Online social networks as a tool to support people with special needs

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ABSTRACT

Supporting people with special needs is a multi-disciplinary endeavour that involves many stakeholders. Social relations have a determining impact on the quality of the related processes. Online social networks (OSN) have demonstrated their capacity to change human interaction paradigms; however, their application to disability is a barely-explored field of research. This paper describes the design, development and deployment of an OSN in a 24/7 residence for people with disabilities in order to improve productivity, enhance the quality of care processes and foster social relations. During fourteen months of operation, 46 people, including caregivers, health professionals (psychologists, occupational therapists, and physiotherapists, among others), supervisors, administrative staff, residents and their family members, used the OSN. Our quantitative and qualitative results indicate adequate OSN technical performance; validate user-oriented design methodology; confirm productivity and quality of service improvement; and confirm the capacity of OSNs to positively influence social relations in such environments.

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1. Introduction

Online social networks (OSNs) have a great impact on human relationships and can even generate new interaction paradigms [1,2]. People with special needs and their environment are also influenced by OSNs, although less intensively, and perhaps this is why there has been little attention from researchers as yet into this phenomenon [3].

In healthcare scenarios, which are closely related to the field of disability, health social networks [4] are identified as a useful tool for patient tracking, assessment and rehabilitation, providing a point of contact between patients and health professionals [5], among healthcare practitioners [6], as a data collection tool for researchers [7], or as a social health-data space [8]. Indeed, there are many thematic OSNs available for specific diseases such as Acor.org (cancer patients); Stupidcancer.org (young adults affected by cancer); RareShare.org (rare disorders); and many more. There are also other OSNs that do not focus on specific diseases but on general health-related issues: Medhelp.org (which connects people with leading medical experts and other people who have similar experiences); "Curetogether.com" (this brings people together to monitor and compare their health data); and "Patientslikeme.com" (where members can share treatments and symptoms to follow and learn about a range of medical results). Many works have analysed these OSNs [9–12]: from these

studies we can conclude that the benefits identified can be summarised in two main areas: the increased interactions with others that could provide emotional support; and more available, shared, and tailored information.

Offline social networks are very important for health and subjective well-being across different domains of life [13] as a part of this, participation in OSNs also has the same effect [14]. Asselt-Goverts et al. conclude that people with mild intellectual disabilities prefer strengthening existing ties towards family and professionals as opposed to expanding their network [15]. OSNs can help in both scenarios, and are a valuable resource to avoid social isolation [16], to socialize in order to influence decision-makers, to organize collective action and to raise awareness and collect funds [17].

Shpigelman and Gill thoroughly analyse the literature related to OSNs and disability, identifying as the main challenges **the skill deficiency derived from text-based communication**, that affects both accessibility for people with visual disabilities and intelligibility for people with communication disorders (e.g. autism); **the loss of privacy**, derived from abstract and hypothesis-based privacy rules that may be difficult to understand and **the limited access and use of the Internet** [3]. Moreover, regardless of OSN's potential benefits and due to its challenges, Tonkin and Tonkin (2013) indicate that different **professionals related to disability** (carers, occupational therapists, nurses, healthcare assistants, etc.) are **not too much in favour** of recommending the most popular OSNs to their patients: on a Likert scale of 0 (never recommend) to 4 (often recommend), Facebook scores 2.2, Twitter scores 1.9, Google+ scores 1.7 and Myspace 1.1 [18].

Nunes and Miranda develop an OSN for a learning environment of students with disabilities [19]. It is an innovative work that focuses

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on the creation of a shared informal learning context for teachers and parents, to share experiences and resources using blogs, multimedia, messages and forums. An important conclusion is that while teachers did participate, parents did not really engage in the OSN. The authors point as a possible reason, that parents' primary needs were not met as they needed more support rather than learning.

"People with special needs" is a label that can fit many users [20]. It is usually applied to the elderly and to those with cognitive, sensory or physical disabilities, but somehow, the environment of this target population also has special needs, including next of kin and significant others who are especially affected as their life becomes bonded to their loved one's situation [21].

As well as the needs of communication, we can say that the needs of this population are the same as everybody's: those basic requirements (hygiene, alimentation, leisure, self-realization, etc.) are detailed in various classifications of daily living activities [22]. Additionally, they have other requirements derived from their health condition: periodical rehabilitation and therapy, medicine intake, close medical follow up, etc. Of course, these needs must be addressed in all the environments where the users may be: at home or residence regardless of the personal assistance they may have, at the day centre, at work, etc. Often, assistance from third persons with different professional profiles is required, and such teamwork needs to be coordinated and user-centred.

As a conclusion, there are usually a large number of people in different scenarios who have the same objective: to meet the needs of the person. Unfortunately, the management and organization of the related processes are not always structured or formalized and there is usually a lack of specific tools. If we focus on day centres (which provide therapy, rehabilitation and also serve as a social hub) or on residences (providing 24/7 attention), this issue can lead to inefficiencies and sometimes deficient performance of the duties that, similarly to ERPs (enterprise resource planning software) in companies, can be notably mitigated using ICT [23]. Although attention to disability is an eminently human-centred process and one that must remain so, some common issues may be identified:

- **Inefficiency in communication.** Attention to diversity is by definition a multi-disciplinary process requiring different professionals (psychologists, occupational therapists, social workers, speech therapists, physiotherapists, among others) to work together with each person. Formal and informal meetings, e-mails, and more recently SMS messaging (e.g. "WhatsApp") are the instruments commonly used. In an internal audit we conducted within the framework of this research, the association members polled estimated that between 10% and 20% of their time is devoted to these tasks.
- **Format of shared information.** As is the case with hospitals, a great deal of paperwork is needed to track records, therapies, evolution, reports, etc. However, unlike currently in hospitals, this is mostly done using paper.
- **Limited office time available.** Attention to people leaves little time to complete reports, attend meetings, respond to communications or read other professionals reports [24].
- **Exclusion of user/relatives in the process.** Disability varies greatly, making each person unique. Relatives are usually the most experienced in caring for their family member but, once the person enters a residence or day centre, they barely contribute to the care-giving process from that point on.
- **Changes in professionals.** There is a considerable turnover of the persons involved in support tasks. This requires specific training with high associated costs in terms of human resources.
- **Little penetration of ICT communication in daily living.** Undoubtedly, mobile devices are enabling successful e-inclusion of the elderly and people with disabilities, bringing together remarkable emotional benefits. Regrettably, as the first priority in

residences is to ensure that the residents are properly attended to in terms of their basic needs, the emotional aspects derived from communication through new ICT media (pictures, videos and quick messaging) are often neglected.

In this paper, we present a successful design, development and evaluation of an OSN as a tool for assisting people with special needs. To the authors' best knowledge, this is an **unexplored area of OSN application** which could have a major impact on society. The following section presents the design phase, describes the conceptual approach and the basis upon which the development was implemented. Section 3 presents the implementation phase detailing the OSN backbone platform and the application architecture. Section 4 presents and discusses the results achieved with the actual deployment of the OSN in a residence and its operation over a one-year period. Finally, conclusions and future work are discussed.

2. OSN design

Any "design for all" project is a challenging process [25], due to many factors, such as the distinctive features of the user, the need for a mixed yet cohesive multidisciplinary team, or the wide variety of stakeholders involved, with a range of objectives throughout the process.

Besides the obvious reasons, designing an OSN for people with special needs is a challenge, due to the wide disparity of the user profiles and their expectations (since usually people with and without disabilities will share the OSN). That results in different intertwined user levels, according to their **capacities** (people with and without disabilities); their **technological skill** (from expert users to the technologically illiterate); and their **roles** within the community (patients, therapists, relatives, caregivers, etc.). In addition, there are also noticeable **variations within each role** (different types and degrees of disabilities, different specialties of therapists, or different levels of responsibility of the job, among others). Hence design and development processes need to be user-centred, focused on both the common and the differentiating factors in each subgroup, while striving to respond to each user at all **points of heterogeneity at each level**. Moreover, the **novelty of the technology** and the lack of methodological references in this area require a design process flexible enough to be adapted to any emerging issues that may arise. Therefore, the challenge is to use appropriate methodologies to address the user needs in the framework provided by OSN technology.

The project methodology we followed has been designed, validated, and improved in the course of several OSN projects for people with special needs. In the first attempts, the methodology depended mostly on user profiles, with an extensive initial design phase, followed by successive cycles of development, evaluation and redesign. This process achieved very good results in terms of accessibility, usability and user experience, but required too much time and human resources to later implement the design in an OSN engine. This experience allowed us to develop a specific design methodology, **"Community"**, that seeks a better balance between OSN technological foundations and user-centred design. This methodology focuses on how users interact in their offline social groups and on how these processes would be virtualized, according to the relationships defined by OSN groups. In this way we achieved consistently good results in meeting the functional requirements, while notably reducing the implementation and optimization effort.

2.1. Users and groups modelling

Providing the right answer to all of the users involved was a major concern, since as stated before, some cases of OSN with different profiles failed to engage with any of the user profiles [19]. Furthermore, regarding attention to disability, the user focus is usually the

person with special needs, while the proxies being relegated to the background. As our aim was precisely to ensure the quality of this care, we elevated proxies to primary users.

The first step was the **profiling of the users involved,** defining groups (e.g. residents, families, carers and professionals) and sub-groups that met these conditions: the individuals' different capabilities, their role within the community and their ICT skills. For example, in the professional group, the subcategories were based on their disciplines, combined with their position in the workplace hierarchy (manager, administrator, coordinators, supervisors or direct care staff), and with their information access permissions.

We then **identified the needs, preferences and concerns of each group**, using both qualitative and quantitative methodologies to gather this information, in a funnelling strategy that included literature reviews, tests and semi-structured questionnaires, focus groups [26], and "extreme" single-case analysis through interviews and ethnographic techniques such as video self-recording [27]. Main issues identified have been already detailed in previous section.

From the conclusions of the needs assessment phase, we devised workshops with designers and developers, based on the **Personas-Scenarios method** [28,29], in order to facilitate focusing on and visualizing the diverse types of user (archetypes), understanding and empathizing with them, and reaching an inter-disciplinary agreement about the outcomes.

Finally, we created and developed **"Community"** as the main tool of relational groups' methodology. We use it to (i) **define relational needs and requirements** arising from the idiosyncratic group interplays of an OSN and (ii) **construct required network spaces where the interactions among user profiles take place**.

Software design is usually formulated from a linear perspective, mainly considering intrinsic profile issues. Nevertheless, when dealing with social networks, as they evolve in uncontrollable and sometimes unpredictable ways, it is necessary to consider how different users' profiles will influence one another, generating unexpected needs and restrictions. Therefore, the "relational need" concept defines the need of a particular user profile with regard to the other user profiles of the virtual community, bringing to light actors' interdependences which had not yet emerged or had not been sufficiently considered. This will have direct repercussions on process of defining the platform requirements as well as on the specifications hierarchy. The procedure consists of the following steps:

(1) To graphically delineate the **interaction flows between the archetypes** generated in the Personas-Scenarios method, defining which profiles should be connected and which should not (see Fig. 1). In line with Service Design theory, it is useful to establish two **conceptual interaction areas**: the "backstage" and the "onstage" areas [30]. The backstage is the sphere "invisible" to the final user, where processes that build services take place. Here communication revolves around the internal management of human resources and the official communication about the patient. The onstage is the visible part that includes the service recipients, residents and family in this case.

(2) To formulate the relational needs of each archetype, following the next scheme: **"As [*user profile*], I need [*other user profile/other users from my own profile*] (not) to [*action*]"**. In our case, we define sentences like "As [*coordinator*], I need [*the relative*] to [*receive the information as soon as possible*]" or "As [*director*], I need [*the supervisor*] to [*be the only person who sends the notifications to the relative (to avoid misunderstandings)*]".

(3) The first two steps can also be done in reverse order or iteratively. For example, we noticed in the second step that patient reports should reach the family only through the coordinator; thus, we cancelled the online links between other professionals and family (see Fig. 1).

(4) To build the **"Network Spaces"**, defined as virtual workspaces with different objectives and subjects, where the interactions take place, and which comprise one or various user profiles or archetypes. Interaction can be internal or external to conceptual interaction areas, determining the "touchpoints" between the OSN and the users. Fig. 1 illustrates the correspondence between interaction flows, network spaces and conceptual interaction areas; Table 1 details these network spaces objectives and the users involved. Both will serve as the main guide for later technological OSN architecture, defining modules, profiles, access rights, etc.

2.2. Prototyping

From the relational needs, interaction mechanisms and network spaces, we developed a feature tree for each user profile, which informed the OSN architecture. With this, we developed several prototypes at increasing levels of detail, in an evolutionary process of design-evaluation that allowed us to assess specific aspects as the final solution was being modelled. We executed them using rapid prototyping programs, combined with graphic design and Flash software. In early low-fidelity prototypes we found a quick way to explore navigation functions and to analyse organizational issues and data hierarchy, so we sketched the contents of each screen paying no regard to the final layout definition. As prototypes were functional, evaluation was done by experts through cognitive walk-through technique [31], recording all the sessions with screencast software.

Evidently, the simplicity of prototypes was inversely proportional to the completion of the iterations. The process ended with the development of **high-fidelity prototypes** (see Fig. 2), and with the specification of a **Style Guide** (Fig. 3), containing a detailed definition and dimensions of the general layout and the distribution of the elements in all sections. At this point, the functional prototype was identical in appearance to the final implementation; so we were able to evaluate aspects such as usability, accessibility, and user experience with end-users. The methodology used for the functional assessment of the prototypes relied on the **Wizard of Oz technique**, which simulates the OSN functionality, generating the responses that the system would provide to the users' actions [32]. Final users, without previous knowledge of the prototype and without any external help, were asked to carry out some platform activities, while the process was observed by an examiner (checking the right and wrong actions performed, collecting their difficulties and other details such as user gestures and reactions) all of which were recorded by the screencast software.

3. OSN development

When we consider the development of an application based on social networks, the first idea that comes to mind is working with an existing social network such as Facebook. However, this presents some drawbacks such as not having full control over the application or possible functionality limitations. But the most important concern is privacy: Who will have access to the data? Is it acceptable to store users' information on external systems? Moreover, even if we were able to successfully address such security concerns, users are usually reluctant to provide sensitive data (medical, psychological, etc.) to such external mainstream platforms.

That led us to face the challenge of developing our own social network platform. On this premise, rather than coding the entire application from scratch, we decide to use an existing platform that provides the basis for ours. There are a number of solutions for developing social networks, such as Elgg [33], Diaspora [34], and OpenSocial [35], which are open-source and free to use, as well as commercial alternatives such as Ning [36] and Get Satisfaction [37]. Among
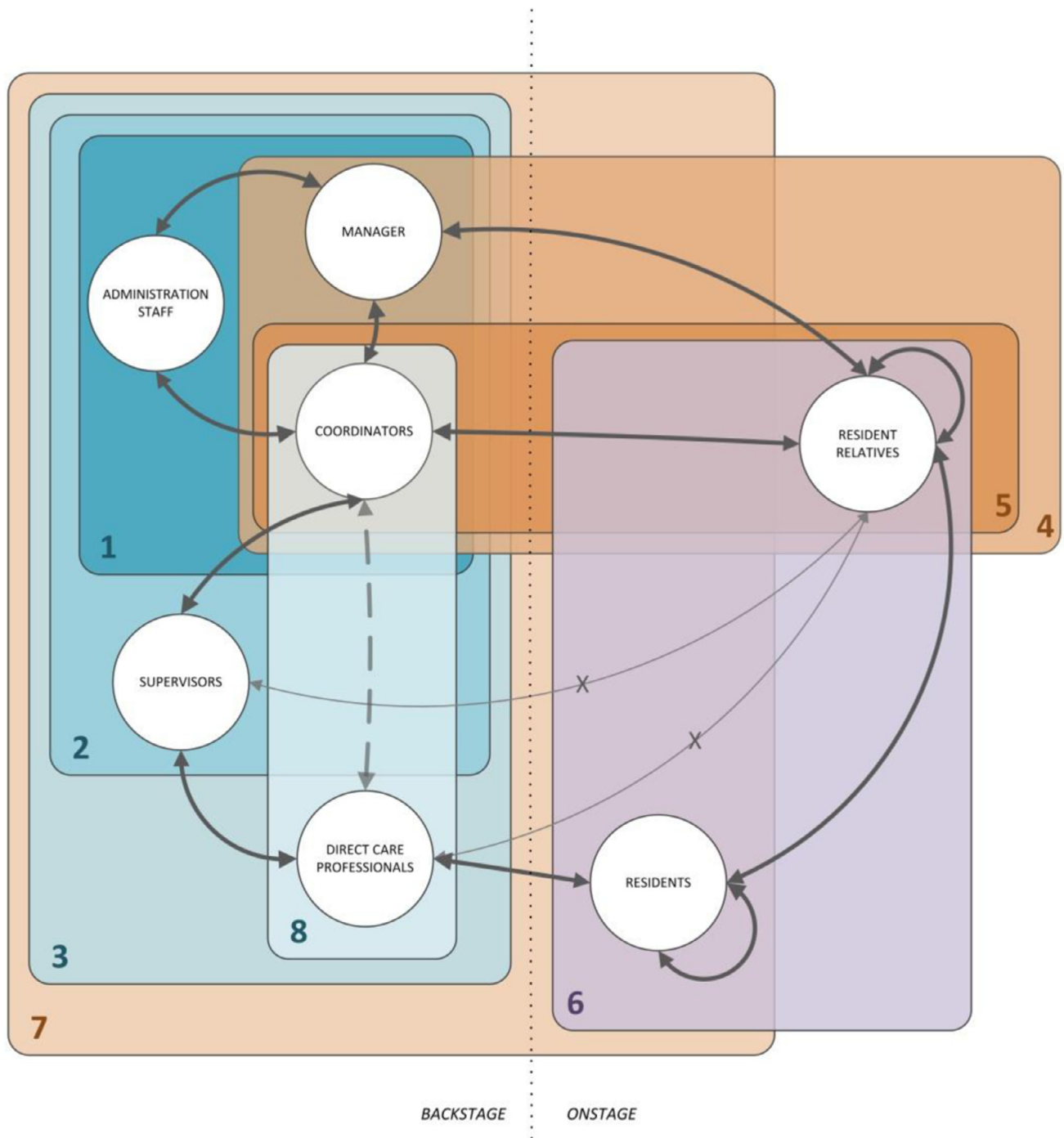
Fig. 1. Interaction flows, network spaces and conceptual interaction areas.

these alternatives, we chose Elgg because its plugin-based architecture allows us to easily include all the desired functionalities and there is a highly active developer community around this platform.

3.1. Platform architecture

As mentioned, Elgg architecture is based on the use of plugins, which provide the desired functionality (see Fig. 4).

The Elgg Engine implements the core functionalities, such as database access or content generation, while basic functionalities such as messaging, user management or popular components (blog, wall, etc.) are implemented by plugins that are bundled with the main Elgg distribution. Platform functionalities can be extended using plugins provided by the community, which are not included in the default distribution, but behave in a similar way than core plugins. Depending on the requirements of our application, it is also possible

Table 1
Network spaces definition and description.

#	NETWORK SPACE	ROLE	Direction	Coordinators	Administration staff	Supervisors	Direct care professionals	Resident relatives	Residents
					USERS				
1	Coordination	Discuss strategy and organizational issues	X	X	X				
2	Supervision	Coordination of residence procedures (workplans, holiday plans, organizational updates, etc.)	X	X	X	X			
3	Direct attention	Implementation of residence procedures (workplans, holiday plans, organizational updates, etc.)	X	X	X	X	X		
4	Relatives	Inform relatives about events, publish pictures from events, provide a discussion channel, provide notices, etc.	X	X	X			X	
5	Resident's relatives	Private group per each resident where coordinators inform relatives about health issues, weekly reports, etc. Also relatives inform about diet and medication changes and other relevant issues for resident's care		X				X	
6	Family	Private group were resident and his/her relatives share personal information and pictures. Similar to Whats'up groups this is mainly intended for keeping in touch regardless the distance.						X	X
7	Residence	Open group where all the residents discuss and share pictures. This is call the private facebook of the residence.	X	X	X	X	X		X
8	Departments	Some direct care professionals have specific specialties such as psychology, occupational therapy, physiotherapy, etc. This group is used to define and assign specific therapies to residents.		X			X		

Fig. 2. Example of a prototype evolution from low to high fidelity.

Fig. 3. Example of various sections of a style guide.
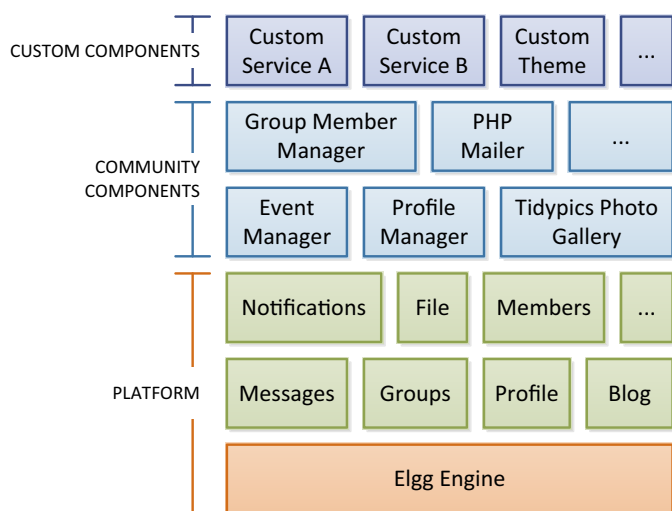
Fig. 4. Social network platform architecture.

to develop custom plugins to provide such functionalities, as well as personalizing the look and feel of the platform with a custom theme.

The platform follows a classic MVC (model-view-controller) pattern in which the engine (the controller) responds to page requests, and forwards them to the appropriate handler based on a context-subscription mechanism. The page handler then retrieves the required content and generates the appropriate view that is returned to the navigator.

Basically, Elgg data (Fig. 5) is modelled by the ElggEntity class, which contains common properties such as identification, type or name. Particularly, the derived ElggObject class serves as a basis for any other content, such as blog entries, files, discussion topics, etc. These objects are connected with Relationships, which, for example, are used to define which users belong to each group or whether two users are friends. Modelling the particular properties of each object (e.g. the content for a blog entry) is based on defining metadata and annotations that allows any object to be fitted on the model, and the information to be store without requiring having to modify the database.

Regarding views, their generation is based on a rich set of functions used to render most of the elements we can find in the page.

For example, in Fig. 6 we can see a typical Elgg page listing entities, where every element is generated by calling an Elgg function. These functions are tasked with rendering a specific view by producing an HTML output related to the parameters provided, and the appearance of these elements can be adjusted using CSS markup.

In the example, the entities we want to display are retrieved using a request to the database and stored as an array of entities. Then, for generating the content, we call the ElggListEntities function with the referred array, and this function internally calls ElggViewEntity with all the entities to generate a specific view for that entity, as well as handling list navigation by using another function. Actually, ElggViewEntity looks for a view (a PHP file) suitable for rendering the HTML output related to the entity, and executes it. Once the HTML output of the list is produced, it is passed to the ElggViewLayout function, which arranges the content in one column plus a sidebar (whose content can be set automatically according to the context). Finally, the entire page is generated by calling ElggViewPage, which in addition to the list and the sidebar, will include other elements such as a main menu, a navigation breadcrumb or general elements like the header, the footer or the site logo.

An interesting feature that Elgg provides, is the view overriding and extending mechanism. Basically, when we develop a custom plugin, Elgg allows us to replace existing views (for example, how a button is displayed), by creating a file with the right name and in the right place of our plugin, so that it overrides the default view provided by Elgg. We can also extend existing views to add specific content after (or before) the output generated by the original view. This eases development, as we can use existing components without worry about "breaking something". Also, as the platform permits enabling or disabling available plugins, we can modify the behaviour of our application without interfering with the base platform.

3.2. Implementation

For the social network implementation, we identified the following components among those available on the platform as required to provide the expected functionalities:

- **Blog component** allows users to submit blog entries on any theme.
- **File component** allows users to upload and download external files to and from the platform.
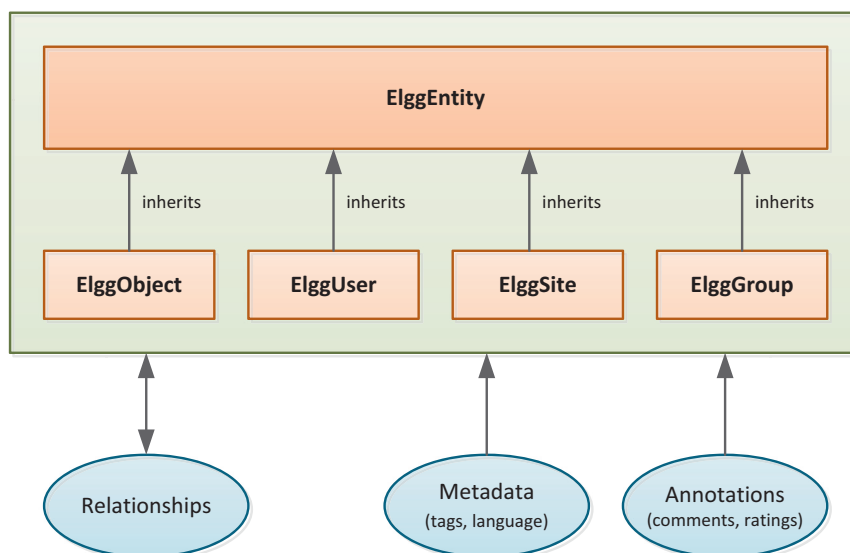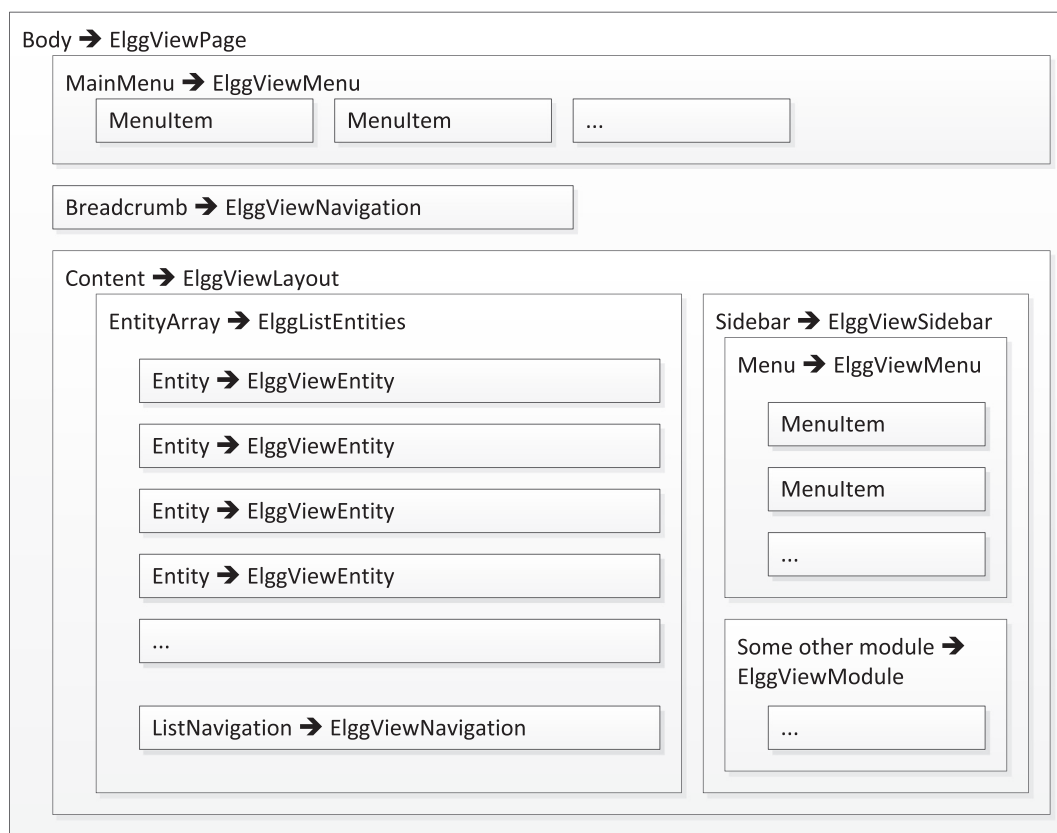

Fig. 5. Platform data model.

Fig. 6. Page composition on Elgg is accomplished by means of views.

- **Discussion component** allows users to initiate and respond to discussion topics on any theme, like a forum.
- **Events component** allows users to create events and invite other users to attend them.
- **Messages component** allows users to send and receive messages within the platform.
- **Notifications component** allows users to be notified when some event occurs (new blog entry, additional comment, a discussion response, etc.), via an internal message or an external e-mail.
- **Gallery component** allows users to upload photos and define albums.
- **Video component** allows users to view videos from external sources such as You Tube directly on the platform.
- **Therapies component** allows treatments to be defined and assigned to users. As there is no platform or community plugin implementing such functionality, we developed a custom plugin for this.

All these components allow the content owner (the user which creates the content) to establish an access level for contents that can be private access (only the owner user can access the content), or public access (which can also be restricted to only friends, any user, a user collection, etc.). In addition, some contents allow users to add comments to them or state if they like/unlike them.

In order to ensure data privacy, the platform was configured to allow contents to be viewed only by registered users and not allow them to self-register; the administrator must create all the users. The platform permits also the use of HTTPS authentication, which will provide a higher privacy level.

As stated before, we followed two approaches in the application development: a traditional implementation based on **user profiles**, and a social network-oriented implementation based on **network spaces**. In the first approach, we strove to provide the availability of differentiating users according to their profile type, and condition platform functionality on this characteristic. We also extended the users' relationship mechanism available on Elgg to include the user profile (a user can have a "therapist to patient" relationship with another user only if the first user profile is "therapist", and the second user profile is "patient"), and to define a permission framework that includes user profile and user relationships (a therapist can only assign a therapy to a patient if there is a "therapist to patient" relationship among them). With this approach, the platform decides which pages the users can access according to their profiles, and how they are presented to them (therapists have access to therapy definition and related patients, whereas patients only have access to therapies assigned to them).

User profile differentiation was accomplished by using a community plugin (Profile Manager) that extends the default user profile available on Elgg and introduces a profile type field. Then, we developed a custom plugin, implementing the new relationships and permissions mechanism, so that platform functionalities that behave differently depending on the user profile could use this module. That is the case of the therapies plugin, which delegates control of who can define, assign or execute therapies on the previous plugin. We also dealt with platform personalization with another custom plugin that provides contents, functionalities and appearance depending on the profile of the current logged-in user and their relationships.

There was a shared section for all profiles, which includes common social network functionalities like activity, gallery or messaging, and other sections that depend on the user profile, and includes functionalities related to each profile (e.g. therapies definition and patient management for therapists or treatments currently assigned to patients). With regard to personalization, as the navigation flow depends on the user profile and differs from the default platform

Table 2
Network spaces implementation.

#	NETWORK SPACE	PROCEDURES	Blog	File	Discussion	Events	Therapies	Messages	Notifications	Gallery	Video
1	Coordination	Discussion forum	X	X							
2	Supervision	Decide monthly work plan	X	X							
		Decide organizational changes		X							
		Organize holidays plan	X								
		Announce meetings				X		X	X		
		Open discussion topics			X						
		Share images								X	X
3	Direct attention	Access to the "Welcome Manual"		X							
		Share monthly work plan	X	X							
		Announce organizational changes		X							
		Create holidays plan	X								
		Announce meetings				X		X	X		
		Send residents duties assessment	X	X							
		Open discussion topics			X						
		Share images								X	X
4	Relatives	Access to the "Welcome Manual"		X							
		Share news	X	X							
		Announce events				X		X	X		
		Share images								X	X
		Open discussion topics			X						
5	Resident's relatives	Share weekly report		X							
		Share health status	X	X							
		Share news	X	X							
		Inform about new health issues	X	X							
		Open discussion topics			X						
		Arrange meetings			X	X		X	X		
6	Family	Open discussion topics			X						
		Share images								X	X
7	Residence	Open discussion topics			X						
		Share images								X	X
8	Departments	Define and assign therapies					X		X		
		Record evolution of resident	X	X	X						

navigation schema, it was necessary to override the platform views which render navigation, so that they meet our needs, and also to modify the behaviour of some common functionalities to comply with the user profile.

In the second approach, the focus was not on who the user is, but also on what the user needs from other users, leading to the concept of working spaces where users interact among themselves based on a specific relational need (therapist needs to coordinate among them, patient relatives need information from the therapist about the patient). We implemented this approach with ElggGroups, which allow creating spaces on the social network where users can communicate and share contents. We can control which users have access to which groups, taking into account not only the user profile but also users' relationships, or even if these spaces are open to all the users. Groups behave as content containers, and define a common permission set over those objects for all the users belonging to the group.

This approach does not require the development of custom plugins, as all the functionalities can be achieved with the platform or community components, by simply enabling or disabling the required ones, and establishing the proper configuration for each plugin. For that reason, we selected this approach for the final implementation of the network spaces presented in Section 2. Table 2 completes Table 1, adding enabling components required for each procedure on each space.

4. OSN deployment and results

The OSN was deployed and evaluated in a residence for people with disabilities in Villamayor (Zaragoza, Spain). This is the home of

76 persons with different levels of cognitive disabilities and employs 41 people, including caregivers, health professionals (speech therapists, psychologists, occupational therapists, educators and physiotherapists), supervisors and administrative staff. Other services not related with direct care, such as cleaning or cooking, are subcontracted. To date, the OSN has been operational for more than one year (since September 2013) and there are currently 46 active users and 14 network spaces (coordination, supervision, direct attention, relatives, three resident relatives, three families, residence and three departments).

The whole team of employees participated in the OSN evaluation as primary users, along with a small sample of three residents and their respective families. It should be noted that, although just these three residents were active OSN users, many more interacted with the OSN but just as observers. This is because the cognitive profile of the people in the residence is very low: most of them cannot read being their technological abilities are almost inexistent, some barely communicate and some even move. Indeed, residence personnel considered only 7 out of 76 residents technically eligible to autonomously use the OSN. Nevertheless, "computer classes" of a group of those not eligible included observation and comment of the OSN's picture galleries. This allowed us to qualitatively assess the influence of the tool in these residents through caregivers as proxies [38].

4.1. Assessment methodology

All along the project in the intermediate evaluations, we considered a plurality of dimensions, interests, needs, and demands. Evaluating with real users in real scenarios indicates weaknesses and specific problems arising from exclusively performing evaluations by qualitative or quantitative approaches, thus following mixed-method strategies overcome the weaknesses that both approaches have [39].

As detailed in Section 2.2, before the field test, we assessed the prototypes with two qualitative techniques, to ensure the usability and navigability, as well as to preview the acceptance of the interface by users. Previous to the users' evaluation of the prototypes, a cognitive walkthrough was done by experts in several iterations, with prototypes evolving from low to high fidelity. Once we obtained the best prototype from an expert point of view, we accomplished the Wizard of Oz method plus personal interviews to participants. This methodology allowed us to observe in a controlled environment if the user was able to carry out several predefined tasks, feeling comfortable, being executive and effective, etc. and also if the user had errors, expressed doubts, or stopped too much in any step. Results obtained retrofitted the design process to produce the definitive platform structure and interface appearance with the certainty to implement a well-designed solution ready for the field test.

Already with the design fully implemented and deployed in the residence context, we based our final evaluation in four **aprioristic dimensions**, which we had settled at the beginning of the project: (i) the acceptance of the tool by users; (ii) the productivity improvement in residence's procedures; (iii) the change in the quality of service both perceived by staff and families; and (iv) the impact on social relationships of all stakeholders. These dimensions acted both as design objectives along the project, and as general indicators for the final assessment. Moreover, we also needed to be sensitive to **emergent dimensions** that could arise in any point of the evaluation process. Thus, we conducted a mixed-method assessment approach, following a **quantitative–qualitative combination strategy** [40,41] in which the qualitative part served as a means of complementing and confirming the quantitative one. Table 3 summarizes assessment objectives, indicators and instruments put into place.

The first dimension was key because otherwise the rest could not be achieved. Thus, we needed to find out whether the OSN was being really utilized, how, and to what extent; in other words, whether or not it was a "living tool". The assessment of most indicators (user interactions with the OSN, type and quality of contents created, access via mobile devices or from outside the residence, hours of access, etc.) were not be evaluated through direct user-feedback methods, to avoid influences like the Hawthorne effect [42] or the

Table 3
Summary of assessment objectives, indicators and instruments.

Assessment objective	Indicator	Instruments	Reference
Acceptance of the tool by users	Users' OSN adoption (log in, create content, etc.)	Number and types of operations registered by OSN log	Fig. 6 Fig. 8
	Access via mobile devices	Quantitative comparative of metadata associated to OSN log	Fig. 9
	Type and quality of contents created	OSN contents review	Discussion paragraphs
	Users' attitude towards OSN (and emergent issues)	Interviews and focus groups	Discussion paragraphs
Productivity improvement	Access to platform from outside the residence	Quantitative comparative of metadata associated to OSN log	Fig. 9
	Hours of platform access	Quantitative comparative of metadata associated to OSN log	Fig. 7
	Use of platform messaging	OSN log interviews and focus groups	Discussion paragraphs
	Use of paper	Interview to administrative staff	Table 5
	Administration time devoted to attend staff issues	Interview to administrative staff	Table 5
Change in quality of service	Improvement of communication with families (immediacy, quantity, quality, reliability, security)	Interview to management and families	Table 5
	New communication channels between staff and families	OSN contents review Interview to management and families	Table 5
	New discussion channels to prepare residence's activities	OSN contents review Interviews and focus groups	Table 5
	Emergent issues (use of the OSN to brainstorm about innovative activities to do with residents)	Interviews and focus groups	Discussion paragraphs
Fostering of social relations	Social activity (messages and picture gallery)	OSN contents review Interviews and focus groups	Table 5
	Emergent issues (use of the OSN to organize external activities among staff members)	Interviews and focus groups	Discussion paragraphs

Table 4
Data cross reference.

	Activity	# Operations	User profiles	Data operator
Activity		X	X	
# Operations	X		X	X
User profiles	X	X		X
Data Operator		X	X	

pressure that an employee may feel. They were undertaken from a quantitative perspective, analysing the platform activity records throughout one year of use, from several points of view that affects all the evaluative dimensions. The platform recorded the operations carried out by users (session log in/out, contents creation, adding comments, etc.), which allows an analysis to be conducted of the platform operation. We analysed four main facets: **level of activity**, **operations performed**, **user profiles participation**, and **IP source**. From a cross-reading of the interconnections between these dimensions, we draw the conclusions explained below. Table 4 shows the matrix used for the analysis.

Qualitative assessment is often used in healthcare research and social media [43]. Thus, in line with our assessment strategy, we found it necessary to qualitatively analyse the contents created, the users' opinions, to gain insights about other more subjective dimensions and to explore possible emergent issues. To do so, the final step of the evaluation was a focus group with nine users belonging to all the profiles in the platform except residents (whose perspective was transmitted by proxies [38]). Two experts conducted the meeting, one acting as moderator while the other as assistant. As usual, the session was recorded on tape, and field notes of observations were also kept.

The focus group was launched after we extracted the first inferences from the analysis of evaluation instruments formerly explained, grounding on which we settled three main objectives: (i) to

complement metrics, going into those aspects we could not explore; (ii) to deepen or watch from a different perspective some quantitative outcomes, combining the results from both sources; and (iii) to be open to unexpected and emotional issues. Specifically, we dealt with (i) **productivity improvements**, talking about the effectiveness of meetings, the training times reduction, changes in procedures, etc.; (ii) **changes in quality of service**, exploring users' satisfaction, their perception of having a better service, communication errors, etc.; and (iii) **fostering of social relations**, asking for new communication channels, group interactions, etc. Although we had a structured script based on those aprioristic and emergent dimensions, the moderator led discussions on a deliberately free and open manner, to allow participants to freely express themselves without feeling questioned, but at the same time, covering all aspects of the research. After the session, selected users were interviewed in order to deepen key aspects.

4.2. Results and discussion

One of the main quantitative indicators is the **number and type of operations** carried out throughout the operation period (see Fig. 7). Most of the operations relate to contents editing, and we can see two activity peaks during the beginning of the trial and shortly before the summer period. On the other hand, the activity decreased in March (due to technical issues) and in summer to coincide with holiday periods. It appears that the OSN is currently not being used, but as we obtained the data on 10th of October 2014, use should be extrapolated to the entire month, yielding similar results to April 2014. Consistent with this finding, qualitative research also indicates that the use of the OSN increased with the start of the school year.

If we look at the **daily distribution of these operations** (Fig. 8), most of them are performed during office hours, when coordinators, supervisors and clerical staffs' schedules overlap. We can see also that direct care professionals use the platform out of the office hours, as the residence operates 24 h a day, and so do relatives. The use of the tool in off-peak hours is a reflection of the acceptance that the tool
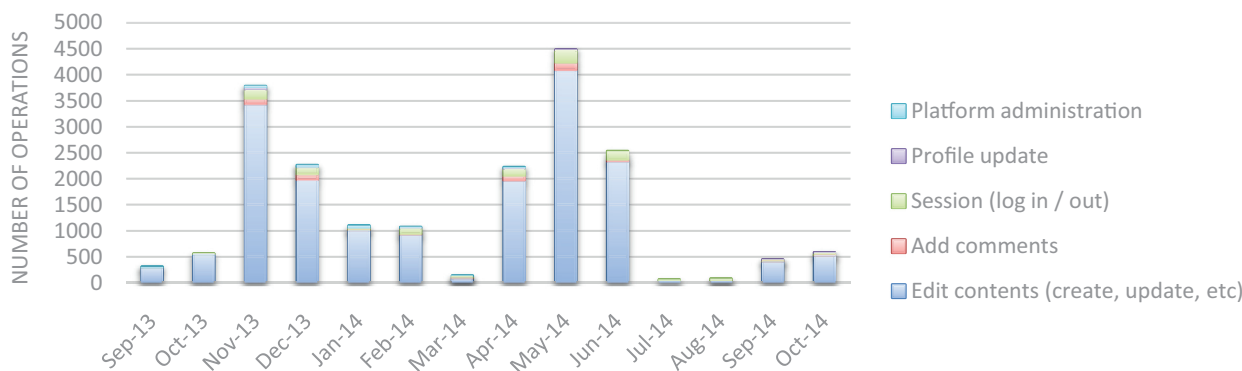
Fig. 7. Platform activity throughout the operation period.
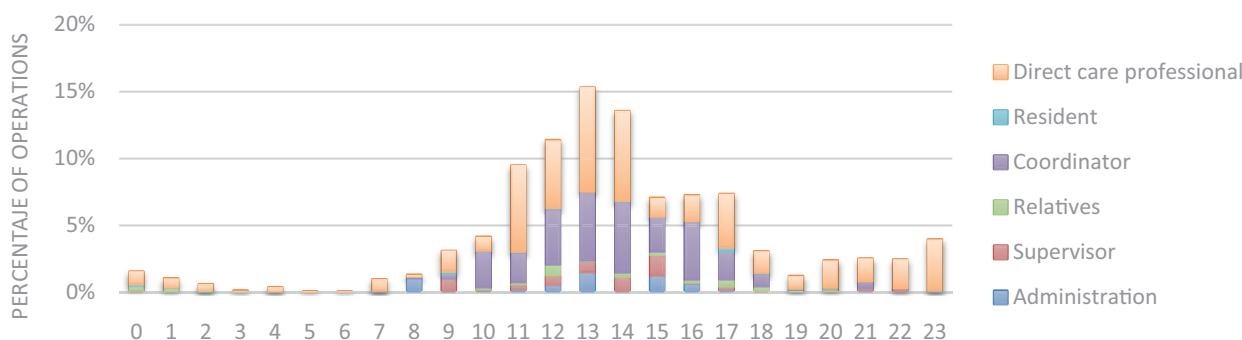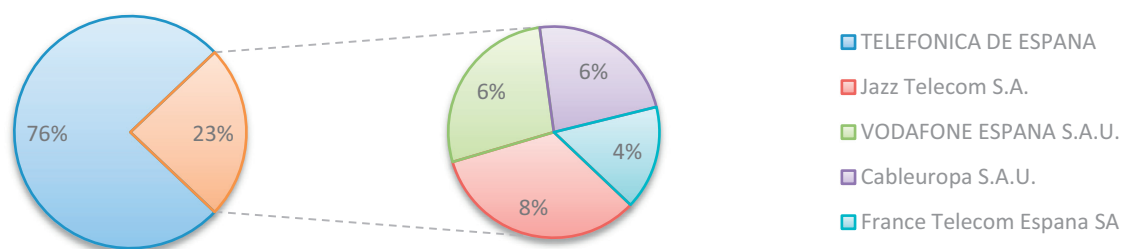

Fig. 8. Daily platform activity.

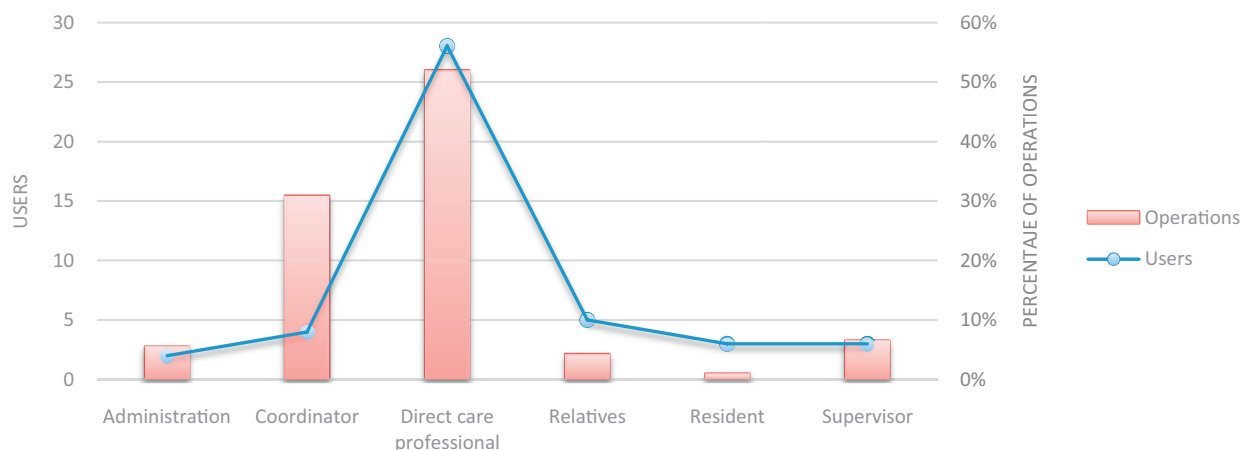**Fig. 9.** Local vs. remote connections to the platform.

Fig. 10. Platform usage by profile.

has acquired in the association. Use of the platform by residents is limited however, and mostly at specific times, constrained to tutored activities in the residence.

From the operations log, we can also analyse the IP origin of the connections to the platform, looking at the **operator who owns the IP** (Fig. 9). Most of the connections come from one operator, which indeed is the residence provider, so we cannot distinguish whether they are local or remote connections. However, we can say that at least 24% of the operations were performed either remotely or through mobile devices, as they relate to IPs belonging to different data providers. Looking into the details of these connections, most of the main provider connections are related to caregivers, coordinators and administration staff (which reinforces the impression that they are local connections), and the remaining connections are related to all the profiles homogeneously. This indicates that people use the platform similarly to work email, mainly in working hours but also, to a lesser extent, via mobile devices or at home. The number of remote operations can be considered a sign of the good functioning and OSN acceptance.

We can obtain a better overview of **what kind of users** use the platform most by looking at Fig. 10, which displays the operations performed by each profile and the number of users corresponding to that profile.

Most of the operations belong to the group of direct care professionals, which seems to have been the most active group, as we saw in the qualitative assessment. However, cross-referencing the two types of data we realize that coordinators are the most active profile, as comparatively they engage in thrice as much activity per person with respect to carers. Supervisors, administrative staff and caregivers participate to a similar extent, even though this last group demonstrated a special motivation in the qualitative assessment. It should be noted that the platform records those operations that entail modifying the database, while merely displaying content is not logged. This affects residents' activity records, as due to their

cognitive disabilities they began acting as observers of the picture galleries during their computer classes. In the second phase, those more autonomous individuals were expected to use the platform increasingly independently, with less supervision. The same applies to relatives, as they are mainly intended to consume information (weekly reports, announcements, events, etc.), not create it, and make comments on the contents, which is reflected in the data.

Another parameter of interest is the **interaction level** between different profiles. We consider the following indicators to measure that interaction level:

- **Relational interaction**, which measures the basic interaction level between users, derived by their existing relations (i.e., users' friendship and common groups' membership). This interaction level is usually established at the beginning (as group membership and friendship relations are created when the users are introduced on the platform) and tends to be static (due to proper nature of the OSN: closed and private).
- **Content-driven interaction**, which measures the specific interaction through available services between users, and their visibility (if it can be seen only by friends, group members or public). Examples of this type of interaction are publishing new content, sending a message, posting on a discussion topic, making a comment, and "liking" a content.

To calculate interaction level, we use two components: **friendship** and **group membership**. First, if user A is friend of user B, we account for one relational interaction from user A to user B. Note that Elgg friend mechanism implementation does not require user B to be friend of user A, thus, that interaction is not symmetric. Second, if user A and user B are members of the same group, we account also for another relational interaction from user A to user B (as many as the number of groups they share). In this case, the interaction level is symmetric. The sum of the two components is the **relational interaction level** from user A to user B. We repeat this process for all
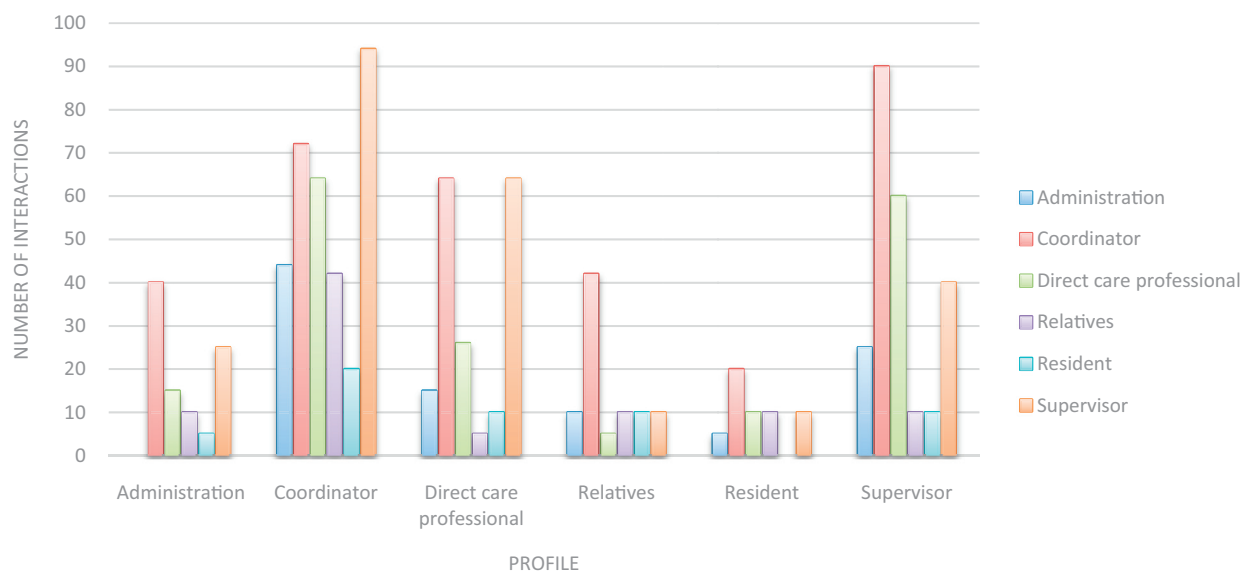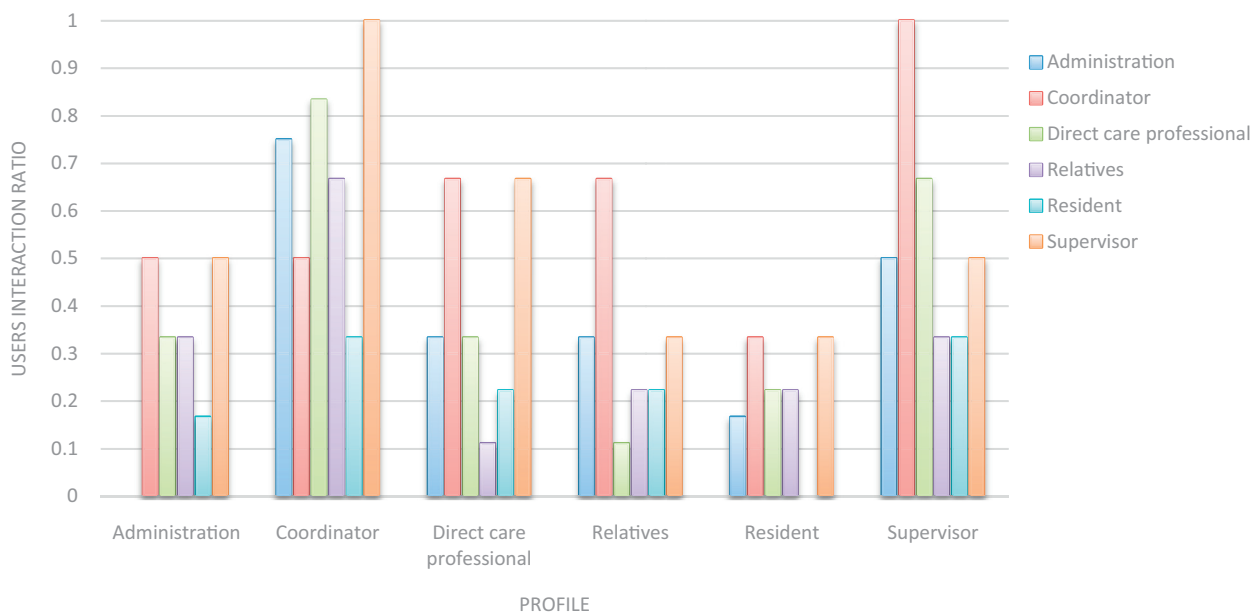
Fig. 11. Relational interaction.

Fig. 12. User interaction profile ratio derived from relational interactions.

the users to obtain the relational interaction level from each user to others.

Fig. 11 shows the interaction levels that each user establish with the others, aggregated by profile. Most of the interaction level is derived from group membership, and thus, the total relational interaction level is almost symmetric, whereas small differences are due to friendship contribution. Higher interaction levels are established between coordinators, supervisors and direct care professionals. In the case of coordinators and supervisors (four and three users respectively), this is due to their responsibility duty, hence they belong to most of the groups. In the case of direct care professionals, this is because they are the most numerous group (29 users). Interaction with relatives is mostly constrained to coordinators, which are the only responsible for communication tasks with them. As we see in Fig. 1, interaction among relatives and direct care professionals and supervisors should be null; although very limited, the number shown is only due to specific friendship relations. We decided not to forbid personal relations in the platform, but direct care professionals are trained to avoid any exchange of information about the resident, which is confirmed by content-driven interactions.

Derived from the relational interactions, we can analyse also the **user interaction profile ratio**, i.e., the ratio of users in each profile with which the user has at least one relational interaction, averaged by profile (Fig. 12), which provides an idea of how connected are each profile. For example, we can see a close connection between coordinators and supervisors, with a user interaction profile ratio of 100%, which indicates that every coordinator has as least one relational interaction with every supervisor and vice versa. In general, these profiles are the most connected with the other profiles, achieving the highest user interaction profile ratios, whereas relatives and residents present lower values, which indicate that users belonging to these profiles interact with a reduced number of users from each profile. Those high user interaction profile ratios are related also with the number of users. When the number of users in the platform is reduced, interactions are established among almost every user, whereas in scenarios with a great amount of users,

a

b
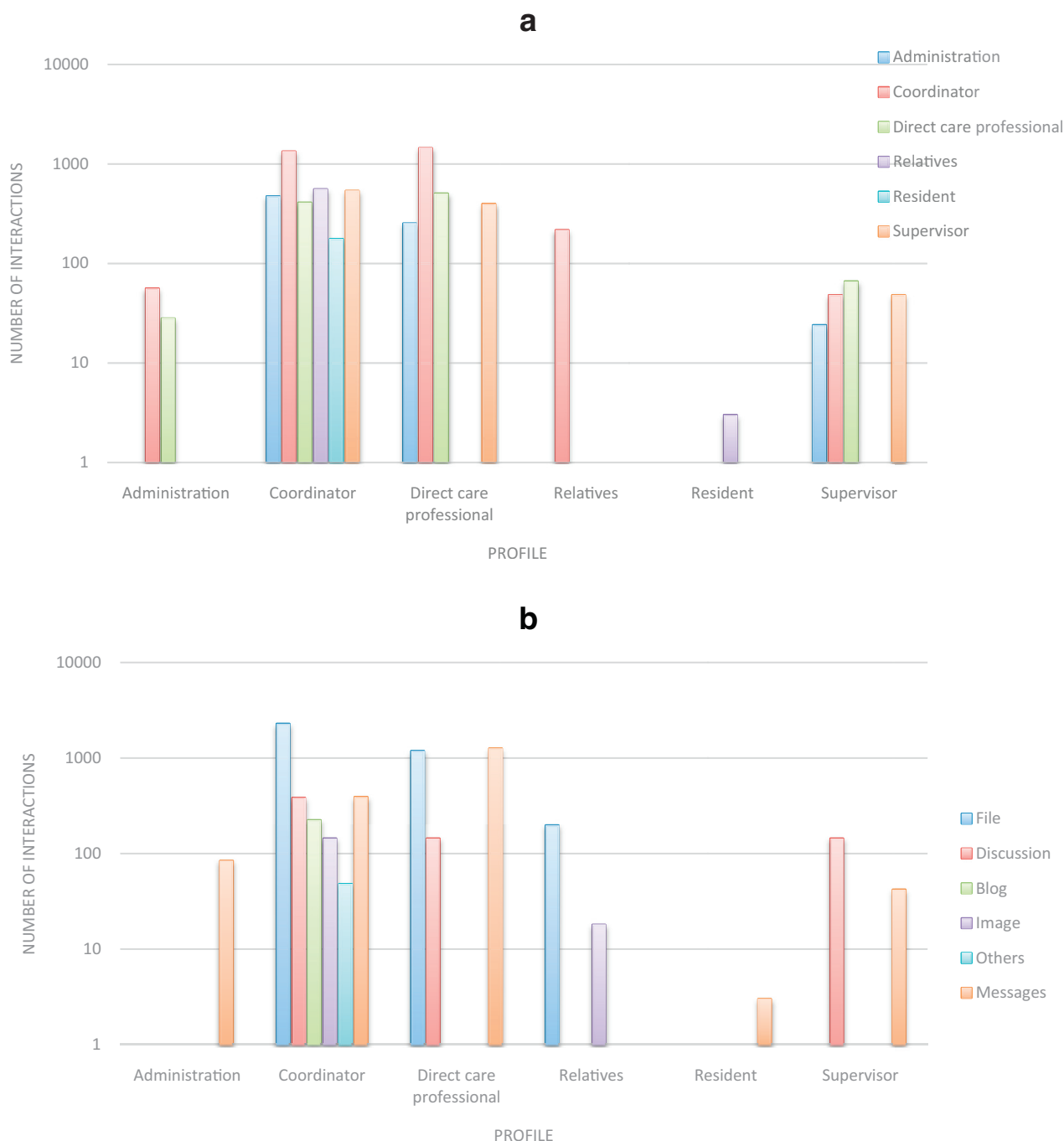
Fig. 13. Content-driven interaction, aggregated by (a) profiles and (b) services. Note that *y* axes are exponential to ease interpretation.

we could expect lower user interaction profile ratios for all the profiles.

To calculate the **content-driven interaction level**, we consider the users creating content. When creating content, the user can establish the visibility (which users can see the content) to four levels: private, only friends, group members or public. Thus, according the type of visibility of each content, we account for one content-driven interaction from the user who creates the content to every user that have access to it. We repeat this for every content created, and obtain the content-driven interaction level from each user to each other users. Some services imply direct interaction among two users; thus, we also include every message sent from user A to user B, every time user A "likes" or comments some content created by user B, and every time user A post on a discussion topic created by user B. Fig. 13 shows

content-driven interaction aggregated per profiles (Fig. 13a) and per services (Fig. 13b).

Fig. 13 reveals that files (including adding comments or "liking" entries), messages and discussions (posting to existing topics) are the most used services. Merging data from Figs. 11 and 13 we confirm that although a relational interaction existed among relatives and direct care professionals, they did not exchange any kind of information. Indeed, relatives just communicated with coordinators through files (mainly periodic reports about residents) and images available to all the residence. Coordinators are the most proactive users leading the platform operation and in charge of the services in contact with relatives (setting events, publish the residence blog and images). They are using all the services with all the profiles, especially files with direct care professionals and relatives. Discussions have been always
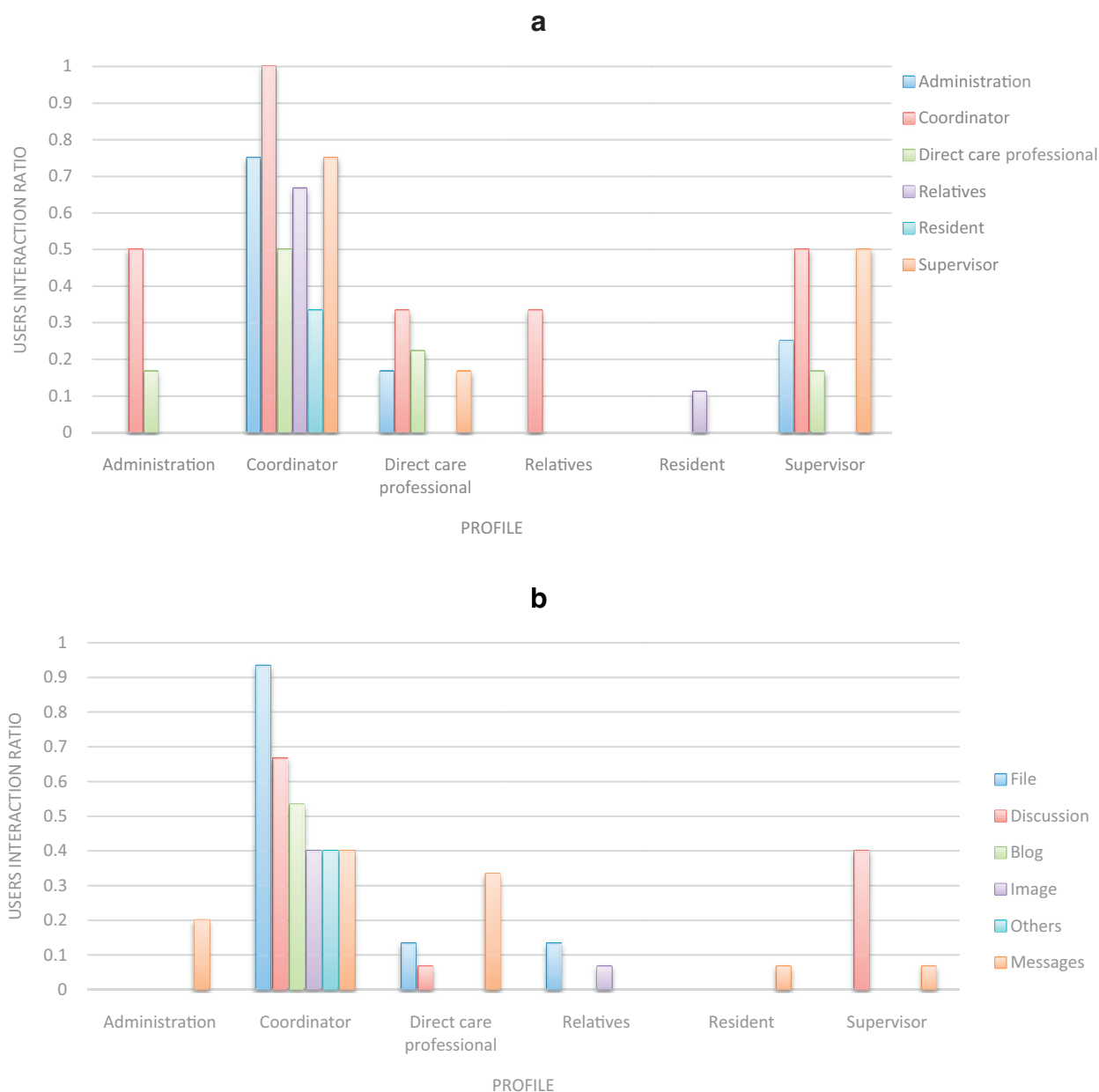
Fig. 14. User interaction profile ratio (a) and user interaction service ratio (b) derived from content-driven interactions.

generated by coordinators (to organize interventions on residents) and by supervisors (to manage administrative and organizational issues such as working turns and holidays).

As with relational interactions, we can analyse the **user interaction profile ratio** derived from content-driven interactions (Fig. 14a), and the **user interaction service ratio**, which reflects the ratio of users in the platform with which the user has at least one content-driven interaction from each service, averaged by profile (Fig. 14 b). Again, data shows that coordinators are the most connected profile, followed by supervisors and direct care professionals, but with significant lower user interaction profile ratios, and highest values are established with the coordinator profile. This indicates that those profiles use to interact through content generated by coordinators, whereas interaction through their own content is lower. We can highlight also the supervisors' own user interaction profile ratio, which suggest a strong usage of the platform for organising themselves, similar to the interaction with coordinators.

If we look at the user interaction service ratio, we can see a prominent usage of the files service by coordinators, whereas messages service is used regularly by all profiles (and should be noted that the files are usually accessed by several users, whereas messages are accessed only by the addressee, thus its interaction accounting is lower). This is confirmed also with Fig. 15, which plots the overall service content-driven interactions, and shows that most of the interaction comes from the files and the messages services.

Finally, results in Figs. 11–15 together with qualitative assessment allowed us to fine-tune the statistical data, confirming that the high participation rate was not due to superiors' impositions (e.g. from managers to employees), but to the actual effectiveness of the OSN. The user motivation and satisfaction in every dimension is therefore remarkable; so much so that they have found unexpected uses for the tool and are liking forward eagerly to new functionalities. The immediacy of information, the improvement of communication in various senses and the enhancement of the working environment are the
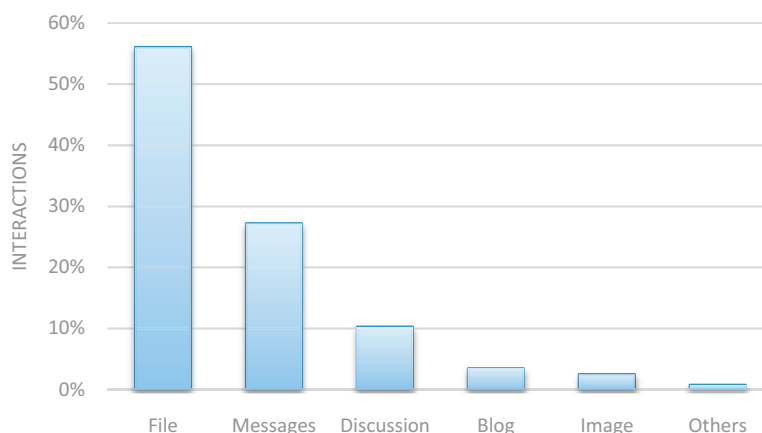
Fig. 15. Overall services content-driven interaction.

Table 5
Qualitative evaluation of the OSN.

Productivity	Coordinators make information (e.g. organization sheets, schedules, new procedures, etc.) simultaneously available to everybody through file service. This has reduced informal visits to administration (around 50%) and has accelerated planning.
	People with limited technology skills often double check information in person.
	Confirming high use of file service (including associated comments), it is very useful to have updated procedures always online available with a communication channel attached and it increases efficiency.
	Sensitive procedures are not online to avoid unauthorized copying.
	A communication forum using discussion service to inform about meetings, events and doubts is highly appreciated.
	Confirming large use of message service, private messaging on the OSN was preferred than usual email because it was faster access and because carers do not have a corporate email account.
	Carers being hired and leaving are quite usual. OSN has proven to be very useful in the integration process of new carers as a tool to hit the ground running and facilitate their participation in proposed activities.
	In line with the material uploaded using file service, there is an expected reduction in stationery and printing costs around 20% derived from both communication to families and printing material for staff.
Quality of service	The use of file service to provide message delivery has been significantly improved in four main aspects:
	- Information immediacy: Relatives living outside the metropolitan area received notifications via postal service several days after notification, often when the information had expired. Now this is immediate.
	- Information quantity and quality: Relatives living far from the residence who see their family members from time to time have an online and written communication channel with residence coordinators.
	- Information reliability: As residents sometimes carried notifications, sometimes they did not reach the addressee. Now this does not happen.
	- Information security: OSN provides data encryption and access security which is needed to send health information, otherwise not considered.
	Being able to post comments on files using the file service make relatives to perceive the OSN as a new useful bidirectional communication channel with residence professionals for different uses:
	- Discuss notices, reports, etc. of the residents
	- Reliable channel to inform about resident health issues; for example, medication changes
	Carers' community was very active proposing new activities for the residents using message and discussion services. The open forum encouraged discussion and involvement from many of them and as result, more ideas emerged more leisure activities than before were done, and there is a spread of enthusiasm among the workers.
Social relations	Having a private OSN is highly appreciated, since it allows users with disabilities to be protected from inappropriate external influences.
	Although not yet allowed to do so (they just sent one private message to relatives in a classroom), residents are very motivated to use the OSN; especially the gallery module.
	In line with image service use, the private OSN has replace some uses given to Facebook (as share photographs of residence activities).
	With quite a high turnover of carers, OSN has proven to be very useful in the social integration process of new carers.
	Employees find the site fun and now use it also for leisure activities such as weekend plans, picture sharing, etc. This has had a positive influence on the atmosphere in the residence.
	All the users made correct use of the OSN. There has only been one inappropriate comment that was quickly identified and removed.
	Relatives perceive the OSN as a new useful bidirectional communication channel with the residence
	- to provide personal information about the residents who are unable to express themselves; for example explain what they did during their family vacations or post nephew's pictures.
	- to keep members of the family that might live abroad (e.g. siblings) informed about the resident's life in the residence.

most appreciated benefits. A summary of the main highlights from the focus group and interviews is presented in Table 5.

Turning over the initial analysis of needs and weaknesses, stated in Section 1, we can say that the designed OSN contributes to the following:

- **Inefficiency in communication.** OSN improves this aspect in many dimensions. Thematic areas of discussion are far more efficient than mails or instant messaging as they provide a shared and common place where all the information (messages, opinions, files, etc.) is available, discussion threads are organized, etc.

- **Format of shared information.** Much information is created in digital format (intervention strategies, resident evolution, family reports, staff organization charts, etc.) and the OSN proved to be an appropriate media for sharing it and substituting paper. It is private (data hosting is local), secure (only available to selected users), persistent and organized (files are

always where they should), and ubiquitous (mobile access is available).

- **Limited office time available.** Besides making some office tasks more effective, OSN enables a ubiquitous and mobile channel to attend communications, read reports or diverse organizational matters.

- **Exclusion of user/relatives in the process.** OSN proved to open a new bidirectional and multimedia channel between families and residence personnel. It makes easier for relatives to send information about the resident (e.g. pictures about the weekend at home or medication updates) but also about their feelings, suggestions or opinions. It also creates a private and secure communication channel that the residence staff uses to send the weekly report (including health, nutritional, physiological issues).

- **Changes in professionals.** Training and adaptation of carers is easier thanks to OSN: internal regulation and actuation protocols are always available; and integration in the group is facilitated thanks to immediately being included in virtual community of carers.

- **Little penetration of ICT communication in daily living.** Per definition, OSN is a step towards the integration of ICT in the scenario, favouring emotional aspects derived from communication through pictures and messaging.

5. Conclusions

In this paper we have described a successful case of applying an OSN as a tool for assisting people with special needs. This included the design and development of the OSN and its evaluation over a one-year period of real operation of the platform.

As an important aspect of this application, we confirm the importance of differentiating users according to their profiles, as it encompasses very different realities, and we furthermore stress the relevance of tackling the OSN design and development from a different point of view: that derived from the natural interaction between actors, and from what an actor "expects" from the users he relates with. The concepts of *Relational Groups, Relational Needs* and *Network Spaces* arise as convenient mechanisms to address the OSN design process.

Further, it is important to bear in mind the specific features of the OSN when developing the application. Following a traditional software design and development approach and putting the focus on the requirements may probably lead to complexity and wasted efforts (which in practice will entail higher maintenance costs and unsustainability), whereas including platform capabilities in the analysis allows alternative models to be found that can meet the application's requirements with less effort required for its development. Therefore, developments should include an in-depth review of the OSN model to ensure that it strikes a good balance among functionalities, complexity and costs.

The one-year pilot evaluation clearly demonstrates the utility of the OSN in the support of people with special needs. It provides benefits in terms of productivity and quality of service, as well as contributing to relations between users. This has been evidenced by means of a deep quantitative analysis based on the platform operations and confirmed with a qualitative evaluation with different profiles of the OSN users.

Acknowledgments

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