not easy to manage. We may need specialised figures to help us with this workload (Int. #4).

Another concern is related to the financial sustainability of the introduction of robots in the ordinary practices of the services. To the best of our knowledge, with the exception of Finland and Sweden which are the frontrunner or robots in health-services, in other European Countries the main (often unique) channel of fundings to this kind of experimentations is through research-oriented grants provided by the EU (e.g., Horizon 2020), or, very less

frequently, by national governments [5]. Even more, these fundings are limited in time, and often focused specifically on pilot experimentations, without the specific goal of consolidation in the ordinary practices of services.
Due to uncertainty in funding, it is thus typical that after a project ends, there is no continuity regarding implementation also despite promising results. Inherent to the short-term perspective of this fundings, mostly intended in a research-based feature, also raises problems in terms of applicability and diffusion of these pilot projects. The latter are often scarcely devised to be a viable solution to everyday care challenges:

A problem encountered in scaling up pilot projects is that we are often not used to thinking from the beginning to the real industrialization possibilities of the experimented solutions. Usually, in research projects, the focus is on the experimentation of the most 'futuristic' technologies because the researcher needs to publish, perhaps without thinking much about who might then actually adopt them in everyday situations. In a rational way, now in European calls for proposals they ask you to include companies right from the start, and this is useful. However, from my experience, in practice there is often a problem of matching the researcher's interest in publications (hence the interest in innovativeness) with that of the companies (which aim at commercialization). It is not always easy to find this match, legitimately everyone tends to pursue their own interests (Int. #1).

However, even when the instruments are certified for clinical use and commercially available, their use in routine service practices is still limited by problems related to reimbursability. In fact, in Italy the health services guaranteed by the NHS are outlined in the BLC legislation ('essential level of care': DPCM 29 November 2001). The list is periodically updated, most recently in 2017 (DPCM 12 January 2017). In that occasion, robotic rehabilitation was included in the list, thus recognizing the possibility for public services to provide this type of robotics-enabled therapy, or the possibility for the patient to be reimbursed by the NHS in case of provision by private agencies.[3]
Despite this important step forward, the pricing of services (based on the model DRGs – Diagnosis Related Groups) were only approved six year later, in 2023, by the State-Region Conference. Nevertheless, to date, many regions have still not updated their pricing nomenclature. For these reasons, the entry into force of the new pricing, initially scheduled nationally for January 2024, was then postponed once to April 2024, and subsequently to January 2025, thus leading to difficulties in providing or reimbursing these therapies within the BLC.
In addition to the slowness of the processes, further complexity is determined by the uncomprehensive definition contained in the BLCs. As proved by the results of the focus group 'TECHNOLOGICAL INNOVATION, ROBOTICS, AND HEALTHCARE: TUSCAN EXPERIENCES AND THE NATIONAL DEBATE' organized in April 2024 by the Sant'Anna research team, this means that:

We do not know clearly which instruments and which robotic therapy protocols are covered by the definition. It depends if we consider the instrument or the therapeutic function. For example, can robotic rehabilitation be carried out only with mechanical, 'physical' applications, or also with virtual reality? This is decisive because the category includes services that have very different costs, but from the point of view of DRGs they are priced in the same way (FG #1).

The participants complain about a further problem related to the BLC-DRG issue: "even for those therapeutic applications where robotics has proven to be better than conventional therapy in terms of clinical outcomes, the former is still more expensive than the latter, and this means that, since the public provider is reimbursed only on the basis of the standard price, it has no incentive to purchase instruments that offer better but more expensive outcomes" (Int. #3).[4]
This does not mean that Regional Health Services (RHS) cannot decide autonomously to invest in more expensive instruments by relying on their own additional resources. However, considering the heterogeneity of the different configurations of social and health services in the various territories (particularly in Italy: [44], [45]) there is a risk

[3] With the wording: '93.11.G Rieducazione motoria mediante apparecchi di assistenza robotizzati ad alta tecnologia'.
[4] In addition, from another interview: *«I must certainly not overlook another fundamental aspect, which is the cost of this technology, because so far the real reason why it is not widespread in the home is because it still costs too much. It's out of the consumer target. One day we will make a robot that costs less than €1,000. But until then, it is objectively not sustainable for a wide user base» (Int. #5).*

that the introduction of these technologies may only be possible in richest contexts, further exacerbating already strong territorial inequalities.

4.3 End-Users

The introduction of robots in welfare and healthcare services is primarily intended as a way to improve the quality of life of the service users (not only the assisted ones but also their informal caregivers). As previously mentioned, while the attitudes towards robots in the general public is quite often positive, more concerns are observed with regard to the use of robots in care services, a subject that is always seen as highly sensitive [22]. In this perspective, it is strategic to examine the factors which can enable a better *fit* between care robots and their expected users.

A relevant field of research investigates the different factors that are crucial in determining the level of *robot acceptance* – i.e., perceived usefulness and intention to use them if available – in potential users [29]. Seminal works of Broadbent and colleagues [27][28] set an analytical framework with which to assess acceptability factors according to robot characteristics and ones of their users. With respect to the robot, the elements of ‘appearance’, ‘humanness’, and other technical features (like size, facial expressions, etc.) are usually relevant. As a general recommendation, the robot’s look needs to be coherent with the therapeutic needs of the user, as well as the need of conservation of his/her self-representation, in order to avoid unnecessary ‘medicalisation’ of the patient.

As stated by the Authors [27]: «Careful consideration of the health robot design is needed to minimise the stigma of disability. Older people value not only independence, but also the appearance of independence, and they may not use assistive robotic devices that they feel portray them as disabled, dependent, weak or feeble» (p.323). Also, regarding the level of humanness, it is important to maintain the coherence between the concrete applications of the robot, user needs, and the needed degree of humanlike appearance. If the robot is a companion one, a discrete level of humanness is desirable, while in case of robots intended to assist highly personal tasks, such as showering, a high level of humanness could be perceived as intrusive. Finally, a general recommendation for robot design stated that: «the robot must meet the person’s needs, be slow, safe and reliable, small, easy to use and have an appearance that is serious, not too human-like, not patronizing or stigmatizing, and have a serious personality» (p. 324).

As for users, age and gender are scarcely influencing factors (ibid.). While older people have in general less confidence towards technology than the younger, recent research confirms that the most important predicting factor is technology confidence, intended in terms of exposure and (positive) previous experience with technology and robots. It will predict the positive attitude to future interactions with robots, almost independently of the age of the user [29] [33] [46].

A more relevant factor is the educational level, which is positively correlated with greater acceptance of the use of technological solutions for everyday problems [27]. The cultural factor is significant too. People from different cultural backgrounds may have different crystallized representations on what a robot is, because, as noted by Tuisku *et al*. [22], media representations are often the most frequent and enduring source of information about robotics, also for, in theory, high informed people (e.g., nurses and care workers). Moreover, for acceptability, cultural differences in attitudes towards aging and independent living will be relevant, as well as differences in how societies traditionally conceive care for older people [27].

On top of that, the level of acceptance will be influenced by the specific features of the needs of the users. Being acceptable, by definition, is a function of the potentiality of the instrument to satisfy needs. As a consequence, different people will perceive the same robot differently depending on what it can offer to them. The adaptability of robots to different potential categories of users, and even more, the personal interest of each of them (i.e., degree of personalisation) will be crucial. In other words, besides general recommendations, acceptability needs to be assessed precisely for each specific robot-need basis, thus revealing a high level of socio-technical complexity. However, all these attentions allow one to avoid falling into the risk of considering users in a static, stereotyped and unrealistically homogeneous way (e.g., ‘the older’; ‘the disabled’), often framing them only in terms of illness, frailty, dependency, and as costs and burdens for care [35], [47].

With this predisposition, the work of Vandemeulebroucke and colleagues [48] reverses the perspective, asking which applications are considered the most promising from the point of view of the elderly themselves. Through a large review of field-based studies, the authors identify five main functions that socially assistive robots can perform to improve the lives of elderly people:

- the first function is consistent with the image of the robot as a servant-like assistant that can support older people in practical operations such as handling and carrying heavy objects, cleaning the house, etc.;
- the second function concerns the robot performing home safety purposes, such as detecting patient falls and then notifying caregivers or doctors. However, this function is also mentioned as a cause of possible tension between the monitoring role of the robot and the privacy of the user;
- the third function is linked to cognitive assistance and represents the high perceived usefulness of robotic applications which can help the elderly in remembering appointments, time, and procedure of self-medications, as well as where certain objects were placed. In sum, these three uses represent the monitoring and practical assistive functions of socially assistive robots already mentioned in par. 2;
- two further ‘social’ applications involve robots as a form of entertainment (e.g., playing music, games, presenting news, etc.) and, even more, companionship. The latter is the most debated one. Although the potential of socially assistive robots in alleviating isolation and loneliness is sustained by significant evidence [9], there are still some scepticisms, related less about the effective usefulness of robots for that purpose, rather than to scenarios of dehumanisation and social disintegration they might evoke [26][48]. This worry is related to the frequently detected fear of loss of opportunities for human-human contact as a result of the diffusion of robots in care services (see also par. 4.1).

Although care robots are intended to foster independent living, some observers note older’ concerns over robots as a possible source of loss of autonomy. This is related to the perceived technological complexity of these applications and consequently the high level of skills required. Overcomplication of the technology could provoke feeling of inadequacy and lack of control, and so a sense of dependency to the machine [26]. To avoid ‘infantilisation’ of elderly [48], considerations about robot functionalities and usefulness must take into account the balance between the robot’s possibility to solve tasks, the level of skills and effort needed to ‘assist robots in doing the assistive task’ (in parallel with the aforementioned ‘machine babysitting’ concern: par. 4.1), and the desired level of user of autonomy. Put another way, care robot’s design should prioritize user self-determination purposes rather than merely the fashion of technological novelty [46].
In conclusion, to avoid the risk of medicalization, infantilization and objectification of users, they should be not only a key target for the designers (as well as consumers), but also assumed, as far as possible, as protagonists of the design process of robots. These users’ empowerment strategies are going to be discussed as one of the “good practices” which are the center of the attention of the following paragraph (see Boxes from 1 to 5 below).

5 Good practices to approach stakeholders’ needs and actions

The exploration of stakeholders’ needs and attitudes has highlighted how the introduction of new technological devices in home-care services requires multiple and complex socio-technical changes which regards the dimensions of the techology design, regulatory and organisational frameworks, human-human and human-machine interactive practices. All of the identified positive and negative expectations are summarised in Table 1.

Table 1. Expectations and concerns of the stakeholders in regard to robots in home care, and promising good practices.

	Stakeholders		
	Professional care workers	**Management**	**End-users**
Positive expectations	• Support for physically intensive tasks • Reduction of work injuries • Reduction of workload for simple operations • More time to work on high added value therapies	• Improving quality of care • Work efficiency (e.g., time, workers allocations, etc.) • Cost reduction	• Improving quality of care • Enhancing stay at their home • Independent living (mobility, handling & lifting, cooking, cleaning,

		• Acquisition professional status as "innovators"	"robot as home-servant", etc.) • Communication to doctors and injuries alerts • Cognitive assistance (e.g., remember medications time, etc.) • Entertainment and companionship
Concerns	• Fear of losing job • Lack of technological skills • Large and undesired changes in work practices organisation • Lose of control over their practices • Subordination of their work to robot's necessities rather than to care receivers (mechanisation of care) • Loss of human contact • Work overload as "machine babysitters" • Depreciation of their professional status • Reduction of safety and quality of care	• Lack of workers motivations and related resistances • Lack of skills of workers • Lack of a consolidated regulatory framework • Intense need to revise therapeutic protocols. • Legal liability for injuries and robot malfunctions • Arduous procedures for ethical consent • Intense and complex data management • Privacy and confidentiality of collected data • Financial sustainability and discontinuity of fundings • Short-term perspective of experimentation pilots • Reimbursement issues under ELC rules	• Loss of human touch • Isolation • Threats to self-representation • Infantilisation & objectification • Lack of technical skills to manage the robot • Lack of control and sense of inadequacy • Dependency on robots • Threats to privacy
Good practices	• Effective change management practices		/
	• Information, training, orientation for all		
	• Users and workers involvement, and the user centred approach		

In the act of facing these multifaceted challenges, early field-work experiences have identified some promising good practices. A first field, in addition to a broader revision of the regulatory and the financial frameworks, is about the needed changes in the frontline organisations of home-care services also requires an adequate investment in terms of *change management* to sustain the socio-technological transition [20].

The multitude of involved actors (i.e., R&D companies, manufacturers, managers, frontline workers) need to be sustained in the set-up of an effective implementation network for robot operativity in the services [22]. Each of the actors must establish new collaborative relationships and/or adapt the existing ones to strengthen the potentialities of robot applications, thus creating a new division of labour both between different professions, and between human and robotic components of the organisations [21].

The management level should accompany their professionals through information, orientation, and activation of practices of reflexivity during the process. This can ensure that worker's expectations and concerns are taken into account and thus avoids rejections determinable by top-down impositions (par. 4.1). In addition, it permits, through reflexivity, to valorise the expertise of those working in the field in the aim to improve both frontline working conditions as well as organisational and technological refinements [43].

Moreover, the establishment of structured ongoing monitoring and evaluation practices of the implementation process are required [20]. These are not only needed to accompany inter-organisational experimentations, but also to ease knowledge exchanges between different experiences. In this sense, specific instruments and specific actors designed as *brokers* of networks of information's sharing [23] are highly recommended to foster alignment of different *niches of innovators* [21].

In addition, a frequently mentioned concern in the previous paragraphs was the lack of knowledge and technical expertise regarding robots. This is a problem at every level, since it affects all actors, and it influences the attitudes towards robot acceptance (both for users and workers), as well as it determines the actual level of operational capacities (i.e., using robots for therapies, solving malfunctions, etc.). As a consequence, adequate information, orientation, and training practices of all the involved actors are crucial[5] [36] [36bis]. The European Public Service Union specifically calls for investment in *re-skilling* and *up-skilling* of the workforce when undertaking automation processes in healthcare settings [49].

In the first instance, the inclusion of technology and robot-oriented training during the overall cycle of education (not only tertiary education) is recommended. It is intended not only to improve specific technical skills, as well as a broader competence ground needed in the increasingly technology-intensive economy of the future (with robots as ones the main components). As stated by an interviewed:

There is a problem with specific skills, but we realised that a broader preparation is also needed. The development of digitisation, artificial intelligence, and then also robotics, raises a whole series of issues at the level of professional exercise, deontology, etc., which become crucial. In this sense, there is a need to build a broad set of knowledge appropriate to the new digital society that is emerging. It means creating a prerequisite of mentality and more general knowledge on which to then graft specific training, which is in any case necessary (Int. #5).

Furthermore, specific training activities are needed for actors involved in robot implementation in healthcare. Due to the general lack of knowledge of all actors, and the fact that negative attitudes toward robots are often correlated with this paucity of information, the first and most important piece of required knowledge regards is the benefit of using robots for all the stakeholders [24]. They need to understand why they should use care robots, what kind of care robot to use and in which situation, and, finally, how to use it: "know-why, know-what and know-how" [26].
Feedback from the stakeholders involved in the focus group 'ATTEMPTS TO SIMPLIFY ACCESS TO ROBOTIC DEVICES: THE INAIL EXPERIENCE' - organised by the Sant'Anna research team in June 2024 - provides further evidence of the issue. Professionals are also key actors in fostering users' knowledge and capability: «operators are not only called upon to use these instruments, but they are also called upon to help people use these instruments. They must be able to accompany the user, so that the user is not afraid, and uses it correctly, etc. This is important because the

[5] Box 1 provides a summary of the seminal research project MARIO dedicated to the experimentation of robots in healthcare: the project aimed at diffusing information and knowledge about the introduction of robots in care activities with the involvement of care workers and managers in the collection and interpretation of the first experiments. See Annex.

robot is not a drug that is simply prescribed and taken. And many users obviously do not have the necessary skills» (FG #2).[6]

Moreover, after improving perceived usefulness, care professionals, informal caregivers and patients could benefit from adequate training in using the intended robotic application. In doing so, practice of *collaborative learning* for the different involved actors are promising, because they become an opportunity not only to acquire skills but also to assume different experiential perspectives and build trust among actors [50].

The previously discussed intense need of involvement and participation of frontline workers and end-users (parr. 4.1 & 4.3) suggests the need to empower them as protagonists of the robots' design and implementation. In this perspective, many scholars advocate for the adoption of a *user-centered* approach[7] [43].

To foster care robots' acceptability and usability, potential users should be involved in public discussions about using robots in the welfare and healthcare services, and in the conceptualization, development, and testing of new applications [14], [36]. The recognition of care professionals and their involvement "from planning to testing and evaluation" is similarly called for by the European Public Service Union [49].

In regard to the professional workers, as noted by Glomsås and colleagues [43], for the successful consolidation of these innovations there is a need to valorise the expertise of the workers that are expected to be engaged in the implementation. On the contrary: «When health professionals were asked, and their recommendation was not followed up, they were disappointed and felt that democracy and involvement only existed in theory. This could inhibit further involvement and collaboration» (p. 4016). Instead, the involvement of professionals is recognized as beneficial in preventing conflicts, and valorizing user's expertise for technology improvement and for better implementation outcomes [26]. However, as detected by Nilsen *et al*. [19] also when workers' resistances emerge, if their concerns and expectations are considered, and conflicts are managed in a dialogic way, the solving process can be a source of further innovations based on the encounter of different points of view.

Finally, robot designers also must valorise the experiential knowledge and the desires of end-users. They must be assumed not just as consumers but rather as partners of the development process [51]. In this perspective, an interviewed reports colourful experiential evidence of the importance of involve users in the development processes:

User involvement is crucial. Because between the idea written and thought up even by experts in the field and what is then the result for the user there is often a big difference. Unfortunately, today the vast majority of technology is thought up in engineering labs, and only once the idea has been built do we turn to the clinician for experimentation. But this means that the concept was born by an engineer who thinks the patient should do it a certain way. But it should be the other way around. In fact, in many cases after the test we changed the design of the application, because we realised that it had to be completely different. That is why users should be involved right from the design phase, not only afterwards in the testing phase. I believe that this would also improve acceptance levels, both for the professionals involved, who will then have to use the tools, and for the patients (Int. #5).

This disposition prevents the risk of objectification and medicalization of users and recognizes their desires, needs, and knowledge as valuable for technological improvements. Moreover, this approach is also acknowledged as a way to enhance robot acceptability, user's skills, sense of participation and autonomy[8] [49].

Lastly, this participative and user-friendly spirit can benefit as well from mobilizing the participation of NGOs (particularly associations of users). NGOs should play a direct role in supporting robotics research and development by participating in experiments and disseminating research results, thus helping to promote the culture of technology applied to healthcare. Indirectly, they can also act as a fundamental stimulus being the main driver of

[6] The same from the patient's representative (FG #3): *«There is a need for all-round training for both operators and users. Having in mind, however, that this knowledge cannot be for everyone. We are also experiencing this with telemedicine, teleconsultation, etc. These are solutions that cannot be for everyone, such as the elderly or the most serious non-self-sufficient. It is important here to work a lot with caregivers but knowing that there are some insuperable limits».*

[7] Box 2 refers to the case of the ACCRA project, one of the seminar research projects on robotics in the field of healthcare and elderly care. The project was based on the principle of co-creation that is the active participation of end users in the design of policies for the elderly (see Annex).

[8] We refer here to the seminal experience of the CARESSES project (see Box 3 in the Annex).

market demand (again highlighting the decisive role of diffuse information on robotic applications). An interviewed note:

User associations can become a critical mass that demands and finances product development. They could also be targeted for operations to raise awareness and build a culture of technology. Associations are very active in this, and I believe they are fertile ground, intercepting novelty. Indeed, often it is they who knock on our door because they want to follow all our developments to try to improve their quality of life and that of their families. Then in turn they can also be an engine for spreading knowledge to a wider audience (Int. #5)

Eventually, they should be a strong stimulus towards companies and policy makers, through their weight in lobbying actions, demanding more investments and new regulations to fostering technological developments in order to improve their quality of life: “Certainly the associative world is fundamental for dialogue to convince the political decision-maker, because they actually do that very well. In fact, a good part of the laws we have today arise precisely from the positive action of the patients' associations” (Int. #4).

6 Conclusion

The present report has shed light on the stakeholders’ needs and actions in the field of robotics and digital technologies in the field of health and social care. Through desk research, 6 pilot interviews and the feedback provided by the stakeholders involved in two focus groups, we have collected evidence on the main challenges at stake.

In line with the contemporary literature reviewed so far, we have focused on the critical case of home care. The latter is a sector characterised by the complex interaction of many stakeholders, the need for their effective coordination, and the extreme relevance of the users’ needs and opinions about new technologies. The analysis has confirmed the further diffusion of robots and digital technologies depends on the match between their supply and demand. Needs and actions of stakeholders are crucial to support new technologies.

Social demands and positions are mixed. Different target groups have different positions and opinions on the subject. The literature usually refers to three main target groups: care workers; managers; and end users. Care workers are the more sceptical about the diffusion of new technologies. Negative opinions are based on the fear to be substituted by robots and new devices, and the supposed need for additional training and skills and the consequent risks of additional tasks and increased workload. What is more, care workers express negative opinions about the risk of a deterioration of care and of the services (e.g. due to the dehumanisation of the same care activities). Complexity of the organisation of the interaction of machines and devices and carers is also at the top of the care workers’ worries.

Both management and end users show more positive attitudes. For managers, in particular clinicians, hopes for more efficient care activities and more innovative work organisations are widespread. At the same time, managers have more negative positions about the costs of skill-formation and re-training of the labour force, and to regulatory issues. The latter have to do with the protection of patients’ privacy and the responsibility for injuries and malfunctioning of new technologies, especially robots. As for the end users, their worries are focused on the accessibility of the new devices. Risks of invasive technologies, bad design of new devises, over medicalisation of care activities and of impersonal ‘cold’ treatment are at the top of their negative opinions on robots and digital technologies.

The pilot interviews carried out so far have largely confirmed the main conclusions of the literature review. The clinicians interviewed by the research team have confirmed the mixed opinions – both positive and negative – about the development of new technologies in the field of health and social care. A common concern is about the need for more articulated forms of coordination of the different stakeholders and need to improve the diffusion of information among the different target groups. The good practices mentioned in the text (and detailed in Boxes from 1 to 5 in the annex) also confirm the main challenges to address worries and preoccupation about the diffusion of new technologies in the field, while they also show the potential impact of a more participatory approach to the diffusion of robotic technologies.

Innovative research based on the active involvement of stakeholders prove effective to overcome scepticism and opposition. Additional evidence is provided by recent projects. '*ergoCub*' - a joint project between the Italian National Institute for Insurance against Accidents at Work (INAIL) and the Italian Institute of Technology (IIT) - aimed to develop technologies targeted at reducing musculoskeletal disorders (MSDs) stemming from (future) biomechanical risks in the workplace. The project included a survey involving workers from manufacturing and healthcare to monitor the acceptability of humanoid robots.

The project SPRING (short for Socially Pertinent Robots in Gerontological Healthcare) represents a further good practice. The project - coordinated the France National Institute for Research in Digital Science and Technology (INRIA) and financed through Horizon2020 - aimed to develop socially-aware robotic solutions able to provide assistance and interact naturally with patients in healthcare settings, with a specific focus on geriatric care. It did so by addressing fears and vulnerabilities of users. Robots have been tested with elderly patients and consequent insights have been used to refine the technology: an instance of user-centered design.

These practices represent a further proof that it is crucial to inform all the stakeholders on the potential impact of new technologies for more effective health and social care. It is also important to allow the development of open forms of governance where different practitioners and stakeholders may contribute to the management of robots and digital technologies.

List of Abbreviations

BLC	Basic Levels of Care
DRGs	Diagnosis Related Groups
EU	European Union
IIT	Italian Institute of Technology
INAIL	Italian National Institute for Insurance against Accidents at Work
MSDs	Musculoskeletal disorders
NGOs	Non-Governmental Organisations
NHS	National Health Service
RHS	Regional Health Service
TSO	Third Sector Organisations

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ANNEXES

For the purpose of this report, five relevant Italian experts were interviewed. They are clinicians (e.g., neurologist, rehabilitation specialist, neuropsychiatrist, etc.) who also have strong expertise in terms of academic research. In fact, two of them are also university professors.

The semi-structured interviews were administered online by the Authors. The length of the interviews was between 30 and 60 minutes.

The questions were designed to address the issues most relevant for robot implementation: the organisational impacts; the training needs; the policy context; and the practices of user involvement and promotion of social participation (Table 2).

All the interviews were recorded and transcripted. The analysis of them was aimed at bringing out the most relevant themes for the future introduction of robots in the Italian healthcare sector. Results are synthesised in the table below.

Table 2 Exploratory interviews' themes and codes.

Interviews	Themes			
	Organisational impacts and needed change	**Information and training needs**	**Policy context**	**User involvement and NGOs participation**
Int. #1	• Negative attitudes of medical and care professionals towards robotics in healthcare (fear of being substituted) • The absence of a proper information system • Lack of inter-operability between platforms and information systems	• The need for training is at all levels • There is no need for specific, sector-specific skills, but there is a need to integrate technological knowledge into the background of clinicians	• Short-term vision of the project-based funding system • Stricter device certification policies are needed • the political environment is uneven, the different levels of government are not coordinated • the main funding level is European, but resources are poorly utilised, too many projects are similar	• User involvement is not institutionalised, but validated through autonomous practices during research projects • NGOs involvement is low, lack of concrete co-decision initiatives • There is no consolidated network to linking clinicians, users and NGOs
Int. #2	• There are still few robotic devices available, the organisation of facilities is not in step with scientific evidence • Still too high cost of technologies to be used by a large population	• Need for training and specific professional figures for data collection and security • Clinicians do not have the possibility to easily process and manage the data they collect	• Uncertainty of the regulatory framework for data management • Bureaucratic workload as hindering factor • Politicians does not perceive technology implementation in the social and health sector as a priority	• User involvement through tests and questionnaires • The participation of NGOs is low; their involvement is not structured and institutionalised • There is a lack of awareness among users of the benefits that technology can bring

			• Need to streamline the local and regional level of governance	
Int. #3	• Still too high cost of technologies to be used by a large population	• Staff training needs to make effective use of robotic technologies in clinical practice	• Bureaucratic workload as hindering factor • Lack of clarity in the ELC definition • Misalignment between DRGs and technology costs • Limited financial capacity of public health agencies	
Int. #4	• Still too high cost of technologies to be used by a large population • Still insufficient readiness of robot technologies • Need to convince therapists to use robotics	• Broader need for more information and skills enhancement for a digital society (even before robotics) • Lack of field training for operators • It is necessary to implement rehabilitation programmes by introducing robotics. • Robotics need to become a subject in university courses • Need to set up information campaigns to raise awareness among clinicians	• The socio-political context still perceives robotics as a niche element, not as necessary tools to improve care. • Politicians does not perceive technology implementation in the social and health sector as a priority • A step forward in budgetary policies could be costs incentives related to the purchase of robotic technologies • Data security issues	• It is crucial to involve the patient at an early stage of experimentation precisely to improve the acceptance rate of treatment with robotic devices • Involvement of patients is crucial also for technological improvements (as testing practices) • NGOs should structure themselves better because they are a key actor in the acceptance of robotic practices
Int. #5	• Still insufficient readiness of robot technologies • Still too high cost of technologies to be used by a large population • Negative attitudes of medical and care professionals towards robotics in	• Broader need for more information and skills enhancement for a digital society (even before robotics) • There are still few examples of specific robotics training activities in tertiary education	• The only sources of funding are those related to research projects • (opportunity) Recent government investments in telemedicine (and the NRRP overall) • (opportunity) the experimentation of the Italian national	• Acceptability and usability assessment as diffused practices in research projects • (about the previous) added value: information share and collaborative learning • NGOs as basin of market demand

	healthcare(fear of being substituted) • (opportunity) disruptive technology development in the field of AI and ICT can also be a reinforcing factor for the development of robotics	• Need for training and specific professional figures for data collection and security	platform for telemedicine	• NGOs as protagonists of information sharing practices and dissemination of technology culture
Int. #6	• Need for a digital infrastructure for data collection, monitoring of patient's follow up, information sharing between different professionals • Need for trained specialists for the coordination of rehabilitation services	• Need for continuing education of involved professionals • Training for robotic applications in healthcare needs to be included in tertiary education courses (especially for nurses & physiotherapists) • Targeted training as well for engineering and management students	• Regulatory uncertainty on the reimbursability of instruments • Insufficient consideration of the costs necessary to ensure continuity of care	• Acceptability and usability assessment as diffused practices in research projects

Of all of the themes listed above, it is possible to identify some as recurring and/or emerging as particularly significant. They are presented in the table below (Table 3) along with the related quotes from the interviews.

Table 3 Key interview themes and exemplifying quotes

Main themes	**Quotes**
Negative attitudes of medical and care professionals towards robotics in healthcare	Nobody wants to substitute professionals with robots. Somebody has estimated the amount of economic savings obtainable with that substitution, but I think it is just an academic exercise. No one believes that robots are going to be more effective in therapeutic settings than humans. The right perspective is to conceive technology as complementary to the work of professionals. The question is the maximisation of the therapeutic advantage offered by technologies. Home-care robots could assure promptness and continuity of assistance when doctors are (temporarily) not available, they could monitor physical parameters and transmit information to the doctor, and so on. Moreover, robots could conduct some standardised and simple therapeutic practices to free time for professionals to work more on practices with therapeutic added value (and even for more users). In other words, I conceive robots similarly to a medication, which is an instrument available for therapists, but which does not substitute them (Int.#1). Therapists are afraid to approach robotic devices because they are not adequately trained and fear consequences. The problem also arises for younger therapists who are not yet familiar with robotic tools and therefore prefer to use standard care in order to avoid risks (Int. #4). It has to be said that in the health sector this story of a robot threatening a profession is very much present, so there is definitely a need for information. It must be made clear that this technology is a support and not a replacement for humans.. It may seem trivial, but at the level of nursing itself we have found so many difficulties, so much resistance. You have to explain well why you use the robot and what it can help with. In a certain sense you really have to raise awareness about the need to adopt new technologies, not only because resources are tight, but also because they are actually useful. Is to be said that in the health sector this story of a robot threatening a profession is very much present, so there is definitely a need for information. It must be made clear that this technology is a support and not a replacement for humans. It may seem trivial, but at the level of nursing itself we have found so many difficulties, so much resistance. You have to explain well why you use the robot and what it can help with. In a certain sense you really have to raise awareness about the need to adopt new technologies, not only because resources are tight, but also because they are actually useful (Int. #5)
The cost of technologies is still too high	Even for those therapeutic applications where robotics has proven to be better than conventional therapy in terms of clinical outcomes, the former is still more expensive than the latter, and this means that, since the public provider is reimbursed only on the basis of the standard price, it has no incentive to purchase instruments that offer better but more expensive outcomes (Int. #3) The costs of robotics are the real limiting factor. The need to incur exorbitant costs results in a patchy spread of robotics, with the consequence that those institutions that can afford to bear certain costs grow, the others remain paralysed (Int #4). I must certainly not overlook another fundamental aspect, which is the cost of this technology, because so far, the real reason why it is not widespread in the home is because it still costs too much. It's out of the consumer target. One day we will make a robot that costs less than €1,000. But until then, it is objectively not sustainable for a wide user base (Int. #5)

Still insufficient tech readiness	There is a problem of usability on the part of professionals. The technologies available today are still difficult to use, not very autonomous and difficult to transport. If we had tools that were, let's say, easy to use, not particularly expensive, and that allowed them to be used in some way and actually transportable, they would be the best tool for continuity of care. Today, this is still not the case, because it is obvious that if I have to move an exoskeleton, which has a certain cost, a certain expense and also a certain size, then it requires a certain intensive training on the part of the physiotherapist. And if this already applies to the hospital context, it is even worse for the physiotherapist on the territory. He goes to the patient's home with his backpack to do therapies, and so he cannot carry around large equipment. So, whoever designs the technology should think of instruments suitable for homecare practices (Int. #5).
Bureaucratic workload as hindering factor	An important problem is with the ethics committee, which are very restrictive, but even more very slow to give their consent. In general, the regulatory framework is still inadequate for these innovative fields of experimentation. For example, we have to ask the informed consent of our patient to involve them in the trial. If we are trying to change something in the protocol (even little change in the use of the same instrument) we have to obtain their consent and of the committee. Moreover, for each experimentation that lies outside the consolidated protocol the companies want patients to be insured. In sum, all of these legal requirements are legit and useful, obviously. But this means that every experimentation has substantial costs and an arduous bureaucratic burden. This clearly does not ease research (Int. #2). Each time an instrument is approved for a specific therapeutic use, if it has to be tested on another, even if it is very similar, or even simpler and less risky, a new protocol approval must be sought for each new applications, and this process can take months, sometimes a year! This is a this is truly a nightmare for any researcher (Int. #3)
Data management, security and safety	As clinicians who do research, we have a huge problem with the data we produce. We have a constant fear of doing something bad (breaking privacy rules, sharing data inappropriately, etc.), when in fact we are just trying to help our patients. Data collection and security are our constant apprehension. As clinicians we are not trained for this complex and constantly changing privacy regulations. Moreover, this results in a considerable burden that is not easy to manage. We may need specialised figures to help us with this workload. It is essential that doctors doing research be assisted by professionals who can easily manage the administrative data protection procedures (Int. #4). The cybersecurity aspect becomes crucial because all the services on which the robots rely (e.g. image processing, language processing, etc.) are potentially at risk. The point is not only that of data ownership by the producing company, but also a question of security. A robot, being able to move within a physical environment, can generate physical harm to a patient if, for example, it gets into the hands of a malicious person. So the issues of privacy and cybersecurity are very relevant (Int. #5).
Issues regarding 'Essential Level of Care' regulations	The inclusion of robotic rehabilitation under the ELC legislation is an important step forward. Nevertheless, the definition of the ELC is ambiguous. We do not know clearly which instruments and which robotic therapy protocols are covered by the definition. It depends if we consider the instrument or the therapeutic function. For example, can robotic rehabilitation be carried out only with mechanical, 'physical' applications, or also with virtual reality? This is decisive because the category includes services that have very different costs, but from the point of view of DRGs they are priced in the same way (Int #3).
Short-term vision of the project-	A problem encountered in scaling up pilot projects is that we are often not used to thinking from the beginning to the real industrialisation possibilities of the experimented solutions. Usually, in

based funding system	research projects, the focus is on experimenting the most "futuristic" technologies because the researcher needs to publish, perhaps without thinking much about who might then actually adopt them in everyday situations. In a rational way, now in European calls for proposals they ask you to include companies right from the start, and this is useful. However, from my experience, in practice there is often a problem of matching the researcher's interest in publications (hence the interest in innovativeness) with that of the companies (which aim at commercialisation). It is not always easy to find this match, legitimately everyone tends to pursue their own interests (Int. #1). Analyses regarding technological implementation are not conducted in depth; an accurate cost-benefit analysis on the use of robotic devices is lacking and therefore planning is never wide-ranging. Only individual devices are reasoned about, from time to time, without a certain framework (Int #2). It is difficult to build something structural with project funding. We can do a lot of independent research projects, all of them certainly worthwhile, but maybe if we go and look at some statistics, we see that only 1 in 100 goes on to create something that really spreads in a structural way. Because it is usually not one of the objectives at the heart of the project. Maybe it can be a specific choice like 'I want to use this money to invest in a tool that I have left after the project'. But that is not always the case (Int. #4). The lack of a wide-ranging planning vision is evidenced by the fact that legislative choices have never yet moved towards de-taxing the costs associated with the purchase of robotic technologies (Int. #5).
Information and training needs	The problem is not the absence of highly professionalised figures in the field of technology. There is no need for computer technicians in the strict sense, the pressing need is to train professionals, to bring doctors closer to the use of devices that today are perceived as a problem rather than a resource. The urgency of increasing the training of health personnel must be perceived from the earliest stages of study (Int. #2). There is definitely a problem with specific skills, but we realised that a broader preparation is also needed. The development of digitisation, artificial intelligence, and then also robotics, raises a whole series of issues at the level of professional exercise, deontology, etc., which become crucial. In this sense, there is a need to build a broad set of knowledge appropriate to the new digital society that is emerging. It means creating a prerequisite of mentality and more general knowledge on which to then graft specific training, which is in any case necessary (Int. #4). The proposal is to include biorobotics within the curriculum of medical faculties. The entry of robotic devices into universities would promote research and raise the awareness of tomorrow's doctors right from the start (Int. #5).
User involvement	User involvement is crucial. Because between the idea written and thought up even by experts in the field and what is then the result for the user there is often a big difference. Unfortunately, today the vast majority of technology is thought up in engineering labs, and only once the idea has been built do we turn to the clinician for experimentation. But this means that the concept was born by an engineer who thinks the patient should do it a certain way. But it should be the other way around. In fact, in many cases after the test we changed the design of the application, because we realised that it had to be completely different. That is why users should be involved right from the design phase, not only afterwards in the testing phase. I believe that this would

	also improve acceptance levels, both for the professionals involved, who will then have to use the tools, and for the patients (Int. #4). From a professional point of view, for everyone involved in the project, it is certainly an advancement of skills. Incremental skill value is created through the testing of the various solutions, and obviously the testing with users is the key one. We could work much more on this. Not least because it allows more widespread knowledge to be built up, and thus possibly a greater impact (Int. #5)
The role of NGOs	Honestly, the participation is very little. It seems to me that there is little participation or inclusion of associations in the pre-production phase. Why? Because traditionally robotics and technology have never been thought of as being part of the treatment process, and so there is more a lack of knowledge, rather than a lack of will, to understand the potential of these technologies, and then from this also a lack of willingness on the part of the patients themselves, to be involved. Perhaps on the part of the patients' associations themselves there is not a strong demand to be involved, but because there is not enough knowledge of all that could be done, is there not? The system of patients' associations in Italy in this field is very weak, partly because of tradition partly because there is no tax relief, they don't have many economic resources. So I think that final little piece of the user is missing. That lobbies, that spends the money for the robot or for a certain type of rehabilitation, etc. And then also to lobby directly, as a demand and as an investment, to support the development of a technology of their interest (Int. #2). Certainly, the associative world is fundamental for dialogue to convince the political decision-maker, because they actually do that very well. In fact, a good part of the laws we have today arise precisely from the positive action of the patients' association (Int. #4). User associations can become a critical mass that demands and finances product development. They could also be targeted for operations to raise awareness and build a culture of technology. Associations are very active in this, and I believe they are fertile ground, intercepting novelty. Indeed, often it is they who knock on our door, because they want to follow all our developments to try to improve their quality of life and that of their families. Then in turn they can also be an engine for spreading knowledge to a wider audience (Int. #5).

BOX 1

MARIO
Managing Active and healthy aging with use of caRing servIce robots

2014-16

European Union Horizon 2020 – the Framework Programme for Research and Innovation (2014-2020)

Project MARIO "Managing active and healthy aging with use of caring service robots"

MARIO focused on the difficult challenges of loneliness, isolation and dementia in older persons through innovative and multi-faceted inventions delivered by service robots. The effects of these conditions are severe and life-limiting. They burden individuals and societal support systems. Human intervention is costly, but the severity can be prevented and/or mitigated by simple changes in self-perception and brain stimulation mediated by robots.

From this unique combination, clear advances are made in the use of semantic data analytics, personal interaction, and unique applications tailored to better connect older persons to their care providers, community, own social circle and also to their personal interests. Each objective is developed with a focus on loneliness, isolation and dementia. The impact centres on deep progress toward EU scientific and market leadership in service robots and a user driven solution for this major societal challenge. The competitive advantage is the ability to treat tough challenges appropriately. In addition, a clear path has been developed on how to bring MARIO solutions to the end users through market deployment.

ADDED VALUE FOR THE STAKEHOLDERS:

Provided a link between the target group of old people with: their community and social support programs; the medical community and caregivers; their social network (family & friends); their interests (stimulation for cognitive aspects); the developer community that can make available new robot applications.

Provided room for experimentation for the systematic collection of information about users' needs and the complex interplay between care givers and users.

Website: http://www.mario-project.eu/PORTAL/communication/press-kit/53-mario-project-presentation

BOX 2

ACCRA

ROBOTS FOR AGEING

European Union Horizon 2020 – the Framework Programme for Research and Innovation (2014-2020)

The objective of the ACCRA robotic solutions was to improve or maintain the level of autonomy, to secure daily lives and to promote the maintenance of socialisation of the elderly people with loss of autonomy.

The project consisted of the building of applications to support older people in ordinary daily life at home and in care facilities.

The ACCRA solutions are driven by the needs, interests and lifestyles of senior people through personalised and self-adaptable human-robot interaction. The objective of the ACCRA robotic solutions is to improve or maintain the level of autonomy, to secure the daily lives and to promote the maintenance of socialisation of elderly people with loss of autonomy.

Robotics can contribute to this age friendly environment. The ACCRA partners focus on three main elderly needs identified during analysis: Mobility, Daily life, and Socialisation.

ADDED VALUE FOR THE STAKEHOLDERS:

The project was needs-based, it aimed at identifying needs and investigating the context in which the applications was to be used

The project was inspired by c-creation, by placing users in the centre of the innovation process. The aim of this step in ACCRA was to design a robotic solution.

The project was based on experiments. The experimentation consisted of testing the robotics solutions (e.g. an assistive smart robotic platform dedicated to mobility and user interaction; and a small-size robot and designed as a companion home, in a real context by a larger group of end users).

Website: https://www.accra-project.org/en/sample-page/

BOX 3

CARESSES

Culture-Aware Robots and Environmental Sensor Systems for Elderly Support

European Union Horizon 2020 – the Framework Programme for Research and Innovation (2014-2020)

Project funded by the European Union and the Ministry of Internal Affairs and Communications of Japan

CARESSES (short for Culture-Aware Robots and Environmental Sensor Systems for Elderly Support) was a multidisciplinary, international project whose goal is to design the first care robots that adapt the way they behave and speak to the culture of the person they assist.

The project was to design culturally aware and culturally competent elder care robots. These robots were designed to adapt how they behave and speak to the culture, customs and manners of the person they assist.

The project's innovative approach was to shape the design of care robots to be sensitive to the culture-specific needs and preferences of elderly clients, while offering them a safe, reliable and intuitive system, specifically designed to support active and healthy ageing and reduce caregiver burden.

ADDED VALUE FOR THE STAKEHOLDERS:

The project aimed at improving the acceptance of elder care robots, as well as their marketability. It dealt with users' demands and attitudes towards robots and new technological devices.

The project did develop and test the first ever culturally aware and competent robot.

The project set up a safe, reliable and intuitive system, specifically designed to support active and healthy ageing and reduce caregiver burden.

Website: http://caressesrobot.org/en/project/

BOX 4

ergoCub/ergoCub-2.0

Integrated, predictive and responsible management of risk profiles in new hybrid work contexts: human-robot collaboration and artificial intelligence

ergoCub is a joint project between the Italian National Institute for Insurance against Accidents at Work (INAIL) and the Italian Institute of Technology (IIT). The project's aim is to develop technologies targeted at reducing musculoskeletal disorders (MSDs) stemming from (future) biomechanical risks in the workplace.

After an initial three-year term (ergoCub), supported by a €5 million investment from INAIL, the collaboration has been extended for a further three years in 2024 (ergoCub-2.0).

ergoCub - a portmanteau of *ergonomics* and *iCub* (an existing robot developed by IIT)—is the name designated for the new humanoid robot at the hearth of this project. This robot will be integrated with wearable technologies, designed to track the physical condition of workers and deliver warnings in real-time.

The project's innovation lies in advancing monitoring capabilities through wearable devices, moving towards proactive and preventive risk management, by incorporating fatigue-resistant machinery and AI-enabled processing approaches. ergoCub acts as a workmate (co-robot), assisting workers with physically demanding tasks and helping prevent injuries and the onset of work-related diseases. Special attention is given to lifting tasks, where associated risks can be significantly reduced.

Psychosocial factors have not been left aside, with ergoCub being equipped with OLED lights to convey "emotions" in order to enhance its acceptability and foster relations with human workers.

ADDED VALUE FOR THE STAKEHOLDERS:

According to INAIL, over 70% of work-related diseases in Italy affects musculoskeletal and connective tissue system [52]. Addressing and preventing the most prevalent workplace-related disorders, ergoCub might thus significantly enhance workers' health and wellbeing. Health and social care workers, who are among the most exposed to MSDS [53], might particularly benefit.

ergoCub further has a specific focus on the healthcare sector, aiming at aiding healthcare professionals, remotely monitoring patients and improving rehabilitation procedures

The uptake and acceptability of humanoid robots and wearable technologies is closely monitored, also through a survey involving workers from manufacturing and healthcare. Two laboratories have furthermore been established to validate the new technologies in settings replicating high-risk workplaces

Website: https://ergocub.eu/

BOX 5

SPRING

Socially Pertinent Robots in Gerontological Healthcare

European Union Horizon 2020 - the Framework Programme for Research and Innovation (2014-2020)

SPRING (short for Socially Pertinent Robots in Gerontological Healthcare) is a 8-partner project that has been coordinated the France National Institute for Research in Digital Science and Technology (INRIA), financed through Horizon2020. The aim of the project was to develop socially aware robotic solutions able to provide assistance and interact naturally with patients in healthcare settings, with a specific focus on geriatric care.

The project aimed at overcoming gaps in social robots' sensory and perceptive capabilities. Distinguishing signals emitted by different people and understanding which of the many different inputs in an environment are specifically addressed towards the robot are hard-to-realize, but necessary, features for a robot to naturally interact with patients (and workers).

SPRING thus, is designed to perform repetitive duties that are usually conducted by healthcare professionals in gerontological healthcare settings. Specifically, five main use cases have been identified and tested during trials at Assistance Publique Hopitaux de Paris: i) Reception and Welcoming; ii) Information and Reminders; iii) Assistance Throughout the Care Process; iv) Orientation and Guidance; v) Entertainment. According to No physical provision of care is envisaged among SPRING tasks.

ADDED VALUE FOR THE STAKEHOLDERS:

SPRING might reduce the workload of healthcare professionals by taking over routine duties.

SPRING aims at complementing the work of humans and taking advantage of what technology can offer, not substituting humans with robots. As the PI of the projects himself stated, the replacement is "neither possible nor desirable" [54].

Fears and vulnerabilities of users have been taken into account from the onset of the project. Robots have been tested with elderly patients and consequent insights have been used to refine the technology: an instance of user-centred design.

Website: https://spring-h2020.eu/