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Social Robots Acceptance and Marketability in Italy and Germany: A Cross-National Study Focusing on Assisted Living for Older Adults

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Abstract

In the last years, social robots have become a trending topic. Indeed, robots which communicate with us and mimic human behavior patterns are fascinating. However, while there is a massive body of research on their design and acceptance in different fields of application, their market potential has been rarely investigated. As their future integration in society may have a vast disruptive potential, this work aims at shedding light on the market potential, focusing on the assistive health domain. A study with 197 persons from Italy (age: M = 67.87; SD = 8.87) and Germany (age: M = 62.15; SD = 6.14) investigates cultural acceptance, desired functionalities, and purchase preferences. The participants filled in a questionnaire after watching a video illustrating some examples of social robots. Surprisingly, the individual perception of health status, social status as well as nationality did hardly influence the attitude towards social robots, although the German group was somewhat more reluctant to the idea of using them. Instead, there were significant correlations with most dimensions of the Almere model (like perceived enjoyment, sociability, usefulness and trustworthiness). Also, technology acceptance resulted strongly correlated with the individual readiness to invest money. However, as most persons consider social robots as "Assistive Technological Devices" (ATDs), they expected that their provision should mirror the usual practices followed in the two Countries for such devices. Thus, to facilitate social robots' future visibility and adoption by both individuals and health care organisations, policy makers would need to start integrating them into official ATDs databases.

Keywords Assistive technological devices · Social robots acceptance · Social robots marketability · Ambient assisted living

1 Introduction

Socially Assistive Robots (SARs) are autonomous artefacts designed to interact with us and exhibit social behaviours: from recognising, following and assisting people, to engage in conversations; from answering simple questions, to take part in more structured dialogues. Over the last years, huge steps forward have been made and documented in social robotics [33]. There are ongoing efforts to develop and refine robotic platforms both "intelligent" and robust so as to meet people's preferences and needs. Indeed, there is a good chance that SARs will massively arrive to the market within the next decade. In this work, we present the findings of a cross-national study on acceptance and marketability of social robots with 197 persons aged between 50 and 85, conducted in Germany and Italy.

The evolution of social robots from "concierge" via "helper" and "teammate" towards "friend" and even "coach" is well illustrated in a KPMG report[35] on key drivers for their adoption. This evolution reflects the changing tasks that

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can potentially be fulfilled in homes, workplaces, and public spaces: from functional interactions without social aspects, towards the awareness of emotional cues. As the complexity of tasks increases, social robots will have to work closely with humans: for example in the care domain, where robots "remembering" the detailed therapeutic history and caretakers could arrive to "discuss" the treatment of a patient. In the long-term, robots will increase emotional awareness and communication skills and thus potentially create affective relationships with users. The just mentioned more complex tasks are actually far to be ready for the general population and the KPMG report from 2016 imagines this to happen by 2050. Nevertheless, robust robotic platforms with integrated emotions sensing like Pepper indicate that simple forms of affective communication, like a robot actively listening to a person with dementia, could manifest much earlier.

As social robots become more sophisticated, their global market is expected to grow from 321 million USD in 2018 to 836 million USD by the end of 2025 at a compound annual growth rate (CAGR) of 14.7% [54]. In comparison, according to SPARC [1] the industrial market is estimated to grow at "only" 8% to 9% per year [58]. Indeed, predictions of up to 25% annual growth are made for the service sector.

As soon as technology gets more mature and significant, some associated research questions become relevant: Will people accept robots as a part of their daily life? Which barriers and facilitators influence their adoption? How do people look at social robots from a market perspective? Are they ready to buy them - and if so, how much are they willing to pay? Which are the influencing factors with respect to the creation of a market ecosystem for social robots? Are there cross-national differences to be taken into account? These are just some of the starting questions that motivated the work in this article.

In face of the continuous development of robotic skills described earlier, the market development is rather open. To the best of our knowledge, there is no consistent market analysis on SARs and neither there is a clear business model situating social robots in the market. Thus, even if the present work does not pretend to be an exhaustive market survey, it aims to shed light on users' perspective: how would potential users acquire SARs? While it is extremely important to investigate users' preferences and needs to foster the development of suitable technological devices, we believe that their readiness to purchase such devices also needs to be investigated. By understanding whether users conceive SARs as consumer goods or assistive devices would provide valuable insights to policy makers, and these are crucial for developing successful business chains and involving the proper stakeholders, like companies and service providers.

Moreover, cultural aspects become crucial also from a marketability point of view. While investigating the user's preferences from two different Countries (Germany and Italy), we provide evidence of cross-national differences regarding the marketability of SARs. We focused on people aged above 50 years, as we expect them to be the future key users of SARs in both the health area and the domestic domain. Results will also help to tailor business plans to Countries' specifics. Some previous works investigated cultural differences in robot acceptance and Human-Robot Interaction in general, based on the Hofstede's cultural dimensions theory [30]. Indeed, they found relations with its dimensions: for example, higher levels in individualism and masculine culture, implying more sense of control, seem to lead people to conceive robots as tools or machines, rather than companions or personal service providers [37]. However, while there is evidence that the cultural background and nationality of users may contribute to the variability in attitudes and perceptions regarding SARs [44,47], people's readiness for purchasing them still remains unclear.

In the present work, we aim to investigate people's perceptions towards social robots with the ultimate goal of collecting data to foster their marketability and the contribution we intend to offer consists on providing valuable insights for developing effective business models tailored on end-users perspectives, by taking into account also the peculiarities of single Country's systems. More in detail, the presented study aims to answer the following questions:

- Which are the most desired functionalities a Social Robot should have and how these could affect the person's acceptance and willingness to invest money on a robot?
- Are there any individual factors affecting acceptance and willingness to invest money on a robot?
- Could the specific national socio-economic context affect person's opinions and decision to possibly get a Social Robot for assistive purpose?

The paper is organized as follows: in section 2, we provide an overview of the state-of-the-art, focusing on the two key aspects of this analysis: social robots' acceptability *per se*, their desired functions, and people's readiness to purchase them. In section 3, the study is presented and results are illustrated in section 4. We then discuss the outcomes (section 5) considering the specific cultural contexts. In the conclusion, we summarise the major findings (section 6).

[1] A public-private partnership between the European Commission, the European industry and academia to facilitate the growth and empowerment of the robotics industry from research to production.

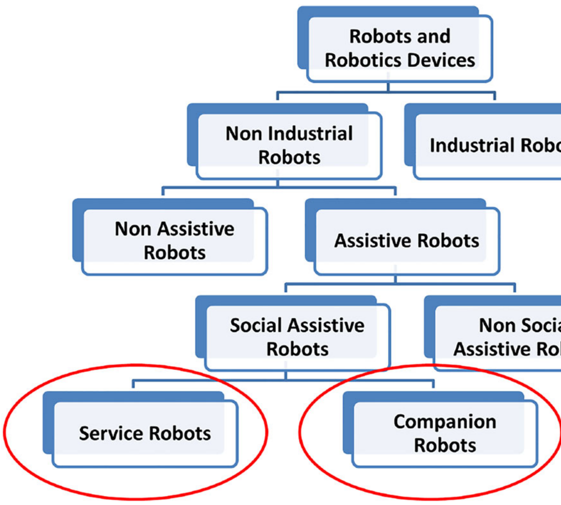

Fig. 1 A general categorization of robots according to [28]

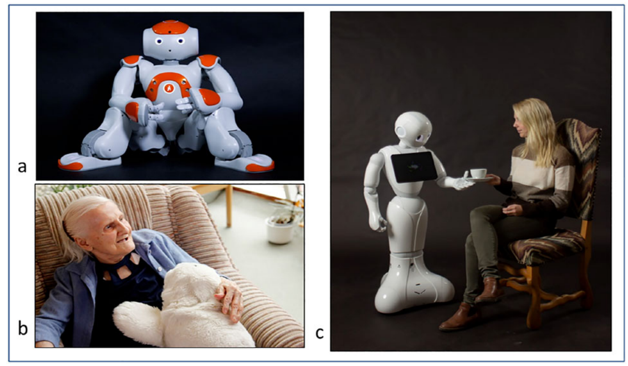

Fig. 2 Examples of social robots: a.NAO, an autonomous, programmable humanoid robot which is available as a research robot for schools, colleges and universities to teach programming and conduct research into human-robot interactions. Moreover, it is tested and deployed in a number of healthcare scenarios, including usage in care homes and in schools. b.PARO, a therapeutic robot baby harp seal, intended to be very cute and to have a calming effect on and elicit emotional responses. It is primarily used in care facilities, especially as a form of therapy for dementia patients. c.Pepper, a semi-humanoid robot designed with the ability to read emotions thanks to its ability on detection and analysis of facial expressions and voice tones

2 State of the Art

In this section, we describe the existing work focusing on two main aspects: (i) how elderly people accept social robots and (ii) economic and financial aspects of SARs that matter to the same group.

Far from claiming to be exhaustive, for a better understanding of the diverse field of SARs, a preliminary overview of robots categories should be done. As it can be seen in Figure 1, the huge family of robots can be subdivided into categories according to the different application fields.

Considering the presented categorisation, this work aims at focusing to non industrial robots with assistive purpose in social environment. More specifically, service and companion robots represent the object of this work, since they represent those platforms which better suits with older adults' needs [6,8,28,34].

While service robots provide support with physical tasks, such as carrying objects or aiding during walks [8,65], companion robots allow some forms of social interaction to provide emotional, social or psychological support. For example, these robots can read news, play music, or engage in conversations [8,32,65]. Social robots of both categories (some examples in Figure 2) have shown to positively affect older people's physical and psychological well-being: they reduce stress [56,68] and depression [67], regulate blood pressure [55] and improve people's mood [68]. Of course, these results are still far to provide evidence that can be generalised to the general population because of small samples involved in the evaluations. Nevertheless, such evidences seem to be promising and would need more structured and robust investigations.

2.1 Acceptance of Older People Towards Social Assistive Robots

Although numerous positive effects have been documented when using social robots in geriatric care, the acceptance of elderly persons varies considerably accordingly to different variables (Table 1).

On the one hand, several approaches reported decreasing levels of acceptance with increasing age [4,6,22]. For example, there is evidence that people older than 75 years are more willing to accept inconveniences than seeking support in assistive devices [25]. On the other hand, the level of acceptance is higher, depending on the context in which social robots are applied. Many elderly persons deem social robots as useful for others whose health and social situation is worse than their own [69]. Moreover, if elderly people are provided with social robots helping them to maintain their independence and autonomy, they also show readiness to overcome their skepticism [3,69].

Several reasons for the varying levels of acceptance among the elderly are discussed in the literature. As two major causes, the fear of getting dependent on assistive devices and an association with negative side effects of aging (e.g., loneliness) are described [69,70]. Another regularly expressed fear is the loss of personal, human contact and its replacement with social robots [69]. Furthermore, literature describes the lack of prior experience with modern technology as a prominent cause for uncertain feelings about robots [6,11,17,22].

A closer look at social robots' acceptance of elderly persons with regard to the two categories (service and com-

Table 1 Summary of evidences for Social Assistive Robots' acceptance

Evidences of high acceptance	Evidences of low acceptance
General	
Social robots can assist in daily activities [4,69]	Social robots are less accepted with increasing age [4,6,22]
Social robots can maintain elderly peoples' autonomy/independence [3,7,69]	Elderly people are less willing to adopt assistive devices with increasing age [25]
Social robots can contribute to elderly peoples' personal happiness [3]	Elderly people fear to become dependent on social robots [69]
	Elderly people fear that the application of social robots result in reduced social interaction and increased loneliness [3,69,70]
	Lack of prior experience with modern technology decrease elderly peoples' acceptance of social robots [6,11,17,22]
Service Robots	
Service robots score higher acceptance rates than companion robots [28]	Abilities to learn and move around freely are less accepted, in service robots [57]
Tasks such as fall detection, monitoring of vital signs, object manipulation, reminder system are accepted for service robots [7,65]	Service robots are not reliable enough [7]
Service robots should perform restricted, pre-programmed tasks [57]	The application of service robots can result in caregivers losing their jobs [7]
Service robots should fulfill individual needs and requirements [4,69]	
Companion Robots	
Companion robots are accepted when providing entertainment, such as playing radio or music, playing games, presenting news, ... [65]	Elderly people fear that companion robots can dehumanize society and increase loneliness [4,65]
Companion robots can provide benefits when applied in hospitals, rest homes and independent living [7]	Elderly people do not want to be friends with companion robots [23,26]
Companion robots show social benefits for people with mild to moderate dementia [7,41,42]	Companion robots are less accepted, if they are not able to adapt to users' needs [1,63]
Companion robots are accepted as a tutor for physical exercises [26]	
Elderly people can imagine to building social relationships with companion robots [7,16,59,63,64]	
Elderly people are interested in and curious towards companion robots [48]	

panion robots) reveals very diverse results. Some approaches report that service robots seem to reach higher levels of acceptance than companion robots [28]. For example, fall detection, monitoring of vital signs, object manipulation, such as lifting heavy objects or transporting objects, cleaning, delivery tasks, assistance with mobility and reminding of appointments and medications are listed among the most preferred tasks of social robots [7,21,65]. More generally, elderly people expect social robots to complete primarily pre-programmed, restricted tasks without the ability to learn or move around freely [57]. Instead, social robots are expected to primarily fulfill the needs and requirements of elderly people. For example, Baisch and colleague [4] reported that elderly people judge on a robot mostly in relation to their own physical and psychological needs and abilities [4,69].

Furthermore, research has indicated that older adults often present contrasting views regarding the use of robots for social support [65]. A few works report on elder persons questioning if they could build social relationships to robots. They could hardly imagine to be friends with them [23,26]. For example, [23] reports that most participants between 65 and 86 years did not want to build a relationship or even friendship to a social robot. Another study [4] reports a negative correlation between low life satisfaction and the level of acceptance for intuitive companion robots.

In spite of the restrictions described above, the majority of studies report positive attitudes and a high level of acceptance of elderly people towards social companion robots [1,7,16,41,42,60,63,64]. In particular, the robotic seal Paro is highlighted in several studies for reaching high acceptance levels [41,42,59]. The work by McGlynn and colleagues [41] for example, found that 30 healthy participants (mean age = 72.17) generally had a positive attitude towards Paro and saw benefits for themselves and others. Another study investigated the effects of Paro in comparison with a stuffed toy on 30 elderly persons with mild to severe dementia: the elderly participants showed more interest in Paro by laughing more frequently, touching and stroking the robot and initiating conversations [59].

Other examples for social companion robots with high acceptance rates are the dog “AIBO”, the rabbit-like social robot “Nabaztag” [16,60] or humanoid robots, such as Nao [26,63] or Pepper [48]. AIBO was found to increase socialization and social activities and triggered emotions among 13 older participants with severe dementia (mean age = 84 years) [60]. Nabaztag was seen as a companion (or having the potential to be one) after a ten-day study with six participants older than 50 years [16]. Four out of six participants even stated that they missed the robot after it was taken away. Participants (8 participants, age range 70 – 95) who interacted with Nao in five everyday scenarios reported to feel comfortable with the small robot and highlighted a potential emotional relationship with it over long-term use [63]. Another study revealed good acceptance rates when 6 participants aged 60 to 80 years did mild physical exercises with Nao as a coach [26].

In a user study with Pepper, Paletta et al.[48] specifically focused on people with dementia. In a qualitative study including 12 focus groups with 57 relatives of people with dementia, dementia trainers, and (care) managers, they found primarily positive attitudes towards Pepper. The interviewed people expressed feelings such as interest, curiosity, and fascination for its support possibilities, e.g., in daily activities and security. Besides the focus groups, three households of people with dementia participated in a one-week hands-on trial with Pepper. All parties, i.e., the individuals with dementia, their relatives, dementia trainers and caregivers were unanimously positive towards continuing to use Pepper after the field trial. The individuals with dementia were found to value most functionalities, such as leveraging communication and contacts with others, motivations and instructions to promote mobility and body posture as well as support with learning and recreational activities (e.g. dance or music).

In general, it become even more evident the importance of applying a user-centred design (participatory design) approach in designing, developing and evaluating technological solutions for social and assistive purposes by taking into account the specific needs of a target population [27]. Some examples where participatory design has been applied in the design and development of SARs can be found in [36] with the involvement of older adults with depressive symptoms and in [18] where different stakeholders were involved in the design of a social robot for educational purpose. It is in fact crucial to get the users involved since the very beginning (e.g. in [10]), considering their iterative involvement throughout the development phases in order to adapt and personalise the interaction accordingly to users individual characteristics [12,13] and increase the acceptance chances. Moreover, acceptance should be better investigated in long-term interactions as pointed out in [16] where the permanent presence of a robot in users' own homes yielded the real environmental context social robots encounter to be successfully accepted by their users. On the contrary, the same conditions are unlikely to be revealed in one-day laboratory human-robot interaction studies or even in multiple observations of short interactions. It has been highlighted the importance of testing robotic systems in ecologically valid settings to determine whether and how it actually meets real-world needs and emphasising the need of long-term assessment for determining the acceptance of such solutions [15].

2.2 Economic and Financial Aspects

The EU health sector considers socially assistive robots in healthcare to be an opportunity for significant cost savings [72]. For example, the social companion robot Stevie, which is being developed by Robotics & Innovation Lab of Trinity College Dublin, is expected to run between 50% to 60% of the cost of a human caretaker [61]. The expected annual growth of the social robots' market is 29% from 2019 to 2022 [61]. Although there are already some social robots commercially available like Paro for 6,000 USD [19], AIBO for 3,000 USD [31], Nao for 9,000 USD [45] and Pepper for 22,000 USD [62] (estimates), many social robots are still prototypes under development, like Care-O-Bot [9], Pearl [50], Hobbit [21], Robot-Era [20] or Stevie [39,40]. In general, social robots are still quite expensive. Although there are successful and price-worthy nice solutions like Paro, to realise major cost savings in the health market, the current robots have too few functions at too high costs.

There is little information about potential financing models for individuals or care facilities that would like to use SARs for elderly care. In general, Japan may be seen as a role model of both, the development and the deployment of social robots for geriatric care. Since 2015, the Japanese government has funded the development of care robots with 45 million USD, to support a lack of specialized workers [53]. Another 50 millions USD were spent by the Japanese Labour Ministry to introduce social robots into 5,000 care facilities [53]. For example, the nursing home Shin-tomi in Tokyo uses 20 different robots in their daily care (e.g., Paro, AIBO, Nao and Pepper) [53]. Although the president and CEO of the nursing home reports that the introduction of the robots has helped the staff and the residents on a psychological and emotional level, the robots could not yet reduce the personnel costs or working hours of the facility [53]. Indeed, even Japan is still actively pursuing the immigration of qualified health personnel, for example via the Philippines-Japan Economic Partnership Agreement. This shows that the robots currently available do not yet meet the requirements of the health markets.

In research, only a few articles have investigated the financial aspect of social robots and the results seem to point in a similar direction. [10] highlight the importance of keeping the costs for services of Ambient Assisted Living (AAL) low. The authors even report that elderly persons expect the National Health Care service to bear part of the costs for services of this kind. More specifically, [21] report that only 4% of their participants were willing to pay an estimated price of € 14,000 for the social service robot Hobbit (49 participants aged above 70 years, from Sweden, Greece and Austria). Other works criticise the high price of commercially available social robots:

- There are different opinions as to whether it [the price] is worthwhile [60].
- "Also, there is an issue of cost as few household robots are available at mass-market consumer prices" [71].
- "[...] the major limitation identified was the cost, [...], but I still think it's highly overpriced" [43].

From this extensive study of related work, it clearly emerged that, despite a plethora of studies investigating aspects like acceptance, research on social robot marketability is very scarce. To the best of our knowledge, few studies consider the financial aspects, and no one considers it as the main target. Our work moved from this consideration, with the aim of pursuing the goal of bringing fresh and hopefully valuable feedback for fostering social robot marketability.

3 Method

Under these premises, the present study aims at investigating the potential marketability of social robots and people's readiness to actually buy them, by considering personal aspects such as socio-demographics, needs, preferences on social robots functionalities, as well as feelings and perceptions towards these technological platforms. The ultimate goal is to involve representative end users by administering them with some questionnaires addressing the below mentioned dimensions (see 3.2 for further description). It is worth noticing that, while the target population of this article are older people, the study considers a wider age range of users in order to combine feedback from current elders and the potential buyers of future social robots. For this reason, the age range also included middle-aged persons as "future older adults". Nevertheless, as we will show in this section, age did not crucially affect the participants' responses on social robots marketability.

3.1 Participants

A convenience sampling method has been chosen for recruiting the participants and 197 persons took part in the survey, 89 from Germany and 108 from Italy. This sample size has been considered acceptable with a margin of error of 6.96% compared to the total population above 65 years old in Italy and Germany, considering a confidence level of 95%. In both Countries there were more female participants (61.80% of German respondents, and 54.53% in Italy). The mean age was 67.87 years (SD= 8.87) for the German group and 62.15 (SD= 6.14) for the Italian one, in a range from 50 to 85 years old. As anticipated, this range was chosen considering that today middle-aged people will probably be the actual users of SARs, and for this reason, their opinion should be taken into consideration. For convenience, we considered as middle-age participants those from 50 to 64 years old (N= 109; M= 59.16, SD= 3.56) and older adults those ranging 65-85 (N= 88; age M= 72.4, SD= 5.14). The participants' health status resulted to be good showing no significant cross-national differences (whole sample: M= 3.87, SD= 0.94 in a 1-5 scale), and their social life was considered satisfying in both Countries ($U = 10152$; $z = 3.092$, p=.002; $Germany : M = 3.97$, $SD = 1.22$; $Italy : M = 3.43$, $SD = 1.28$).

In order to get a better description of our sample, we also investigated some socio-economic aspects in more detail, both with respect to the whole sample and the distribution within the two Countries (Table 2). More specifically, it emerged a quite similar picture in Germany and Italy on education, household composition, average monthly income and professional role. In fact, in both Countries almost half participants reported to get a university degree (Whole sample: 47%; Germany: 45.45%, Italy: 47.22%), a higher prevalence of employees was found (Whole sample: 41%; Germany: 40.45%, Italy: 41.67%), with major part of the sample gaining more than 1,000 € per month (Whole sample: 85%; Germany: 87.64%, Italy: 83.34%). Finally, considering the household composition, although most of participants live with a partner (Whole sample: 70%; Germany: 59.55%, Italy: 77.78%), there is a larger number of persons living alone in Germany (39.33%) than in Italy (13.89%).

3.2 Materials

The questionnaire was administered after signing a consent in which the participants were informed upon research purposes and had the opportunity to ask for clarifications. The questionnaire consisted of five sections investigating different aspects:

- In the first section **socio-demographic information** was collected, describing the involved sample. It included some items on a 5-point Likert scale regarding persons'

Table 2 Detailed description of participants' education level, income, household composition, and professional role

	Total (%)	Germany (%)	Italy (%)
Education			
Elementary school	4	5.68	2.78
Middle School	19	30.68	10.19
High school	30	18.18	39.81
University	47	45.45	47.22
Professional role			
Entrepreneur/Freelancer	11	14.61	8.49
Manager	10	4.49	14.81
Employee	41	40.45	41.67
Teacher	9	8.99	8.33
At home	4	2.25	5.56
Worker	5	3.37	6.48
Other	20	25.84	14.66
Income			
0-500 €	6	4.49	6.48
600-1,000 €	9	7.87	10.19
1,100-1,500 €	16	15.73	16.67
1,600-2,000 €	23	20.22	25.93
Above 2,000 €	46	51.69	40.74
Household composition			
Living alone	25	39.33	13.89
Living with the partner	70	59.55	77.78
Living with a caregiver	1	0.00	1.85
Other	4	1.12	6.48

perceived satisfaction on their health and social life, as well as their technology experience;

- The second section aimed at investigating **participants' needs in daily life** such as needs for support in caring activities, mobility, housekeeping, health monitoring, physical support, reminder services, entertainment, etc. The items' structure was "*I would need help with...?*" and the respondents were asked to rate their agreement on a 5-point Likert scale. The dimensions here considered derived from the Activities of Daily Living (ADL) which are classified into basic ADLs and Instrumental Activities of Daily Living (IADLs) [46]. The firsts are those skills required to manage one's basic physical needs including personal hygiene or grooming, dressing, toileting, transferring or ambulating, and eating. The seconds include more complex activities that are related to the ability to live independently in the community.
- The third section consisted of statements based on the Almere Model [28] that should be rated on a 5-point Likert scale, in order ti investigate the **SARs acceptability**. The Almere Model was primarily designed to measure elderly users' acceptance toward socially assistive robots and it represents an adaptation and theoretical extension of the Unified Theory of Acceptance and Use of Technology (UTAUT) [66] specifically geared and tailored for seniors as end users in a caring / assistive context. According to the Almere Model, acceptance consists of different interrelated constructs which are:

1. *Anxiety* - the user' s feeling of unease when interacting with a robot;
2. *Attitude* toward technology - user's positive or negative feelings towards a robot;
3. *Facilitating Conditions* - Factors in the environment that facilitate the use of the system (e.g., being trained to use a robot);
4. *Intention to use* - The user's intent to use a robot over a period of time;
5. *Perceived Adaptiveness* - The perceived ability of a robot to adapt to the needs of the user;
6. *Perceived Enjoyment* - The user's feelings of pleasure associated with the use of a robot;
7. *Perceived Ease of Use* - The degree to which a user believes that he or she can use a robot without effort;
8. *Perceived Sociability* - The perceived ability of a robot to perform appropriate social behaviours;
9. *Perceived Usefulness* - The degree that a user believes a robot would be assistive;
10. *Social Influence* - User's perception that their social network would want or not want them to use a robot;
11. *Social Presence* - The user's experience of sensing a social entity when interacting with a robot;
12. *Trust* - The user's belief that a robot behaves with integrity and reliability.

Seven out of twelve dimensions have been considered in this study, with an acceptable internal reliability (measured through the Cronbach's alpha coefficient, [14]). The following have been considered in a total of 29 items: *Anxiety* ($\alpha = .83$); *Attitude Toward Technology* ($\alpha = .63$); *Perceived Adaptiveness* ($\alpha = .61$); *Perceived Enjoyment* ($\alpha = .74$); *Perceived Sociability* ($\alpha = .66$); *Perceived Usefulness* ($\alpha = .59$); *Trust* ($\alpha = .81$);

- The fourth section of the questionnaire was dedicated to the investigation of the **desired functionalities** of a robot. Respondents were asked to answer according to their degree of agreement on a 5-point Likert scale to items such as "*A social robot should be able lift heavy things*", "*A social robot should be able to entertain me*", "*A social robot should be able to take care of older persons*", etc.
- The last section covered **financial aspects**, asking the participants about different proposals of purchasing a social robot. Again they were asked to provide their degree of agreement on a 5-point Likert scale with regard to the following statements: I would rather rent or lease

a social robot than buy one; I would only buy a social robot, if another party (e.g. insurance, health national service) finances at least half of the costs; I would only use a social robot if another party (e.g. insurance, health national service) entirely pays for it; State/government should provide me with a social robot; Insurance should provide me with a social robot; Buying a social robot should be up to the citizen; The amount of money I would spend for a social robot varies according to what the social robot can do.

Since it was not possible to make participants to interact with real robots, in order to make them comfortable with such technology, they watched a video showing some social robots to familiarise with the topic, before completing the third section of the questionnaire. Besides, the video served to build up a common knowledge base for the whole sample [2].

3.3 Statistical Analyses

Statistical analysis were performed by using SAS 9.4 software. Desired functionalities for Social Robots have been investigated through Chi-square analysis and Kruskal-Wallis test has been used to investigate cross-national differences, age differences, gender and income. Post-hoc pairwise comparison with Tukey HSD corrections deepened the analysis. Cross-national differences on Social Robots' acceptance have been investigated by using Mann-Whitney test for each Almere dimension. Possible correlations with age have also been investigated with respect to health status satisfaction, social life satisfaction, technology experience, acceptance dimensions, people's readiness to invest money for SARs and adoption modalities by means of Spearman correlation analysis. The same correlation analysis has been used for investigating a possible association between acceptance and both technology experience and desired functionalities. Finally, preliminary correlations analysis has been performed in order to investigate the association between people's readiness to invest money for SARs with income, health status, social well-being, participants' needs, acceptance dimensions, robot functionalities. Linear regression stepwise analysis have been performed in order to deepen the significant associations. Inferential Statistics have been considered statistically significant with *p value* $< .05$, and 95% confidence interval have been computed for means.

4 Results

Desired Functionalities for Social Robots.

Participants were asked to rate different functionalities for social robots on a 5-point Likert scale, in order to state which ones should be part of a robot's functionalities. A Chi-square test revealed that the "should have" rate differed by type of functionality ($\chi^2_{(11,2363)} = 35.81, p = .002$) (see Figure 3). According to post-hoc pairwise comparisons, par-

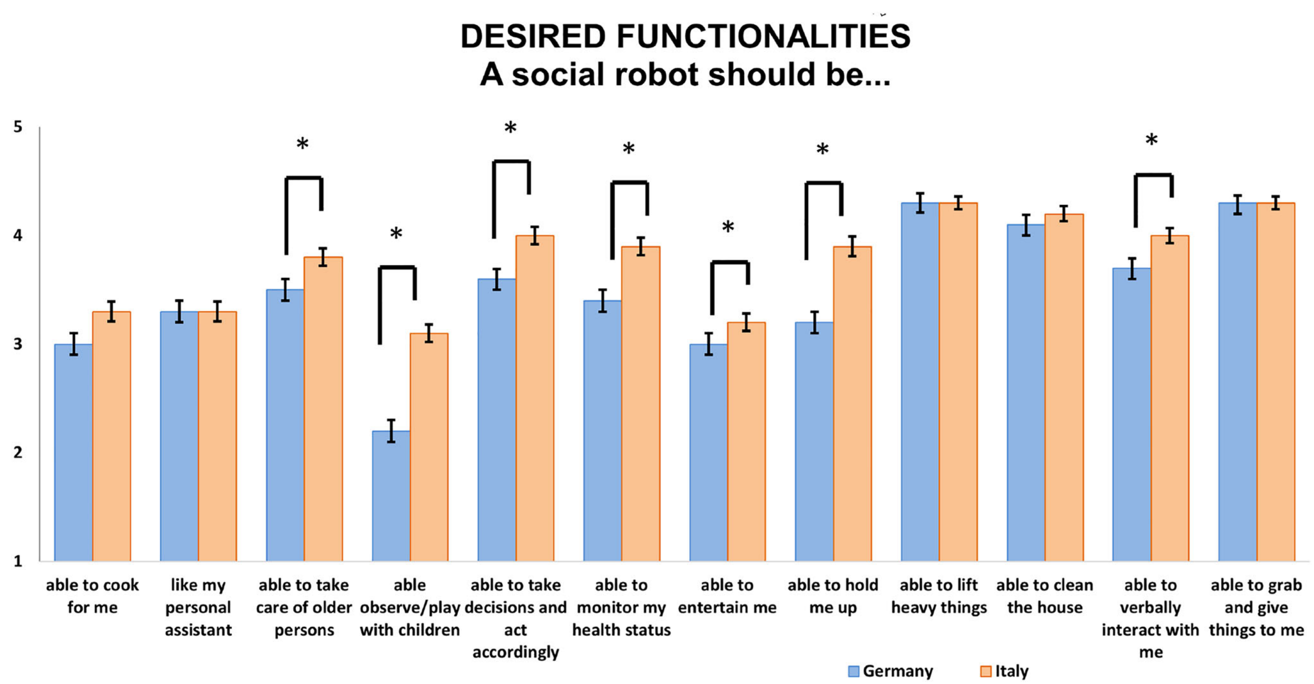

Fig. 3 Desired functionalities for social robots by Country. 1 = completely disagree, 5 = completely agree. Error bars represent S.E. Statistically significant differences are highlighted with *

Table 3 Cross-national differences in desired functionalities for social robots (1 = completely disagree, 5 = completely agree)

Cross-national differences in desired functionalities for social robots						
	Germany (SD)	Italy (SD)	Overall (SD)	$H_{(11,198)}$	Adjusted *p*	Cohen's *d*
Cooking	3(1.4)	3.3(1.4)	3.2(1.4)	−1.49	.13	.2
Personal assistant	3.3(1.3)	3.3(1.2)	3.3(1.3)	−0.37	0.75	0
Caring elderly	3.5(1.3)	3.8(1.1)	3.7(1.2)	−1.83	**.02**	.3
Caring children	2.2(1.1)	3.1(1.2)	2.7(1.2)	−4.88	**.002**	.8
Decision making	3.6(1.3)	4(1)	3.8(1.1)	−2.45	**.01**	.4
Health monitoring	3.4(1.2)	3.9(1.1)	3.7(1.2)	−2.88	**.004**	.5
Entertaining	3(1.3)	3.2(1.2)	3(1.3)	-1.41	**.01**	.2
Holding people	3.2(1.3)	3.9(1.1)	3.5(1.3)	−4.08	**.000**	.6
Lifting things	4.3(0.9)	4.3(1)	4.3(0.9)	0.31	.75	0
Cleaning	4.1(1.1)	4.2(1)	4.2(1)	−0.73	.46	.1
Speaking	3.7(1.2)	4(1)	3.9(1.1)	−2.1	**.03**	.3
Grabbing	4.3(1)	4.3(0.8)	4.3(0.9)	−0.80	.41	0

Statistically significant differences are highlighted with bold Adjusted *p*

Table 4 Correlation between health and social satisfaction and participants' needs in Germany. Correlations are statistically significant at $p < .05$

		Cleaning	Grocery	Lifting Objects	Lifting People	Entertainment
Health	r_s	-0.257	−0.334	−0.302	−0.412	−0.372
Satisfaction	*p*	.014	.001	.003	.000	.000
Social	r_s	−0.382	−0.379	−0.347	−0.367	−0.410
Satisfaction	*p*	.000	.000	.000	.000	.020

		Health monitoring	Caring Children	Caring Elderly	Personal assistant	Preparing meals
Health	r_s	−0.367	−0.347	−0.271	−0.401	−0.261
Satisfaction	*p*	.000	.000	.000	.013	.000
Social	r_s	−0.243	−0.318	−0.369	−0.306	−0.224
Satisfaction	*p*	.020	.002	.000	.003	.033

ticipants were more inclined to consider social robots for *cleaning* (M= 4.18, SD= 1.03; CI: 4.03, 4.32), *lifting heavy things* (M= 4.33, SD= 0.95; CI: 4.19, 4.46), *grabbing objects* (M= 4.29, SD= 0.86; CI: 4.16, 4.41), and *engaging in verbal interaction* (M= 3.90, SD= 1.09; CI: 3.75, 4.05) when compared to all functionalities described in Figure 3 (all $p < .05$, corrected with Tukey HSD). No statistically significant differences were found for the remaining functionalities ($p > .05$).

Cross-national Differences in Social Robots' Functionalities As shown in Figure 3 and Table 3, a Kruskal-Wallis test revealed a statistically significant effect of Country on participants' rating of different functionalities for social robots ($H_{(11,198)} = -6.192, p = .0001$). Seven out of twelve functionalities presented statistically significant differences between Germany and Italy. Post-hoc pairwise comparisons (Tukey HSD corrections) showed that, in comparison with Germany, Italian participants were more inclined towards considering social robots for: *taking care of older persons* (*p* =.02; Germany= CI: 4.02, 4.43; Italy= CI: 4.19, 4.48), *playing with children* (*p* =.002; Germany= CI: 2.05, 2.52; Italy= CI: 2.86, 3.34), *monitoring health* (*p* =.004; Germany= CI: 3.19, 3.71; Italy= CI: 3.70, 4.11), *verbal interaction* (*p* =.03; Germany= CI: 3.48, 3.99; Italy= CI: 3.85, 4.22), *entertainment* (*p* =.01; Germany= CI: 2.67, 3.21; Italy= CI: 2.94, 3.41), *holding people* (*p* =.0006; Germany= CI: 2.91, 3.47; Italy= CI: 3.67, 4.11), and for *making autonomous decisions* such as calling emergency services (*p* =.01;Germany= CI: 3.36, 3.90; Italy= CI: 3.8, 4.2). No statistically significant differences between Countries were found for functionalities as cooking, cleaning tasks, lifting and grabbing tasks, as well as being a personal assistant ($p > .05$).

Effects of Age, Income and Gender on Social Robots' Desired Functionalities A Kruskal-Wallis test revealed a statistically significant effect of age group on desired functionalities ($H_{(1,2374)} = 2.742, p = .006$). Post-hoc pairwise comparisons with Tukey HSD corrections showed that participants aged 50 to 64 years-old (M= 4.43, SD= 0.72; CI: 4.29, 4.56) were more willing to accept social robots that *grab objects and give it to them*, in comparison with participants aged 65 to 85 years-old (M= 4.11, SD= 0.99; CI: 3.89, 4.32) (p =.008). Similarly, participants aged 50 to 64 years-old (M= 4.10, SD= 1.04; CI: 3.90, 4.29) also were more accepting of social robots that could *verbally interact* with them, in comparison with older participants (M= 3.65, SD= 1.11; CI: 3.42, 4.88) who rated social robots that provide verbal interaction less favourably (p =.008). No additional age-related differences for functionalities in social robots were found ($p > .05$). Furthermore, no main effects of income or gender were found ($p > .05$).

Cross-national Differences in Social Robots' Acceptance.

Investigating possible cross-national differences in acceptance of social robots, the Almere model has been used as a theoretical framework. The Mann-Whitney U test has been performed in order to compare each model dimension. Statistically significant differences have been found for Anxiety ($U = 10100; z = 3.261, p = .001$), *Perceived Adaptiveness* ($U = 7676.5; z = -2.869, p = .004$), and *Trust* ($U = 8016.5; z = -1.997, p = .04$). In more detail, it emerged that German participants (M= 2.50, SD= 1.08; CI: 2.27, 2.73) reported more anxious feelings towards social robots compared to the Italian ones (M= 2.02, SD= 0.99; CI: 1.83, 2.21). They also perceived social robots as less able to adapt to their needs (*Perceived Adaptiveness* - Germany: M= 3.24, SD= 0.79; CI: 3.07, 3.40. Italy: M= 3.56, SD= 0.86; CI: 3.39, 3.72) and have proven less confident that social robots could perform with personal integrity and reliability (*Trust* - Germany: M= 2.90, SD= 0.66; CI: 2.76, 3.04. Italy: M= 3.12, SD= 0.73; CI: 2.97, 3.26).

Individual Differences in Social Robots' Acceptance.

When investigating a possible effect of age by performing Spearman correlation analysis, no statistically significant associations have been found when correlating with health status satisfaction, social life satisfaction, technology experience and acceptance dimensions. Age was not even related to people's readiness to invest money for purchasing social robots, and no associations were found with the proposed modality of adoption (i.e., renting, provided by third parties such insurances, health national system, etc.). With regard to the perception of ones own health status perception and satisfaction with social life, only in Germany statistically significant correlations have been found for each investigated user need. Negative associations have been found for each of them, meaning that German people report an increased need for help as their health decreases and their social life gets poorer (see Table 4).

On the contrary, *Experience with Technology* resulted to be associated with feelings of *Trust* towards social robots in both Countries, Italy ($r_s = 0.205; p$=.033) and Germany ($r_s = 0.249; p$=.018). As well as the dimension of *Perceived Adaptiveness*, namely, the degree to which a social robot could be able to adapt to the needs of the user resulted to be positively correlated (Italy: $r_s = 0.208; p$=.030; Germany: $r_s = 0.221; p$=.037), and negative correlations have been found with *Anxiety* in Italy ($r_s = -0.224; p$=.019). This means, as expected, that knowledge about technology can act as a reassuring factor for fostering positive feelings and perceptions in people. Furthermore, a positive correlation has been found also between *Trust* and the desired requirements of a robot. Indeed, in both Countries all the considered functionalities were positively associated with *Trust*, as one can see in Table 5. This suggests that trust on social robots might somehow make people to believe on a wide range of possible functionalities, from simpler ones for service tasks (e.g. grabbing, lifting objects), to those more complex which require higher levels of interaction (e.g. caring activities).

Table 5 Correlation between *Trust* dimension and robot's functionalities

	TRUST Germany		TRUST Italy	
	r_s	p	r_s	p
Cooking	0.313	.002	0.494	.000
Personal assistant	0.468	.000	0.509	.000
Caring elderly	0.485	.000	0.465	.000
Caring children	0.593	.000	0.460	.000
Decision taking	0.365	.000	0.365	.000
Health monitoring	0.288	.006	0.489	.000
Entertaining	0.320	.002	0.436	.000
Holding people	0.261	.013	0.249	.009
Lifting things	0.135	.204	0.220	.022
Cleaning	0.221	.037	0.314	.000
Speaking	0.391	.000	0.467	.000
Grabbing	0.280	.007	0.327	.000

Also other dimensions of the Almere model have been found to follow the same significant trend, showing how the general acceptance of a social robot promotes the desire on people to have different functionalities with different levels of complexity.

Readiness to Purchase Social Robots.

A specific focus has been dedicated to the readiness of persons to invest money for purchasing a social robot and to investigate which factors could somehow affect this willingness. As a first point, no statistically significant differences were reported with respect to the average amount people are willing to spend: 47.72% of all respondents were more inclined to spend from 1000 to 5000€ for such a purchase, followed by 33.00% who would prefer to spend less than 1000€. Only 19.29% of all participants stated to be available in spending more than 5000€. This result was further investigated in order to understand possible relations with the status and attitudes of respondents. While the individual per-

Table 6 Correlation between Almere dimensions and participants readiness in purchasing a social robot. Correlations are statistically significant at p <.05

		Anxiety	Attitude Technology	Perceived Adaptiveness	Perceived Enjoyment	Perceived Sociability	Perceived Usefulness	Trust
Germany	r_s	−0.234	0.481	0.298	0.381	0.451	0.363	0.488
Readiness	p	.026	.000	.004	.000	.000	.000	.000
Italy	r_s	−0.319	0.457	0.338	0.395	0.407	0.455	0.402
Readiness	p	.000	.000	.000	.000	.000	.000	.000

Table 7 Linear regression analysis; readiness in purchasing a social robot vs. Almere dimensions and robot functionalities

Model	R^2	AdjR^2	Factor	t	p	Beta	VIF
Readiness	.23	.22	ALMERE DIMENSIONS				
			Trust	3.48	.000	0.32	1.61
			Attitude toward technology	3.17	.001	0.21	1.61
Readiness	.18	.15	ROBOT FUNCTIONALITIES				
			Speaking	2.05	.042	0.14	1.87
			Health monitoring	−2.20	.029	−0.15	2.33
			Personal assistant	2.01	.045	0.12	2.07
			Caring elderly	2.42	.016	0.16	2.11

Values statistically significant with p-value $p < .05$. R^2, coefficient of determination; $AdjR^2$, adjusted R^2; t-value, slope of the sample regression line divided by its standard error; VIF, Variance Inflation Factor

ception of health status and social well-being did not appear to be related to people's readiness to spend a larger amount of money, significant correlations have been found with all the dimensions of the Almere model (see Table 6).

When performing a step-wise regression analysis in order to identify which of these factors could better explain the model, *Trust* and *Attitude toward Technology* were the two resulting significantly predicting people's willingness to spent money on a social robot (see Table 7). Furthermore, only in Germany, this variable increased with the increasing income ($r_s = 0.273$; p=.009), while Italian responses unveiled positive associations with needs of caring for elderly ($r_s = 0.212$; p=.027), needs of support on daily activities ($r_s = 0.214$; p=.025), need in preparing meals ($r_s = 0.270$; p=.004). On the other hand, statistically significant associations were found with robot requirements in both Countries. In both cases, grabbing, speaking, health monitoring, decision making, caring for children and elderly, personal assistant, and cooking have been found to be significant (in Italy also entertainment).

Also in this case, a step-wise regression analysis was performed in order to better explain the associations. As a result, health monitoring, decision taking and elderly care emerged as predictive factors (see Table 7). This finding suggests that complex services such as health monitoring and caring of older people are those functionalities which would be better worthy for people to buy a robot, as well as for its ability to take decisions and act accordingly (e.g. call for help in case of emergencies, provide help in case the person falls down).

Finally, different modalities for acquiring a social robot have been proposed to participants, which was one of the most important factors to investigate in the present study, and some interesting cross-national differences emerged. It has been shown that Italian participants are more inclined to rely on the support of governmental entities. Indeed, as one can see in Figure 4, significant statistically differences emerged with respect to costs for social robots that should be covered by private insurance companies, or the national health service (U=7898; z=-2.366, p= .01 - Germany: M= 3.17, SD= 1.19; CI: 2.92, 3.42. Italy: M= 3.31, SD= 1.15; CI: 3.09, 3.53), and the same trend resulted when referring to the government as the only provider (U=8030; z=-2.021, p= .04 - Germany: M= 2.86, SD= 1.23; CI: 2.60, 3.12. Italy: M= 3.21, SD= 1.25; CI: 2.98, 3.45). In line with these results, the Italian participants, did not consider that citizens should be in charge of purchasing a social robot when compared to the German group (U=11842; z=7.793, p= .000 - Germany: M= 3.53, SD= 1.19; CI: 3.28, 3.78. Italy: M= 2.04, SD= 1.07; CI: 1.83, 2.24).

5 Discussion

Taking into account the financial aspects and individual characteristics of a specific segment of the population, findings of

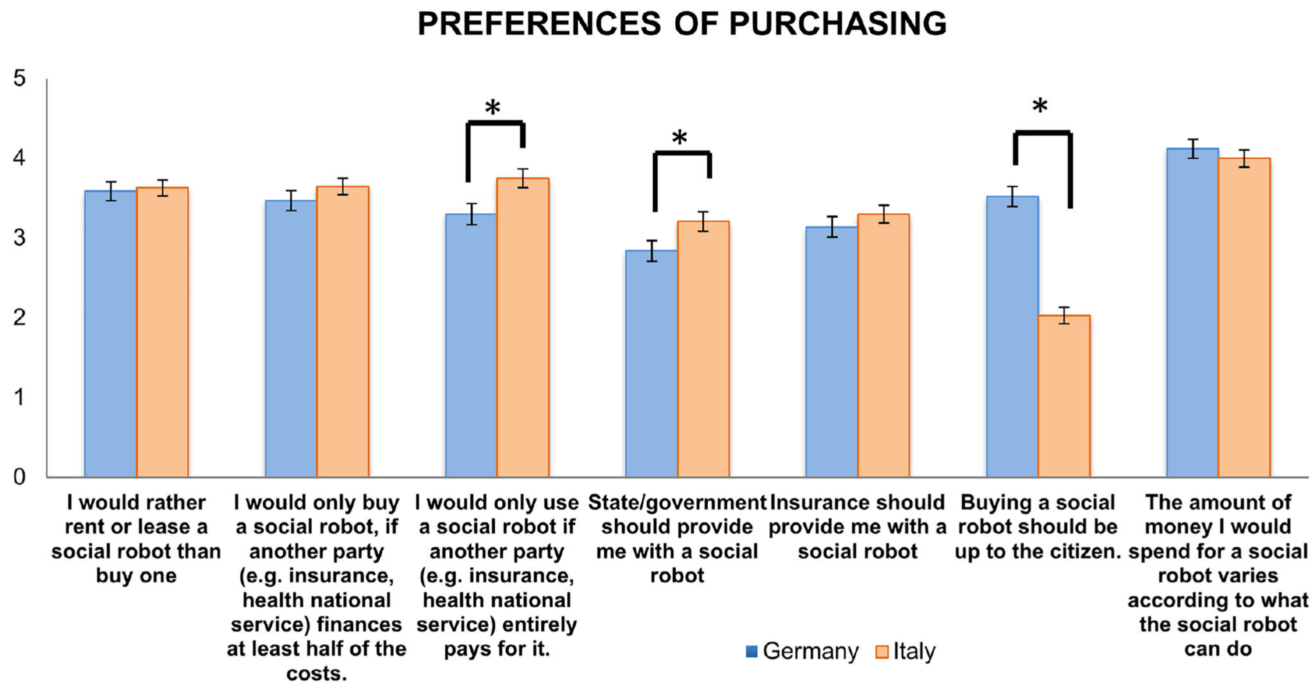

Fig. 4 Respondents preferences among different modalities for adopt, purchase a social robot. 1= Completely disagree, 5= Completely agree. * *p-value* $< .05$

this study suggest some important observations to be taken into consideration when designing and developing social robots to favor their marketability. The target population's age ranged from 50 to 85 years old, namely those segments with supposedly stable socio-economic conditions, including an acceptable income. In fact, the majority of our sample reported to get a good monthly salary, with just a little percentage of them reporting financial difficulties. Also their health status resulted to be satisfying, as well for their social life, with no significant cross-national differences.

Desired Functionalities.

A specific focus has been dedicated to possible desired functionalities for a social robot. Among others, those considered most important were mainly related to the specific categories of service robots, which is in line with previous evidences where supportive tasks to daily living seemed to be most appreciated [7,21,64]. This supports the idea that people are more inclined to conceive a robot as a tool capable to provide physical relief and practical support by completing well defined and restricted tasks, instead of acting as a companion [56]. Our findings suggest that social skills would play a secondary role, and this could be due to the fact that, having a substantial lively social life, people either do not feel like social skills as a priority or do not really feel comfortable / do not want to interact with a companion robot. Moreover, this result somehow supports previous findings which report older adults as hardly inclined to engage in friendship-like interactions with social robot and prefer to get support instead [23,26].

Beside this, some differences have been found with regard to a possible cultural influence between Italy and Germany. Indeed, the Italian group seems to be more inclined to expect social functionalities which somehow require more advanced technical capabilities in terms of interaction. For the Italian participants a social robot should be able to carry out caring activities which also implies proactive capabilities (for example, making autonomous decisions such as calling emergency services), beside verbal interaction and entertaining tasks (see Figure 3). We could speculate on this results by relating them to the differences in acceptance and feelings towards social robots, since the Italian participants appeared to be slightly more trustful towards social robots and reported a higher confidence that a robot could adapt to their own needs. On the contrary, the German respondents appeared less confident and when exposed to some examples of social robots, they reported more anxious or emotional reactions with respect to their Italian counterpart, when it comes to use the system. The significant correlations that emerged between these two variables (expected functionalities and acceptance of SARs) lead one to assume a relation between the person's belief that a robot can perform with personal integrity and reliability – besides general acceptance – and his/her propensity to expect a wide range of functionalities. More specifically, this becomes true for tasks like objects manipulation, or companion-like behaviours, but also for those capabilities which imply a higher degree of risk for one's own safety like health monitoring and calling for warning in case of emergency, or taking care of frail persons (elderly and children).

It is also interesting to notice that the aforementioned attitudes have been found to be associated with the individual experience with technology, in the sense that such knowledge can act as a reassuring factor to foster positive feelings and perceptions in people. This is also confirmed by other studies stating that the lack of prior experience with modern technology was appointed as a prominent cause for uncertain feelings towards robots [6,11,17,22]. Indeed, such findings may suggest the importance of developing support programs for improving the population's technology literacy in order to make them more confident and open minded towards technological advancements.

Readiness to Invest Money for Social Robots.

Considering the aim of the present work, on the basis of participants' thoughts about hypothetical functionalities that a social robot could have, a specific focus has been given to the willingness of people to use a social robot within their daily lives and consequently their readiness in investing money for purchasing it. When investigating which ones among the considered factors would have somehow affected this attitude, a first important outcome is that the readiness to spend money for a social robot is independent from the individual perception of one's own health status and social life. On the contrary, people appeared more inclined to buy a social robot according to their beliefs and perceptions towards social robots and technology in general. Namely, positive feelings about the usage of the technology, positive emotional reactions when it comes to use a robot with no fearful or anxious feelings beside the belief that the robot would perform with personal integrity and reliability, and the perceived ability of a robot to adapt to their own needs, are supposed to positively affect people's willingness to invest their money. This resulted regardless of any cultural influence, demonstrating somehow the generalisability of a well-recognised technology acceptance model, the Almere model, according to which the above mentioned aspects should affect one's intention to use a social robot in daily life [28]. Additionally, it has been seen that some functionalities more than others seem to be considered important and consequently as better incentives for people to purchase a social robot. In fact, services which address health issues and care appear to be those that more than others would promote people's propensity in purchasing a social robot. More specifically, the capability of a social robot to monitor vital signs and intervene proactively in case of emergency (e.g. call for help, provide help in case of falls), as well as a broader service of caring activities towards elderly people, resulted to be the major factors affecting people's willingness in relying on social robots. This is somehow in line with previous findings: The review by [64] found a considerable number of evidences of older adults conceiving SARs as being a complete, or at least a component of a safety system (a SAR that detects falls and alerts other humans could contribute positively to the safety of older adults). The same work reported other evidence of participants considering SARs as virtual doctors or nurses monitoring older adults, notifying health professionals or relatives in cases of emergency.

The Marketability.

Most important to our ultimate goal to investigate the marketability of social robots, was the participants' opinion of who should bear the costs for a social robot. In fact, while German participants are more inclined to consider that citizens should provide for themselves; the Italian respondents seem to refuse this possibility and consider that this responsibility should be up to other parties, especially the national health system or the government. Similar findings on the Italian population were already reported in previous studies [10]. The present investigation unveiled that in both Countries the functionalities considered as more valuable were those concerning health support and monitoring, especially with regard to elderly care; thus social robots could be reasonably conceived as Assistive Technological Devices (ATDs).

Without claiming to be complete, a few words about the health care system in both Countries deserve to be spent, to better contextualise our speculations on these results. In Germany, the predominant system of financing health services is through statutory health insurance, with direct payments for private practice, public taxation and private insurances as supplementary ways. On the contrary, in Italy public taxation is the main way to support health system and private voluntary insurance with direct payments becomes a supplementary system of finance. Regardless of these different business models, both Countries provide universal healthcare. Excluding some frail categories which are exempted at different degrees, in both systems, out-of-pocket contributions are foreseen. Italy has two main types of out-of-pocket payments which have financial benefits in terms of tax returns. The first is demand-side cost-sharing: a co-payment for diagnostic procedures, pharmaceuticals and specialist visits. The second is direct payment by users for the purchase of private health care services and over-the-counter drugs.

In Italy, the provision of ATDs is regulated by the Tariffs Nomenclature (Nomenclatore Tariffario): a law by the Italian state (Ministerial Decree 332/1999, and DPCM 12/1/2017) establishing the norms and tariffs for assistive products provided by the National Health System (Sistema Sanitario Nazionale – SSN). Roughly described, the decree includes a list of ATDs (organised by category, code and tariff) that can be financed by the SSN, and thus citizens with certified disabilities can benefit from such supports at no cost. To initiate the procedure for delivery of prostheses, aids and ortheses charged to the SSN, the persons should already have a certified disability of at least 34% and then follow four steps: prescription, authorisation, supply and testing. The patient, the prescriber and the supplier are involved in each step in a different way.

In Germany, the situation is similar for end users. The financing of assistive technologies through social security systems – through health insurance companies, municipalities, housing cooperatives, etc. - is insufficiently clarified. This is currently done to a small extent by the health insurance funds on the basis of individual case decisions [38]. In [29], an example of the encountered difficulties for getting assistive devices can be found. Regulations for providing and financing ATDs are reported as complex and fragmented and, thus, might affect adequate provision of these devices to people in need. Problems with long approval processes and a serious bureaucratic burden are reported. The basic entitlements of Social Health Insurance-insured to receive ATDs are defined in the Social Code Book V (SGBV), which is the most relevant health care scheme in Germany. A pre-condition for provision of ATDs is a medical provider's prescription. In a second step, the patient must submit to the sickness fund and apply for the provision of an ATD along with the prescription, which must attest the medical need for the device. Clearly, this situation and the pricing currently make social robots primarily affordable for professional health care institutions.

Considering social robots as ATDs for health care, the Italian participants may expect to get them for free, while the German ones seem hesitant to engage in a lengthy process which could end with a poor contribution and the need to pay the most part of an ATD by themselves. This may result the population preferring to rely on its own finance instead of following the institutional path. As a consequence, the German group may be especially concerned about the costs of ATDs. This reflects a wide sentiment and worries already described in the state-of-the-art section, where the importance to keep low costs has been highlighted [10], as well as low percentages of people willing to pay high costs for social robots and criticising the high prices of commercially available social robots [43,53,60].

Social Robots as Assistive Technological Devices.

The major obstacle we found with regard to the possibility for citizens to benefit from robotic platforms as recognised assistive devices is that social robots are still not categorised as ATDs by the health system around Europe. Many Countries have well-established national ATDs databases which are publicly available, for example, in Italy, the Portale SIVA (www.portale.siva.it), and in Germany, Rehadat (www.rehadat.de). Today all these systems collaborate with each other in the EASTIN Association (European Assistive Technology Information Network). Each national database makes available its data to the EASTIN search engine (www.eastin.eu), through which people can search for information on assistive technological products and related resources from any EU Country. The EASTIN system has become the European landmark for assistive technology information, and will gradually increase its coverage by aggregating further resources mobilised by other EU supported networks (ETNA, ATIS4All etc.). Interestingly, when searching for "robot" in this platform, mainly robotic exoskeletons, wheelchairs, robotic arms, and robotic spoons resulted. Just two companion robots were available respectively in Denmark and Austria: JustoCat and Paro, both of them categorised under ISO 04.26 (aids for cognitive therapy) and ISO 30.03.03 (toys).

It is safe to assume that social robots still do not have any certification for being categorised as ATDs. This is also the researchers' responsibility, since not enough technical and even less clinical validation has been done. Of course, this would also imply the involvement of health care systems, care institutions, the government and the companies selling these robots in order to reach robust evidence of clinical effectiveness, making social robots eligible solutions recognised by the medical and social care entities. The HRI scientific community is quite aware of this lack: different reviews pointed out that social robots, and AAL solutions in general, were only tested under laboratory conditions [52] with the specific focus on conceptual validation. To date, there is still a high level of experimentation focusing on the development and implementation of social robots rather than their evaluation and efficacy [24]. Indeed, Pu and colleague, while investigating randomised clinical trials (RCT), have been able to include only 9 studies out of 2,204 articles into their meta-analysis. They found that social robots appear to have the potential to improve the well-being of older adults, but complained that conclusions are limited due to the lack of high-quality studies, recommending for more RCTs with larger sample sizes and rigorous study designs [51].

Finally, it is worth highlighting that our speculations fit into a larger picture taking into account the demographic change in Europe, which is going to inevitably affect the health systems. To date, the main objective is to emphasise the health care needs of the elderly population and the challenges that the "greying of Europe" will pose to health systems in terms of financing and providing long-term care services. A significant portion of EU health care, including Germany and Italy, aims at providing universal care: healthy young workers pay for the care of sick, usually older and/or poorer citizens. In turn, young generations rely on future generations to support their care. However, the demographic changes like a falling birth rate, growing life expectancy and increasing female labor participation will cause severe funding problems within the existing framework. Thus, alternatives should be considered, for example the proposal by [49], of designing pluralistic systems of health care delivery and financing, where a well-balanced mix of public and private financing can sustain investment and innovation, without imposing unsustainable burdens on public budgets, and without denying care to the disadvantaged population.

6 Conclusion

This work presents a study on the marketability of Social Assistive Robots (SARs). Indeed, despite a rich plethora of works investigating dimensions such as acceptability, trust, needs, and impact on people's well-being, to the best of our knowledge there is little data on how users conceive the business perspectives of SARs or on how they conceive the future acquisition of such advanced technology. We investigated 197 Italian and German potential users aged between 50 and 85 years. The findings show, that functionalities aimed at providing physical relief like cleaning, lifting heavy things, and grabbing objects were more appreciated by respondents.

Interestingly, these preferences changed when investigating which factors affected the willingness to invest money: under these circumstances, care-oriented functionalities like health support and monitoring were favoured. Especially for elderly persons, daily health support and a robot serving as a personal assistant proved to be the predictive factors for the readiness to accept and financially invest in SARs.

Regarding the SARs' financing, the results mirrored the usual practices in Italy and Germany: while the Italian group predominantly expected the National Health System to provide considerable support, the German participants relied more on their own financial capabilities. Although compared to other health systems such as USA and eastern Europe ones, Germany and Italy may appear quite similar, it is worth noticing that some differences do exist and that there may be some important market factors needed to be studied more in depth, taking into account the national specificities of the health systems in relation to the people's perceptions and expectations regarding its services.

With the present work we aimed at shedding light on users' perspective with regards to SARs marketability. Indeed, despite a quite rich pletora of works investigating dimensions such as acceptability, trust, needs, and impact on people's well being; at the best of our knowledge there is still no clear evidence on how users conceive the business perspectives on SARs, nor on how they conceive the process for acquiring such technologies. Our results clearly suggest that people's preferences with respect to the acquisition of SARs are strictly connected to the value they attribute to specific functionalities. Assuming that SARs are both financially and socially beneficial, it is crucial for policy makers to develop successful business chains and involve the proper stakeholders. The results show that users do not conceive SARs as consumer goods but as Assistive Technological Devices (ATDs). For this reason, policy makers should probably start integrating them into the official databases for ATDs. This single action would already considerably facilitate both SARs' visibility and their adoption by individuals and health care organisations. This also means that in future, randomised controlled trials with rigorous methods should be carried out in order to prove the benefits of using SARs in both healthcare and domestic care. Indeed, further evidence in SARs' efficacy in the healthcare domain, beside robust investigations on citizens' attitude, could provide valuable material for feeding the nudging strategies of market experts and foster the integration of such a technology in the usual practice.

Additionally, *transdisciplinary* conceived as an action-oriented approach where research questions emerge through consultation and interaction among several disciplines and sectors to develop socially useful, feasible, practical, effective, and sustainable solutions [5], should be the framework within designing, developing and evaluating social robots take place. In fact, integrating the point of view coming from computer scientists, robotics experts, social scientists, psychologists, health professionals, policy makers and users would allow a real world grounded common knowledge able to fostering concrete solutions. This effort would provide valuable guidelines to policy makers in order to develop successful business chains and involve the proper stakeholders, like both companies and service providers in order to foster SARs marketability.

Limitations and Recommendations for Future Work.

The present work provides valuable considerations and insights for future research, but there are peculiarities that should be taken into account when interpreting our results. In order to reach a wide sample of participants, they did not have the chance to physically interact with social assistive robots (SARs). Instead, they watched a short video highlighting their abilities. Although this provided the respondents with a common ground, their answers were based on general attitudes and perceptions towards interacting with social robots, rather than real-life experiences. It would be desirable for future work to integrate real interactions with SARs, and if possible long-term interactions, to let the users experience these robotic platforms under real-life conditions.

A second aspect which deserve to be considered, since one of the main objective of this work was to investigate robot marketability, it is related to the respondents characteristics. In fact, most of them had a university degree and made over €1000 a month. This may have affected the feelings about purchasing something instead of going through the bureaucratic hassle of governments and somehow influenced the obtained results.

Moreover, it would be fair to recognise that most of the robot's functionalities illustrated to the participants during our investigation are still far from being robustly deployed and available to the general population. Nevertheless, they have been proposed as possible solutions reflecting most common users' needs. This somehow reflects the participatory design approach where needs lead the design and development, whenever feasible or not, and the feasibility level consequently set the operational priority.

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Data Availability The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflict of Interest The authors declare that they have no conflict of interest.

Consent Form The subjects involved in the survey participated after having signed a consent form.

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