

Original software publication

## Care4Plant: Mobile application for informal caregivers

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### ABSTRACT

Informal caregivers provide long-term, unpaid support to patients – usually family or friends – with serious illnesses. Although caregiving is essential, it can have adverse effects, e.g. physical and emotional exhaustion. Digital applications are a cost-effective alternative to manage these effects. However, applications for caregivers are usually centered on skill building and education rather than well-being, and general-purpose stress management applications – besides not specifically considering caregivers – frequently change and do not usually incorporate social aspects. To design a caregiver-centered application, we analyzed caregiver needs, specifically focusing on well-being aspects. We present *Care4Plant*, an application designed to measure the emotional dimension of caregivers' burden based on the Zarit Burden Questionnaire, and suggest a set of mood improvement tasks accordingly. *Care4Plant* features a virtual plant that represents informal caregivers' emotional well-being, allowing them to care for the plant through actions intended to manage their mental health and reduce stress, and to share their plant with other caregivers through a social network represented by a greenhouse. We conducted an evaluation of *Care4Plant* with nine users over two weeks. The results indicated good levels of usability and demonstrated that the approach of motivating users through the virtual plant was well-received.

### Code metadata

|   |   |
|---|---|
| Current code version  | 1.0   |
| Permanent link to code/repository used for this code version    | <a href="https://github.com/ElsevierSoftwareX/SOFTX-D-25-00378">https://github.com/ElsevierSoftwareX/SOFTX-D-25-00378</a> |
| Permanent link to Reproducible Capsule                          | <a href="https://rb.gy/wn968o">https://rb.gy/wn968o</a>   |
| Legal Code License  | MIT License   |
| Code versioning system used                                     | Git   |
| Software code languages, tools, and services used               | Dart (v3.0.0), Flutter (v3.10.0), .NET (v7), C# (v11)   |
| Compilation requirements, operating environments & dependencies | Visual Studio (Version 17), Android Studio, Entity Framework Core, Flutter (v3.10.0), .NET (v7), PostgreSQL v15           |
| If available Link to developer documentation/manual             | <a href="https://rb.gy/o5v6v1">https://rb.gy/o5v6v1</a>   |
| Support email for questions                                     | <a href="mailto:bernardo.fernandez@ucsc.cl">bernardo.fernandez@ucsc.cl</a>  |

### 1. Motivation and significance

When individuals are ill and require ongoing care, this care is commonly provided by informal caregivers [1], also called family caregivers [2] or unpaid carers [3]. Informal caregivers are usually

family members or friends who provide care within and outside of healthcare settings [4], who are typically unpaid and without formal training [5]. Caregiving is prevalent and essential, with e.g. 21% of

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the population acting as family caregivers in the United States [6], 24.5% of the dependent adult population in Chile requiring additional help [7], and the chance of an adult in the United Kingdom becoming a carer being 65% [8].

Informal caregivers provide support for a wide range of physically, socially, emotionally, or financially demanding tasks [2]. This high workload may have negative effects on caregiver well-being [1], e.g. fatigue, physical and emotional exhaustion, or depression [9], often called the *caregiver burden*, which can affect caregivers emotionally, socially, financially, physically, and spiritually [10].

Technology-based interventions for caregivers have been found to be able to reduce some of the negative impacts of caregiving [11]. Most existing tools for caregivers, however, focus on education, skill building and assistance with tasks, rather than caregivers' mental well-being [12]. Some examples are *TOGETHERCare*, which simplifies reporting, provides surveys and activities, and facilitates access to health and well-being resources [13], *Carer Guide App*, which provides disease information, well-being activities, social networks, hospital, contacts, and a notepad [14], and *CareFit*, providing tutorial exercise videos, a weekly planner, educational material, and the option to share the caregiver's progress [15].

Recent scoping studies have found that most technology-based interventions to support caregivers are online sessions via videoconferencing [16], and that technologies can be classified as those for communication and support, health monitoring, assistive technologies, and education — including e.g. mindfulness applications, generally with positive impacts, although some negative impacts (e.g. increased stress, technical difficulties) have also been noted [17]. Moreover, most studies with caregivers have been conducted in the Global North [17], and existing applications are generally only available in one language.

General-purpose stress-management applications (SMAs) usually focus on mindfulness and meditation, with about half consisting of evidence-based interventions [18]. A literature review found over 100 SMAs, covering strategies such as meditation, mindfulness, breathing, music, visualization, and accepting reality, but only 9.1% of the apps had any evaluation, and many changed or became unavailable after a 2-year period, demonstrating a degree of volatility [19]. Most applications do not incorporate gamification (i.e., game-related elements such as digital rewards) techniques [20]. Some apps, however, do incorporate persuasive strategies such as personalization (e.g., pre-assessments) and simulations (e.g. flower growth), while social aspects are infrequently used - e.g., social comparison was not found in any of the reviewed applications [21].

We have created a mobile application specifically designed to support the well-being of informal caregivers, incorporating stress-management tools in order to satisfy four previously identified caregiver needs: tracking and identifying mental health and care burden levels, reducing stress and anxiety, reducing isolation, and motivating them to do mood-boosting activities [22]. This application differs from existing solutions because it was designed as a caregiver-centered application with a specific focus on well-being, also incorporating social aspects. To analyze and understand caregiver needs, we developed user Personas based on existing literature [23], secondary research data collected from caregiver forums, and previous literature specifically focused on caregivers' well-being (e.g. [24]). Additional information about the design process can be found in the supplementary material. The application supports several languages, aiming to be available in multiple cultural settings, which can help researchers understand how caregivers' needs e.g. in Latin America differ from those in the Global North.

The implemented application, called *Care4Plant*, focuses on identifying caregivers' emotional burden through a validated test, and suggesting mood improvement activities accordingly. The application is divided into four main sections: (1) *My Plant*, which is an avatar in the form of a plant image representing the caregiver's stress level; (2) *Stress level test*, which implements a short version of the Zarit Burden Interview test [25,26]; (3) *Care center*, which allows users to explore the activities offered by the application; and (4) *Greenhouse*, a space where caregivers can share their thoughts with other caregivers.

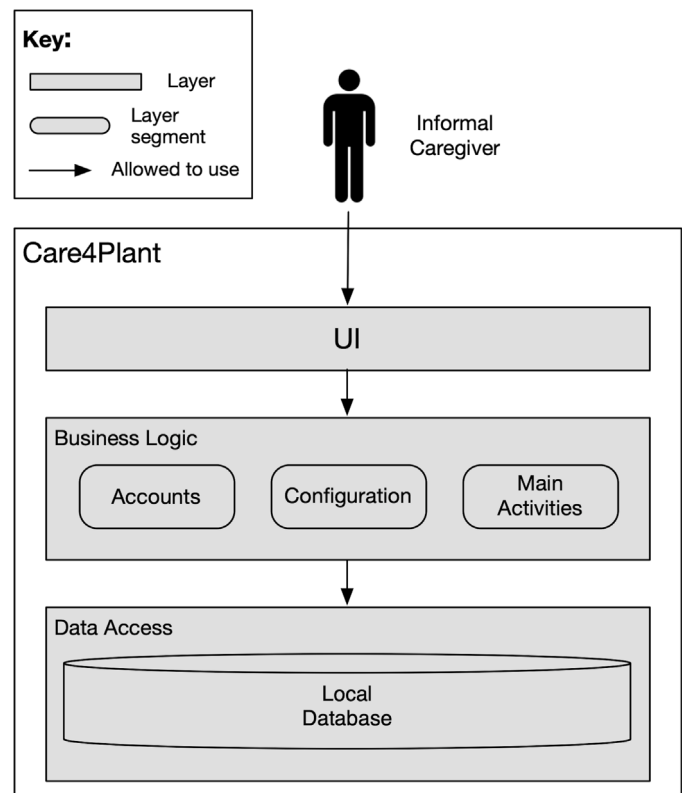


Fig. 1. Care4Plant layer architectural view.

## 2. Software description

*Care4Plant* is a mobile application designed to be simple and easy to use, in order to minimize any difficulties that may affect its regular use [27]. The application was designed to help informal caregivers self-report their emotions and help reduce their stress levels. As a design decision, we used a green color palette as the main aesthetic of the interface, as it is considered a relaxing color, promoting the feeling of calm [28].

### 2.1. Software architecture

For *Care4Plant*, we are interested in prioritizing quality attributes such as modifiability, scalability, and usability, so we chose two classic architectural styles that promote them, aiming to represent the simplicity of our system [29]: client-server style for a general architectural view and layer style for the specific architectural view (see Fig. 1). In the future, if intercommunication with other systems is added, more complex architectures should be considered (e.g. [30–32]).

The architecture consists of three layers: User interface, Business Logic, and Data Access. The Business Logic layer includes three layer segments: (1) the Accounts segment, which allows for the administration of users who will use *Care4Plant*, (2) the Configuration segment, which allows for the configuration of how the application will be interacted with, and (3) the Main Activities segment, which allows caregivers to select the different activities that *Care4Plant* provides for their self-care.

### 2.2. Software functionalities

The main functionalities of *Care4Plant* are the following:

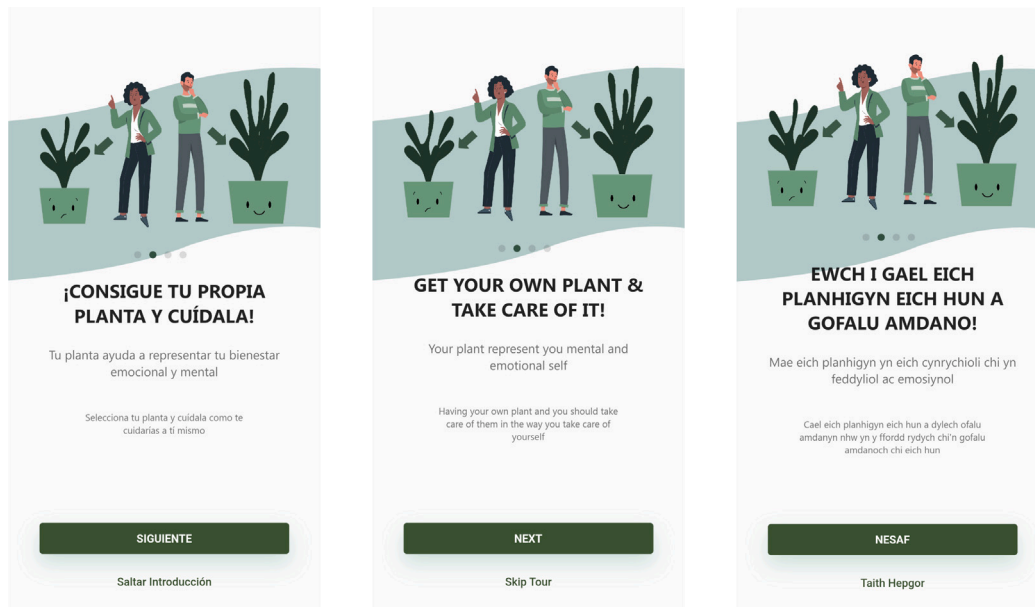


Fig. 2. Onboarding in Spanish, English and Welsh.

- **Language:** *Care4Plant* currently supports three languages: Spanish, English, and Welsh. The application detects the mobile device language and adjusts its user interface accordingly.
- **User Access:** provides functionality related to login and registration.
- **Onboarding:** provides onboarding screens to describe the app's functionalities to first-time users (see Fig. 2).
- **User Center:** allows users to configure their preferred settings regarding plant style, frequency for answering the stress level test, notifications, etc.
- **Stress Level Test:** allows users to answer a stress level questionnaire, based on seven questions from the “emotional well-being” domain from Zarit Burden Interview (ZBI) and *Mapi Research Trust* [26].
- **My Plant:** the main screen of the application, displaying an avatar plant that enables a visual representation of the caregiver's stress level. In the initial configuration of the application, the user can select the avatar plant style, which can afterward be decorated by accessories that the user can earn as rewards for completing activities. The *My Plant* screen gives users access to functionalities such as self-reporting daily mood and stress levels, and offers recommendations based on information collected by the application (e.g. stress levels, interactions).
- **Care Center:** allows users to explore the activities the application offers. Each activity has a time limit associated with it, indicating how long a user must be on the activity screen to receive the reward.
- **Greenhouse:** a shared space designed to allow caregivers to write their thoughts to be seen by other caregivers, if they so choose.

### 3. Illustrative examples

This section presents examples of the main functionalities of the *Care4Plant* application.

Within the *Stress Level Test* functionality, a progress bar with icons is shown, indicating which question the user is answering (see Fig. 3). After completing the mandatory *Onboarding* section and configuring their preferences in the *User Center*, the user should answer the stress level test at least once. After that, the application will prompt the stress level test to be answered according to the frequency configured by the user.

The *My Plant* section presents a personalized daily greeting at the top of the screen, as seen in Fig. 4(a). When the application is used for the first time, the daily greeting is followed by a plant's avatar selection in the configuration section. The plant represents the caregiver's stress levels. Several accessories can be used to enhance the plant's appearance. The accessories are collected by performing stress-relieving activities in the *Care Center*. Below the plant, there are two messages, one giving the option to self-report the user's daily mood (if not yet reported) and another to answer the stress level test (if it meets the settings configured in the Onboarding section). At the bottom of the screen, there is a *Recommended path for you* section, suggesting activities according to the user's stress level, as seen in Fig. 4(b). Once the activities are completed, the user is rewarded with an extra accessory for their plant. The path is updated each time the user completes the stress level test. Both the number of activities and the type of activity offered for each stress level are configurable.

The *Care Center* presents several activities to the user, such as playing relaxing music, as shown in Fig. 5, and a box with mindful readings. Additionally, in the top right corner, it is possible to register the user's thoughts. The user can also self-report stress levels in this section.

In the *Greenhouse* screen (see Fig. 6(a)), a collection of plants is displayed, representing a network of informal caregiver users. Users can visit other caregivers' personal zone, which is a space that lists recorded thoughts, as shown in Fig. 6(b). A user may *like* the thoughts recorded by other caregivers and view the total number of *likes* displayed under the red heart.

### 4. Impact

The potential impact that an application like *Care4Plant* could have on informal caregivers can be seen in two ways. First, the application is focused solely on the caregiver's well-being, unlike other applications for caregivers [33] that focus their attention on functionalities to support caregiving tasks rather than on emotional needs. Designing a mobile application like *MyPlant* with a single target audience, i.e. caregivers, can be beneficial in the following ways:

- **Personalized experience:** By not having to compete with other functionalities, the app can offer a highly targeted experience and a personalized wellness plan, tailored to the user's individual needs and goals.



Fig. 3. Stress Level Test in Spanish, English and Welsh.

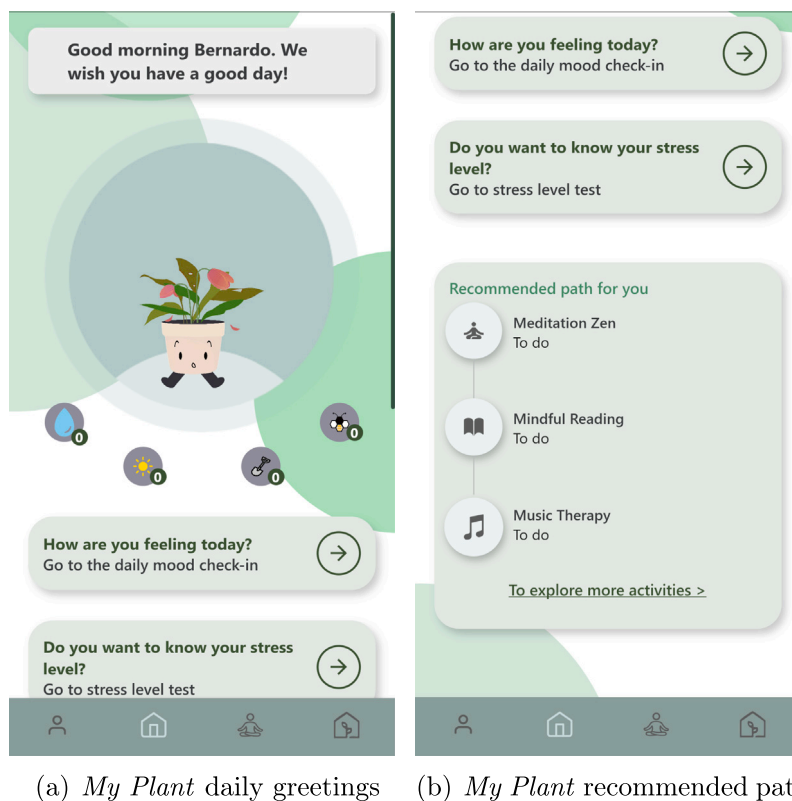


Fig. 4. My Plant.

- Efficiency in content delivery: Applications focused on a specific condition may be more effective in delivering content and tools.
- Reduced information overload: Reducing overload is critical to preserving the health of caregivers, who often face the challenge of balancing multiple responsibilities while managing a large amount of caregiving-related duties.
- Increased adherence and engagement: By offering an interface with fewer elements, well-being applications may encourage greater engagement by users.

Second, *Care4Plant* offers a user interface in three languages: English, Spanish, and Welsh, improving both accessibility and user experience. This has been found to be especially valuable in international contexts or multicultural communities (e.g. [34]), possibly because users feel more comfortable and understand information better when the application is in their native language, which can improve usability and overall satisfaction reducing the possibility of misunderstandings or errors [35]. Finally, an application such as this one can also be a tool of language preservation. For example, Welsh is fundamental to

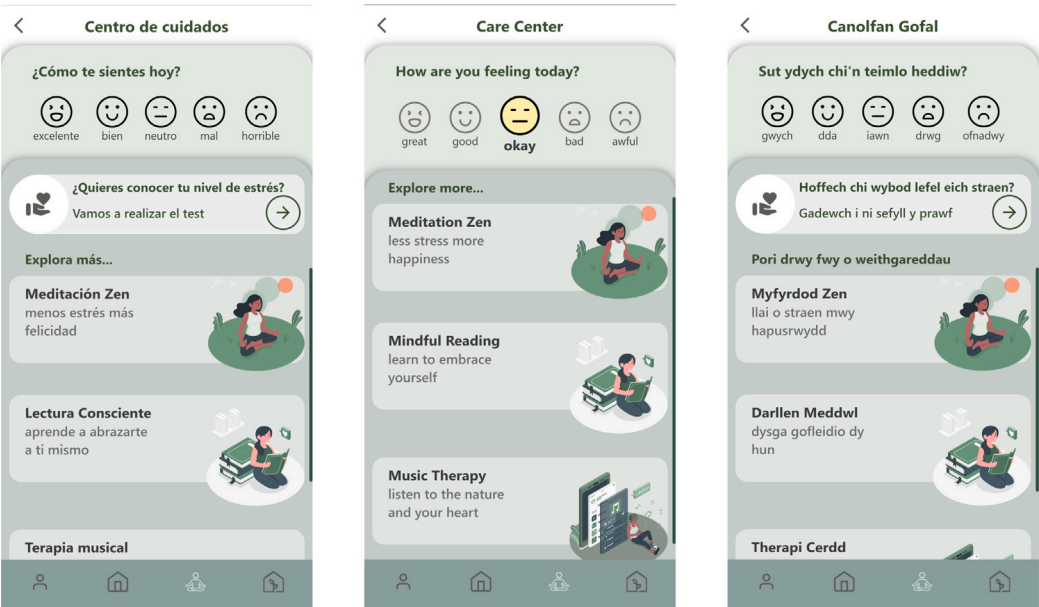
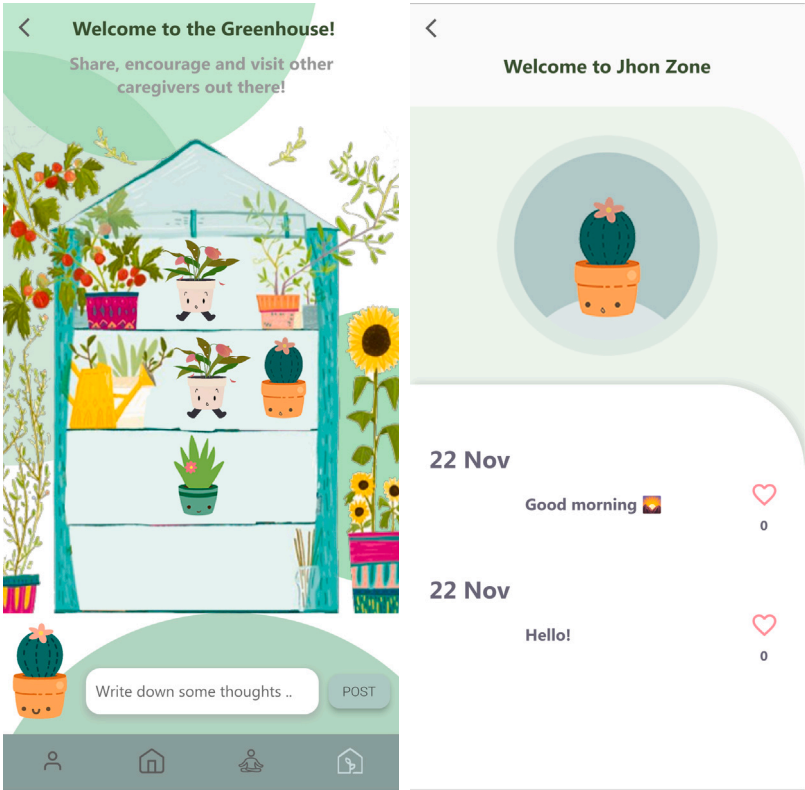


Fig. 5. Care Center in Spanish, English and Welsh.



(a) Main screen of the Greenhouse

(b) Caregiver zone

Fig. 6. Greenhouse.



**Table 1**  
Evaluation results.

| Participant | Age | Gender | Initial Stress Level (0-24) | SUS (0-100) | Open answers (out of 6) |   | In general, what did you think of the interaction with Care4Plant? (summarized) |
|-------------|-----|--------|-----------------------------|-------------|-------------------------|---|---|
|             |     |        |                             |             | +                       | - |   |
| P1          | 24  | M      | 6                           | 95          | 4                       | 0 | "Easy to use"   |
| P2          | 27  | M      | 2                           | 100         | 6                       | 0 | "Excellent"   |
| P3          | 23  | M      | 6                           | 75          | 5                       | 0 | "Relatively easy to use"  |
| P4          | 46  | F      | 4                           | 100         | 6                       | 0 | "Excellent"   |
| P5          | 24  | F      | 8                           | 85          | 6                       | 0 | "Good"  |
| P6          | 35  | F      | 14                          | 72.5        | 3                       | 1 | "At first, a bit complicated (... ) it became easier to use"                    |
| P7          | 26  | M      | 10                          | 92.5        | 4                       | 1 | "Excellent", "Intuitive"  |
| P8          | 23  | M      | 13                          | 17.5        | 3                       | 0 | "User-friendly"   |
| P9          | 24  | M      | 16                          | 85          | 3                       | 1 | "Easy to use", "Attractive"   |

the identity of the people of Wales, so the efforts made to protect this language reflect the desire of the communities to strengthen ties with their roots [36].

## 5. Results

To evaluate the mobile application, we asked 9 non-caregiver participants in Concepción, Chile to use the Spanish version of *Care4Plant* for 2 weeks. This initial evaluation allows us to refine and improve the mobile application before evaluating it with informal caregivers to avoid overburdening them. The study was approved by the Scientific Ethics Committee of the Universidad Católica de la Santísima Concepción (code ORD. N°51/2023).

We asked participants to complete 3 questionnaires: informal caregiver burnout levels (Zarit Burden Interview) [37], system usability scale (SUS) [38] and a tailored questionnaire with 8 open questions about interaction, experience, and perceived usefulness when using *Care4Plant*, advantages and disadvantages of using the mobile application, and suggested improvements, that aim to identify user perceptions of the *Care4Plant* mobile application.

To take part in the study, participants signed the consent form. Then, one of the researchers provided a link to download the application, which was installed on the participant's own mobile phone. They used the app freely for two weeks, continuing with their other daily activities and routines. We contacted them one week after they began their use of the application to offer any required technical support. After two weeks of use, we asked participants to complete the SUS and the tailored questionnaire.

Table 1 presents a summary of our participants and the results of the evaluation. SUS results reveal a good level of usability (average score: 80.3), indicating that in general, the application is easy to use [39]. We note that only one participant had scores below 'Good' according to the SUS adjective interpretation [40]. For the open questions, we selected six questions in which users could give positive or negative answers. For each question, one researcher evaluated whether the response was positive, neutral (or omitted) or negative. We provide the number of positive and negative answers for each respondent; the overall percentage of positive answers was 74.1% (40/54), there were 4 negative answers (7.4%), and 10 neutral answers (18.5%). We also provide a summary of participants' responses to the question that asked their general perception about the application.

To analyze qualitative data, two researchers collaborated using the *Affinity diagramming* technique [41]. All answers from the tailored questionnaire were transcribed and organized into themes by using sticky notes in the Jamboard platform. Results from this analysis reveal insights on what motivates the use of *Care4Plant*, and how the *GreenHouse* and activities are perceived by users. These are discussed below.

The strategy of using a plant as a metaphor motivated users to engage and use the application: "I was really interested in being aware of the

plant and taking care to keep it well" (P2). Users suggested improvements on the visual aspects of the avatar-plant to better represent well-being levels, e.g.: "It would be good to make the visual changes more evident, for example, new leaves growing or wilting or new shoots according to the new accessories applied to the avatar-plant" (P7). Only one user had a negative opinion (P7: "(...) it needs a bit more refinement. The process (...) didn't create a sense of ownership for me regarding the plant").

Participants who used the *Greenhouse* functionality considered that having a space to create a community within the same application was a good idea; however, it was perceived to require higher levels of interaction to avoid the perception that nobody else is using the mobile application, and so that the interaction with others could be richer. Four users were neutral or omitted a response, e.g. stating that this section should provide additional interaction possibilities (e.g. P7: "I would have liked more interaction. I wrote a message and received two likes, but I did not see anyone else leaving messages"), one was negative (P6: "No, I thought I was going to get a response or comment on the thoughts I wrote down") and three were positive (e.g. P2: "I found it exciting to be able to relate to more people").

The fixed number of activities also impacted user experience. Participants felt that the mobile application should be more dynamic, regularly update activities and content, and have more options for music for meditation; similarly, the motivational text should be more diverse.

Regarding participants' well-being, six participants felt that the application helped them improve it (e.g. P7: "It helped me connect with myself, create moments of peace, and learn more from the data that appeared in the focused reading. It made me feel good", two responses were neutral, especially because users felt they did not need to improve (e.g. P1: "No, because I haven't been in a bad mood since I started using the application"), and one was negative (P9: "In my case, no").

## 6. Conclusion

This article presents *Care4Plant*, a mobile phone application designed to support the emotional well-being of informal caregivers. We used a caregiver-centered design to focus on caregivers' well-being needs rather than task-related support. The application uses an avatar-plant as a metaphor that represents caregivers' emotional well-being levels, and a greenhouse of plants to promote some social interaction between caregivers. *Care4Plant* provides multilingual support and is currently available in English, Spanish and Welsh.

The application was evaluated by non-caregiver participants who used the application during 2 weeks. Users indicated good levels of usability and were positive regarding the avatar-plant motivational strategies. Naturally, the next step is to involve informal caregivers in a longer-term study. However, this initial evaluation allowed us to identify some required design improvements, e.g. making visual changes more salient, providing more interaction opportunities between users, and integrating a larger number of well-being activities.

## CRediT authorship contribution statement

**Bernardo Fernández-Zambrano:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Investigation, Formal analysis, Data curation, Conceptualization. **Carolina Fuentes:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Investigation, Conceptualization. **Pedro O. Rossel:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Investigation, Data curation, Conceptualization. **Valeria Herskovic:** Writing – review & editing, Writing – original draft, Visualization, Validation, Investigation, Conceptualization.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Appendix A. Supplementary data

Supplementary material related to this article can be found online at <https://doi.org/10.1016/j.softx.2025.102368>.

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