Understanding the Socio-Domestic Activity: A Challenge for the Ambient Technologies Acceptance in the Case of Homecare Assistance

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Abstract. Due to the global aging of population, fatal domestic accidents increase. In this paper we describe a user-centered design process of a new pervasive technology (CIRDO). The aim of this technology is to empower the elderly people by the detection of their physical falls and to alert family or caregivers. Two different studies were performed. First, we analyzed the actual risk situations. Second, social acceptance was investigated for the different stakeholders involved. Altogether 63 older adults and 38 other stakeholders were subjected to interviews, focus groups, and were observed in user tests. Falls are mostly due to environments, internal factors, external resources, and social factors. Falling scenarios were identified to configure the future device. All stakeholders proved to have different views as to the acceptability of CIRDO, depending on previous experience, trajectory, needs and objective (support, assistance, care, prevention…) Therefore they have specific expectations and fears with regard to the system.

Keywords: Pervasive technology · Social acceptance · Domestic activity · Elderly people · Risk situations

1 Introduction

Our society is experiencing an aging of its population, explained among others by the increase in life expectancy. In parallel, lifestyles change, involving new living conditions for the elderly People (EP) and their families. New needs in terms of dependency care and support are to be elaborated [1]. Indeed, because of the psychological, social or financial costs incurred by the institutional placement of EP, many of them prefer to stay at home, despite physical, psychological or cognitive difficulties. According to a study by ALTIVIS [2], fear of falling ranks second after that of dependence. The consequences of falling are serious, including motor and psychosocial levels [3, 4]. The possibilities offered by gerontechnologies suggest innovative solutions in support of EP. Besides home-care and home-hospitalization as well as the development of autonomy, gerontechnologies aim at rehabilitating or mitigating some deficiencies [5, 6] and improving elderly people's quality of life [7–9].

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Ambient technologies are less intrusive than conventional remote support or monitoring systems, and tend to blend into the living environment [1]. Indeed, they are able to anticipate users' needs by using environment data and then propose appropriate solutions [10]. Moreover, these technologies have been proved less stigmatizing since they do not need to be worn, unlike telemonitoring bracelets, which equate subjects with their handicaps and weakness; Caradec [11] called them *"old age markers"*.

The CIRDO research project (funded by ANR and CNSA[1]) is part of this socio-technical context. It gathers several scientific and industrial partners and aims to develop an ambient technology that fosters keeping dependent EP at home, by means of the automated analysis of their activities.

CIRDO means in French "Compagnon Intelligent obéissant au Doigt et à l'Oeil", that is to say, a device that obeys your every word.

1.1 Presentation of the Technological Device CIRDO

The objective of CIRDO is to provide a relatively discreet technological prosthesis to solve the problem posed by the home-care of very elderly persons faced with the risk of falling.

Technically, the device is composed of a camera(s) and microphone(s) dispersed in the domestic space, and is based on the detection of human activities via video and audio sensors. For practical purposes, the sensors are exclusively located in the living room. The system evaluates in real time and independently (without external human intervention) abnormal, dangerous or risky (falls, immobility, calls for help, accidents) domestic situations and is able to automatically alert family or caregivers if necessary.

1.2 The Theoretical Framework

Defined as "the fact of unintentionally coming to rest on the ground or other lower level" [2], a fall entails a phenomenon that is difficult to comprehend. The studies by [3] show that the elderly underestimate the risks they face. The bias in this self-assessment may be due to a sense of superiority, optimism or the illusion of invulnerability. This denial can influence how the elderly perceive the usefulness and relevance of protection devices such as CIRDO. Findings from the study [12] carried out by INPES[2] show that fall risks are significant. Almost a quarter of people aged between 65 and 75 years old had fallen in the last twelve months prior to the study. These falls represent almost 80 % of everyday life accidents. They are involved in over 60 % of domestic accidents and are responsible for approximately 9300 deaths each year among persons aged 65 years and above. However, these data are generally underestimated as the elderly often forget that their falls [13]. Moreover, age, gender and health status can affect the type and severity of the fall [4]. Falling leads to limited

[1] ANR : (French) National Research Agency
CNSA : (French) National Solidarity Fund for Autonomy.

[2] National Institut of prevention and health education.

outings and increased isolation, and drives elderly people into a state of relative dependence. They are drawn into a dangerous spiral that makes it difficult for them to remain at home and increases the deleterious effects of aging [14].

However, these impairments are neither ineluctable nor irreversible if the elderly are in an environment that is safe and suitable for them and their relatives. This implies that a different perspective must be contemplated in the process of senescence among the elderly. The onset of disability does not reside in the individual alone. It also depends on the interaction between individuals and their environment and specifically, on the incompatibility between the living conditions of the environment and the needs of the vulnerable people. If the environment is not modified to adapt individuals with a "impairment", then they will be faced with an impediment. Such a situation would be non-existent if the environment was adapted to them [15, 16].

Two models can be distinguished in this perspective [17]. The first is the "integrative" model in which reducing disability involves working on the individual through rehabilitation or equipment. The second is a "participative" model where the environment compensates for an individual's shortcomings and therefore transforms the situation into a source of development and autonomy. Naturally, the CIRDO project falls within the second approach as it seeks to adapt the life environment to the risk situation of the dependent elderly. This pervasive technology seeks to transform a situation with obstacles into a suitable situation. We will now turn to this by analyzing the contributions of technology.

New ways in which aging can be supported and falls prevented are necessary to enable the elderly to maintain their autonomy and delay institutionalization. Possibilities opened up by gerontechnology suggest that innovative solutions to assist elderly persons exist. Besides maintenance, hospitalization at home and autonomy development, gerontechnology also aims at rehabilitating, attenuating some deficiencies [5, 6] and improving the quality of life of the elderly [7–9].

Pervasive assistive technologies are less intrusive than conventional systems of remote assistance or surveillance as they tend to blend into the living environment [1]. They are thus able to anticipate the users' needs using data from the environment and propose an appropriate solution [11]. Moreover, these technologies are less stigmatizing because they do not have to be worn, unlike remote surveillance bracelets known as "markers of old age" [12] which equate subjects to their shortcomings and to some form of weakness.

In the second part of this research, we assume from the theory of the Engeström system of activities [18], that the integration of CIRDO in elderly people system of life would not be trivial and would lead to a major reconfiguration of the system of activity (SoA) in presence, each registering as develops Engeström: (i) a community (composed of the elderly and their peer but also family carers, professional speakers), each (ii) rules universe (what to do or not do at home, tasks to do or delegate, safety instructions to follow …) and may be related to (iii) some division of work (who does what,, who intervenes when and with whom to help the elderly, to assist the cure).

Engeström has also identified three tension levels within these SoA and on which we can rely to better identify potential reconfigurations caused by the implementation of CIRDO : (i) tensions within each element of SoA; (ii) tensions between some

elements of the SoA. (iii) tensions between different interacting SA (the EP, the family caregiver who crosses the professional caregivers system at home ….) (Fig. 1).

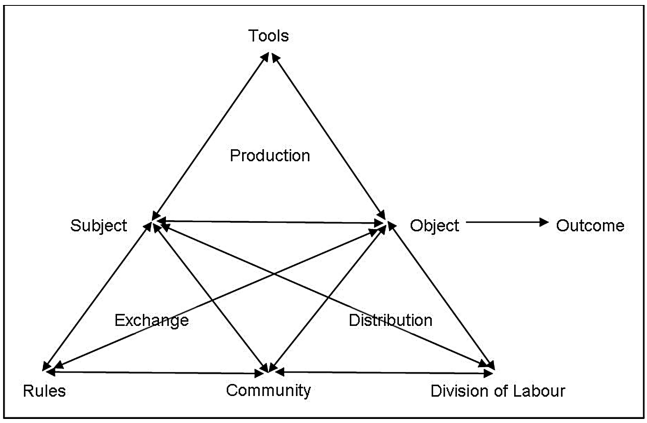

Fig. 1. Model of the activity systems (According to Engeström, 1987)

If these three tension levels have effects on the activities and the final acceptance of CIRDO, they nevertheless constitute the real source of the development of the SoA, based on its dynamic innovation and evolution.

Referring to the SoA for our prospective analyzes seems essential and allows us to direct the research problem on two levels of analysis:

- Firstly, in the domestic environment: we assume that the analysis of the activities of daily living (ADLs) -in elderly people and the associated risks (inventory situations falls) provides information essential for the design of the device, its methods of introduction in the domestic sphere and the adjustments to be made.
- Secondly, in terms of socio-domestic environment of the elderly: we seek to evaluate how the activity, as well as the forms and quality commitment of family carers and professionals can be disrupted by the introduction of the device. Indeed, on the basis of the AS model, it is expected that this may not necessarily be the same purposes of the system or the same practices that are perceived /expected by each player at home.

Ultimately, the tensions, the risk of non-convergence between activity systems should therefore be designed, worked so CIRDO can really fit in and be accepted by the various stakeholders.

To carry out this study, we developed a method, through a methodological triangulation approach: the first study aims to understand and model the processes of domestic falls, from a description of EP's daily activities. Finally, a second study explores the conditions of the system acceptance by the elderly, the family and the caregivers.

2 The Methodology Implemented

2.1 Approach to Understand Falls and Risk Factors for the Elderly, at Home

We have first interviewed 65 elderly people (average of 85 years old, 90 % women) to know their backgrounds and living conditions, in terms of autonomy, needs, isolation and social links with the environment. We also asked them to accurately describe a typical day. The critical incident method [19] was also used to identify the specific circumstances of incidents (causes, modalities) and their consequences.

Then, we focused on actual observations of risk situations. From these 65 elderly, we have selected six seniors with most representative falls descriptions. These people were able to physically and mentally replay their falls, filmed by "tripod" and "embedded" (subcam) cameras. After re-reading him or her the circumstances of the fall, we asked the person to re-act the scene and verbalize simultaneously what they did, said and felt when they fell. We also intervened (via interruptive verbalization) to ask them to specify actions, words or circumstances of the fall (What did you say at the time? What did you do once on the ground).

Finally, we asked them to comment the different scenes previously filmed, by consecutive verbalization.

2.2 Approach to Explore the Device Social Acceptance

In order to identify how each home-care stakeholder perceived CIRDO's contributions and potential risks from the perspective of its own activity system, we developed a methodology that enable us to have the richest and most varied data possible about these experiences.

We added to the first observations and interviews (with the elderly people), semi-structured interviews and focus groups that were conducted with home-care stakeholders (19 professional caregivers, nurses and 19 family members, from 19 years to 62 years, 80 % of women) to better understand their activity (*what they had to do, what they did, what they could not do /no longer do*), the difficulties to perform their activity, as well as the way they understood how their own activity is connected with the other stakeholders'. Finally, after presenting them the aims of CIRDO, we sought, through focus groups, to see how the device could become a resource or a constraint to their activities, including the issues that had been raised before. All these interviews lasted one hour on average and were conducted, whenever possible, either in the elderly people's homes (in a discrete secluded room), or in caregivers' professional organization. They were recorded and fully transcripted to facilitate subsequent analysis.

Based on these interviews, activity assays were performed on the more specific craft of professional home-caregivers. We have conducted an initial series of three field analyzes to better understand this activity and grasp the nature and diversity of tasks performed (operational /relational tasks, contacts with family, with others stakeholders…).

We also "monitored" the activity of two EP equipped with telecare devices (medallion and bracelet). They had to complete a self-reported grid of activities – for 7 days, from sunrise to sunset indicating nature, duration, difficulty, location and time of their domestic, relational and recreational activities. They also indicated the conditions of use of the remote alarm device. Ultimately, we asked them to comment each of these episodes. Finally, we resorted to another technique, the Wizard of Oz method, in order to evaluate the conditions of use of a CIRDO demonstrator. We presented it to 6 elderly persons in their homes. These were asked to simulate an incident (i.e. stuck on the couch with a blocked hip) and interact with a demonstrator that detected a hazardous situation (e.g. *"I detect an abnormal situation. Do you need help?"*). We developped this prototype in the form of a webcam and a microphone connected to a computer. Prerecorded alert sentences were triggered by the researcher, based on the EP's behaviors and calls. This approach has enabled us to evaluate users' reactions in almost real situations

3 Results

3.1 Understand and Specify the Process of Falls

This study aimed at understanding the falling process (by analyzing daily activities within elderly people's homes), in order to:

- identify the different nature of Activity of Daily Living,
- define the different falling profiles
- identify the factors involved
- develop falling scenarios to set parameters and test CIRDO (for further analyses in the second study)

All these objectives aim to gather data for adjusting all the parameters of the device, both videos and audios.

In fact, we were able, using behavioral (key postures) and verbal (key words) descriptors to define much more parameters of automatic detection of falls by the CIRDO system.

The factors involved in understanding ADL and the risks faced by the elderly.

The first part of the study consisted in identifying the different activities of daily living to determine how these situations could turn into a fall. We analyzed the factors that could transform an activity that a priori was normal, into an abnormal and dangerous situation. The analysis enabled us to identify 8 major ADL groups that individuals perform over the course of their day: household activities, food, recreation, rest, mobility, care and hygiene, communication and health. Carrying out these domestic activities requires the mobilization of two types of resources: intrinsic (dispositional) and extrinsic (situational). While intrinsic resources involve the specific characteristics of the elderly, extrinsic resources refer to what the environment provides to enable an individual to achieve a given objective. The interaction between these two conditions defines the context in which the action takes place.

ADL can become "risky" if at least one of these two conditions is absent. This is notably the case when internal functions (motor, perceptual…) of the elderly fail due to a natural (generalized fatigue, hip problems) and/or provoked (taking sleeping pills) weakness. This is what happened, for instance, to one person we studied, a 83 years old woman who fell in her kitchen. Conscious but unable to alert her relatives or trigger the remote alarm device that was in her bedroom, she remained immobilized for close to 36 h. It is her cleaning lady who finally found her. "*At home, I had taken my sleeping pills and I was taking my juice bottle to the fridge. I was wearing my nightgown then as I approached the kitchen door, I felt myself slip; I said 'oh, you're falling'. I felt my head explode as it touched the ground. I didn't quite feel my leg at the time. I felt, but later when I wanted to move it, I suffered too much. I couldn't turn, I couldn't go anywhere, the phone was close by, it was in the entrance hall and so was I…".*

The physical resources of the situation can also be limited (insufficient lighting) or inappropriate (dented carpets, high stairs) and can thus be dangerous. These resources thus become obstacles to the normal carrying out of activities and create a second example of risk situations as the case of our 89-year-old woman who fell in her kitchen shows. After her slipper caught on a screw protruding from the parquet floor, she remained on the floor for a long time, stunned, before managing to get up after several attempts: "*I caught on something. There was something protruding, a screw. Incidentally, it's still slightly protruding because it was fixed askew. So I was eating there, I had my tray and as I was passing, I had soles with laces, so the tip of the sole caught, and I found myself lying down, I glided against the doorpost*".

Moreover, the social circumstances that include individuals' trajectories and the experiences of the elderly persons and their entourage can also have an impact on falling. They can condition risk taking or on the contrary, restrict it. Consequently, if a fall is experienced or shared with a third party, some elderly persons can implement strategies to avoid or prevent falling. This was the case of an 88 years old woman who got rid of all visible cables in her home following a friend's accident.

Accidents can also occur due to non-compliance with the allocation of chores at home. The elderly person takes the task of the absent professional helper, exposing him or herself to risk. This was the case with a 78-year-old woman who decided to move the plants in her living room because her helper was late; she got knocked out against the edge of her fireplace.

Finally, elements in one's personal and social history can also increase the risk of accidents as the following example shows. An 80-year-old woman who wanted to clear the table got her foot caught in the stairs leading to her bay window and fell, cracking a rib. As she mentioned in the description of her story, she could have let go of the plates she was carrying in order to recover her balance. However, she preferred to protect the plates as "*they were part of the family history, passed down from generation to generation*". This fall thus stemmed from situational circumstances (stairs too high, pile of plates reducing mobility), dispositional conditions (reduced motor skills, lack of attention linked to fatigue) and social circumstances (do everything to preserve family assets). Here, social data took precedence over the woman's own safety and protection.

The comparative analysis of 28 falling situations (selected based on spatial and social criteria: see method) revealed three broad categories of falls: Falling (flopping onto the ground from a static posture, whether standing or lying on a couch), slipping

(loss of balance as one is moving) and stumbling (loss of verticality induced by stumbling on an obstacle – a cane, carpet or stairs).

Falls primarily occurred in the living room (13 falls), as this is where various activities were centralized (meals, rest, recreation, relaxation, telephone). Frequent actions and displacements also took place in this room. Other falls (7) occurred in transitional spaces (corridors, stairs or the door between the living room and kitchen or balcony) that had to be crossed and required mobility. This confirms the fact to evaluate CIRDO only in living rooms. The "falling" situations account for more than half of risky situations (57 %). Slipping (17) and stumbling (19) are quit equal. These results provide some interesting insight into the kind of falls that we have to analyze and formalize to allow CIRDO to detect them.

Situational conditions were the most common factors responsible for falls (19 implications). Only 8 cases were related to personal weaknesses. These results suggest that accidents are more the result of the inadequacy of the environment than individual weaknesses. Respondents spoke of their behavior and their level of consciousness after the accident. In 13 of the cases reported, the elderly people were quite conscious and active. They crawled, attempted to get up, cling onto furniture or call for help. In such a context, CIRDO would be able to identify this behavior and engage in dialogue with the person in need (via a microphone). In 5 cases, the elderly persons were rather inert and unconscious. This would entail visual detection and a CIRDO diagnosis with an automated alert. Finally, in 11 situations, the people were able to immediately get up without any specific repercussions or traumatism. In this case, CIRDO would be able to detect that the fall had no harmful effects on the person and/or make the person orally validate that he or she is ok.

Based on the falling simulations by the 6 subjects, we were able to develop 12 scenarios of falls according to the Personas method. On one hand, we described the conditions of the fall, (the person's characteristics, the activity performed, the location, the circumstances of the fall…) on the other hand, the modalities of the fall. We paid particular attention to the different limbs mobilized in the fall (upper/lower limbs), the direction and the magnitude of each movement (arm lifted upwards/downwards, body to the right/left…), the speed (speed and direction of the body), the elderly person's reaction while on the ground (trying to get up, crawling…) and the approximate time of (in)action (duration immobilized on the ground). Phrases of alarm were also identified at different moments of the fall "*Damn, what's happening to me, Oh no*…). For example, this is the scenario of falls using the Personas method (brief):

> *"She gets up in the middle of the night to drink a glass of water in the kitchen. She is walking in the dark when suddenly her foot slips on the floor. She loses her balance and her whole body swings backward. She exclaims "ouaahhhhhh!!!" Her body bends to the right side. First her right knee hits the ground forcefully, then her whole body. She finds herself on her back, arms extended behind her head."*

These scenarios were used for two types of application. Using falling scripts, the first scenario sought to provide specific details on the different actions and postures that lead to falls. We defined this as "key postures". We also identified the "key words" spoken. The designers used these indicators to calibrate CIRDO's video and audio

sensors. All these descriptors are clues which enable the camera and microphone to identify and distinguish fall situations from normal behavior.

The second application was used to replay the scenarios with 22 voluntary actors including the elderly and younger voluntary adults equipped with an old age simulator. This device hampers mobility and reduces vision and hearing when worn.

The simulations were conducted on an experimental platform similar to a living-lab (the Domus platform at the *Université de Grenoble*). Equipped with audio and video sensors and a two-way mirror, this room was configured to resemble an independent living community. We were thus able to reconstruct the scenes of incidents by adapting the living environment to the different scenarios that we sought to simulate (dented carpet, falling from a sofa…). The purpose of these experiments was also to test the first version of the CIRDO demonstrator in order to improve the parameters of detection and validate the detection algorithms.

3.2 Acceptance of the Device by the Elderly and Their Social Environment

The reading grid offered by Engeström's system of activity has shown an ambivalent positioning by these different actors: based on their experiences, their career and needs, each of them (elderly, professional counselors, family) has a different view of the object of their activity (support, help, care, prevention, control), and therefore has specific expectations and fears (Fig. 2).

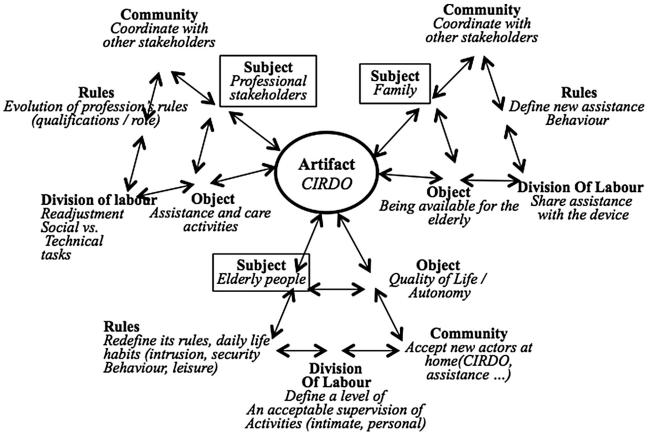

Fig. 2. Model of the activity systems integrating these different actors (According to the Engeström's Model, 1987).

The Seniors: Self-activity statements made on the use of remote alarm systems by EP indicate contrasted positions for the seniors.

First, the remote alarm system can be used according to a subjective estimation of risk: in that, it becomes dangerous because the elderly could put themself in danger

more often for there is a device ready to ask for help. In this context, CIRDO would provide a continuous and discrete supervision, able to overcome the erroneous judgments associated with risk taking.

On the contrary, the elderly could feel less freedom at home, and would do nothing in order not to trigger the alarm. This assessment itself is not risk-free, as falling is unpredictable. Even though the senior does everything to not fall, once more, the device doesn't prevent from falling.

In a second case, the elderly is extremely dependent on the medallion and cannot do anything without wearing the system. Here, the discretion and non-intrusiveness of an ambient environment like CIRDO may paradoxically cause rejection, because people would feel insufficiently protected. How can the senior know that the device is still on and be sure that his family will be aware of what would happen?

Simulated uses of CIRDO with the Wizard of Oz method also indicate seniors' fear to make their homes more accessible and losing control in case of accident; particularly: who to warn after a fall? Who should be involved and how? Indeed, these Seniors are alone and not only dread an internal domestic risk (falls and accidents), but also fear outside intrusion (thieves, salesmen) *"Firefighters, well, er, they will break down the door, won't they? What will they do? I don't want to have my door broken!"* or *"If they (firefighters) break down the door and they take me away, I cannot just leave my house opened to intruders "*The new device may forces the elderly person to redefine compromises about security, domestic and protection priorities.

But, on the other hand, from experiences with their devices and experiences, such as medallion, seniors have described new potential uses of the devices. For example, the devices can be a new way to prevent themselves from intruders or discourage the latter to "harm" them. Indeed, when the elderly activate the medallion, an agent calls the elderly: it's audible and loud. When a senior feels uncomfortable with a situation, this call can reassure by indicating to the assumed intruder that the senior is not alone.

Because it also has the ability to reveal what the elderly would rather keep secret, the system can weaken the elderly person's social position with her relatives. It may provide them facts that betray her vulnerability and potential inability to live alone. *"I fell in the street and told no-one, apart my friend. But otherwise, I did not say anything to my family."* (86years old woman). CIRDO must therefore address the challenge of securing seniors' physical, but also psychological and social protections.

Professional Caregivers: Activity analyses reveal that caregivers' work is to perform technical tasks (cleaning, cooking, healthcare…) but is also based on great emotional and relational work to meet the seniors' psychosocial needs (support, listening, attention, assistance…). Caregivers question the possible intensification and re-engineering risks of their activity, with the new system. They imagine their work being supervised by it, forcing them to make a choice between technical tasks (the prescribed tasks of the job, the Cure), and the empathic accompaniment of people (the actual service activity, the Care). They also fear a reduced scope of action (a system substitution for regular visits or diagnoses).

Coordination appears to be essential to face the multiplicity of professionals and the scattering of their interventions over time. In this context, CIRDO could have an important role to play in providing a digital liaison diary role by facilitating and

enhancing cooperation, ensuring the best possible articulation and continuity of the care process.

Our interviews and focus group also show that CIRDO creates an ambivalent feeling among caregivers: stakeholders assume CIRDO will allow better recognition of their activity by making its reality, complexity and difficulty more visible to the eyes of the family or their own managers. It could also protect them from their "client's" abusive behavior as much as by their own corporation.

In contrast, the CIRDO project could help raise the status of the home help profession. These stakeholders may well contribute to setting the system more finely during its implementation, thanks to their intimate knowledge of EP's habits, risks and practices (e.g. which types of video and /or audio-sensors to install, in which room and at which angle). Likewise, they could be more involved in the definition of the digital liaison notebook: its nature, function and recipient(s). In addition to using their expertise, these professionals can also develop upstream an essential mediating function to get EP and families to accept the device.

Thus, these inputs would contribute significantly to repositioning this exchange, through enriching and expanding their activities (system setup, support to change, usage tips, besides mere operational tasks). But that would require a parallel rise in qualifications and training.

Analysis of the Conditions of the Acceptance of CIRDO by the Family. Notwithstanding its so-called "natural" feature, aid is time-consuming for many, or even, for some, a serious burden because some of the providers could themselves be resorting to such support (some "children" are 65 years old, indeed).

Families deem CIRDO as a potential "competitor": automatic alarm triggering deprives caregivers of their ability to assess the severity of the incident and the adequate alert level that should ensue. They also feel guilty of not being constantly present to assist, support or reassure their loved ones. These concerns can also be interpreted as the fear of being replaced by these devices, even though the caregiver system would not be changed and /or altered by the introduction of CIRDO.

CIRDO would be useful to caregivers by constantly watching over EP and release caregivers of their perpetual burden. Seen as prosthesis, it would reassure everyone, family and relatives. In this sense, CIRDO might well meet one of family caregivers' needs: to be protected from their own failure to be present and intervene.

4 Conclusion

The purpose of the article was double. We have shown how psychology can help and lead the design of a new pervasive technology, by scrutinizing the causes and consequences of falls and by exploring the social acceptance of the elderly system of life.

The approach we used presented first, daily life activities and falls at home, and secondly how each home stakeholder considers the impact of this new device on their respective trade systems and between them.

We have shown that, depending on their experience, backgrounds and needs, each stakeholder in the home (EP, professional help and family) has a different vision of the

purpose of their activities (support, help, care, prevention, control…) and therefore has specific expectations and fears vis-à-vis the system. The function and purpose of the latter are (implicitly) heterogeneous since various stakeholders interpret them differently. Their perceptions may be partial, conflicting, or partially contradictory [20]. The whole difficulty in CIRDO design and implementation is a matter of adjusting to a socio-domestic system that is different every time, given (i) the diversity of EP's at risk activities [21], and (ii) the differing interests of the various stakeholders. The latter also turn out to be powerful mediators in the eventual use and adoption of the system.

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