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Development of a new technology-supported service for geriatric patients

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1. Executive Summary

In this case, digital product studio 3fs aims to design a new tech-supported service for geriatric care. They would like this service to build on their existing expertise in the Internet of Things (IoT), Augmented Reality, and health management records.

Research (through desktop research and stakeholder interviews) was conducted to identify existing problems in geriatric care. Informal caregivers were chosen as a focus. This group, consisting of family members, friends, or other non-professionals taking care of the elders, already provides the majority of geriatric care and is only expected to become more important in the future as the strain on the healthcare system grows. However, due to the informal nature of their care, their work often goes unrecognized, and the group remains underserved with regards to solutions that could support them. We argue that the development of new technology-supported solutions is especially appropriate for this group.

Informal caregivers experience most distress from care for patients with dementia, and this group was thus chosen as a focus. The burden of informal care is especially high for this group, for example, due to the constant need to check up on the patients and the continuous progression of the disease. Smart home monitoring, i.e. monitoring the elders remotely with sensor technology, would decrease the need for caregivers to be physically present or constantly be attentive to the patients, thereby decreasing their caregiving burden. However, current smart home monitoring solutions are insufficiently adapted to this target group, as they fail to address dementia-specific needs adequately, can be overcomplicated or insufficiently versatile, et cetera. Therefore, this causes a market gap, which we aim to fill with our Dementia Monitoring Starter Kit.

The Dementia Monitoring Starter Kit consists of a Smart Mirror that serves as a remote communication channel with the patient, as well as a variety of sensors through which the patient can be monitored. The data from these devices gets sent to an app for the caregiver(s), which, enabled by AI, provides them with insight on how the patient is doing and alerts them in case of atypical events that may require intervention. Furthermore, the app aims to give insight into the disease progression. A customizable set of sensors based on a subscription model, the kit is easily adaptable to the needs and wishes of each caregiver and patient. The kit allows for the caregiver to save time attending to the patient while still keeping the situation under control, and gives caregivers and healthcare professionals more insight into the patient's functioning and cognitive health. The solution furthermore aims to be simple to use for the patient and caregiver. In the future, integrating the kit with formal care systems and distributing it through (local) governments could boost urban resilience.





2. Case description and problem statement

3fs is interested in developing a new technology-supported service for geriatric patients.

2.1 About 3fs

Digital IT studio 3fs provides consultancy services and launches independent ventures. A Slovenian company, it also has offices in the Nordics and Canada. 3fs specializes in digital transformation, with expertise in Web and Mobile development, VR/AR/MR, Cloud computing, IoT, and Blockchain.

Two of 3fs's successful startups in the medical field are Iryo and Awake. Iryo offers a healthcare application platform, while Awake offers immersive clinical simulations with AR. Next to this, 3fs has an ongoing project about IoT platforms connecting medical devices: the solutions help medical personnel and support them during their work. These devices are sensors that measure environmental parameters for offices and emergency vehicles. The data from all of this is brought into a healthcare management system. Furthermore, 3fs is developing new AR applications, such as an upgraded version of Awake, and a tool for ER doctors to remotely perform virtual preliminary checks to patients that are still in the ambulance.

3fs is preferably looking to use all of this experience with AR, IoT, and health data management systems as building blocks for the new service.

2.2 About the case

Geriatric healthcare is a specific branch of medical care that focuses on planning and coordination of the care of the elderly to understand how to accommodate their care needs for their long term well-being. Recently, the high death toll of the coronavirus epidemic in Slovenia highlighted the flaws of the local geriatric care system. This inspired 3fs to look into the use of digital technologies for geriatric care, which it believes can better address the needs of geriatric patients.

Apart from its preference for technologies to focus on, 3fs has left this case open in terms of what problem should be addressed or how a solution should be shaped. The geographic market was also not



specified; In this report, the focus will be on Europe in general, as 3fs is active in Slovenia and the Nordics.



3. Problem framing

3.1 The field of geriatric care

The world's population is aging, with virtually every country experiencing an increasing proportion of elders in their population. In the EU, currently, over 20% of the population is aged 65 and over (Eurostat, 2020); By 2060, this number is projected to reach 30% (Probst *et al.*, 2015). Due to the accompanying shrinkage of the working-age population, more and more elders will be dependent on a smaller group of working people. This trend increases the burdens of healthcare and social care systems of these countries.

In 2012, the EU-wide geriatric care market was estimated to amount to around 65 billion EUR (Probst *et al.*, 2015). According to the European Commission, public spending on long-term care is projected to double the figure from 2010 by 2060, accounting for over 3% of the EU GDP (Probst *et al.*, 2015).

The growing sense of urgency associated with the challenges that this population aging, especially keeping care available and affordable, can be seen in the recent initiation of aging-related policies across a wide range of sectors (United Nations, 2017). The proliferation of new technical solutions for geriatrics, so-called *age-tech*, is also a clear example.

3.2 Stakeholders

A large number of stakeholders are involved in geriatric care. We would like to highlight the following major stakeholder groups:

1. **Healthcare professionals** - All professionals involved in the care of geriatric patients, whether this is their specialization or otherwise. Next to medical professionals, this includes people working in retirement homes or other social care facilities, that provide medical and non-medical care to geriatric patients.
2. **Informal caregivers** - Family members, friends, or other people that are involved in taking care of geriatric patients. While healthcare is commonly understood as those services provided by healthcare professionals, more care is provided informally for geriatric patients (Verbakel *et al.*, 2017).



- Patients** - The geriatric patients themselves. This is a very diverse group, with varying care needs.

The position of and collaboration between stakeholders differ largely between countries. For example, in Slovenia, within the healthcare professionals stakeholder group, there are no medical professionals that are specifically trained for geriatric care, nor are there dedicated hospital departments. Furthermore, medical and social care are poorly integrated. These factors lead to issues in the wake of the Covid-19 pandemic as mentioned previously.

The setup of long-term care also largely differs between countries: For instance, in the Netherlands, the vast majority of care homes are private non-profit institutions, in the UK most are private for-profit, and in the Nordics, the majority is public (Brame, 2020). In various countries, the reliance on informal care differs widely as well. In Figure 1, statistics on the number of informal caregivers in various European countries is shown; As is visible, the Nordic countries have high percentages of informal caregivers compared to countries like Hungary.

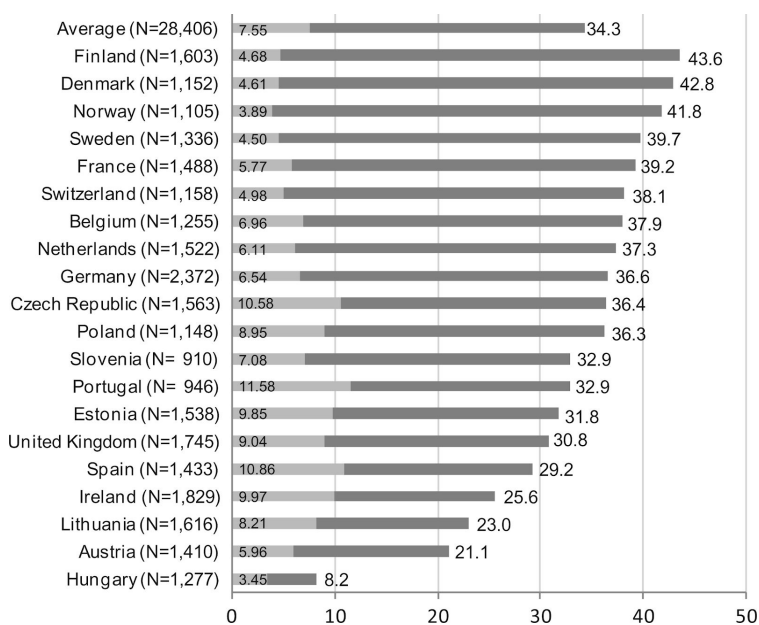


Figure 1: Prevalence rate of informal caregivers by country (%); intensive caregivers (over 11 hours a week) are marked in light grey. Reprinted from "Informal care in Europe: findings from the European Social Survey (2014) special module on the social determinants of health" by E. Verbakel, S. Tamllagsrønning, L. Winstone, E.L. Fjær and T.A. Eikemo, 2017, The European Journal of Public Health, 27, p. 91.

3.3 Problems in geriatric care

As touched upon earlier, there are a variety of problems in geriatric care. The aforementioned stakeholders all have their own challenges related to providing geriatric care services. Because, as explained previously, such varying situations exist in different countries, some of these problems may differ depending on the location; However, there are also many problems that transcend borders. A



(non-exhaustive) list of problems identified from desktop research and stakeholder interviews is presented in Figure 2.

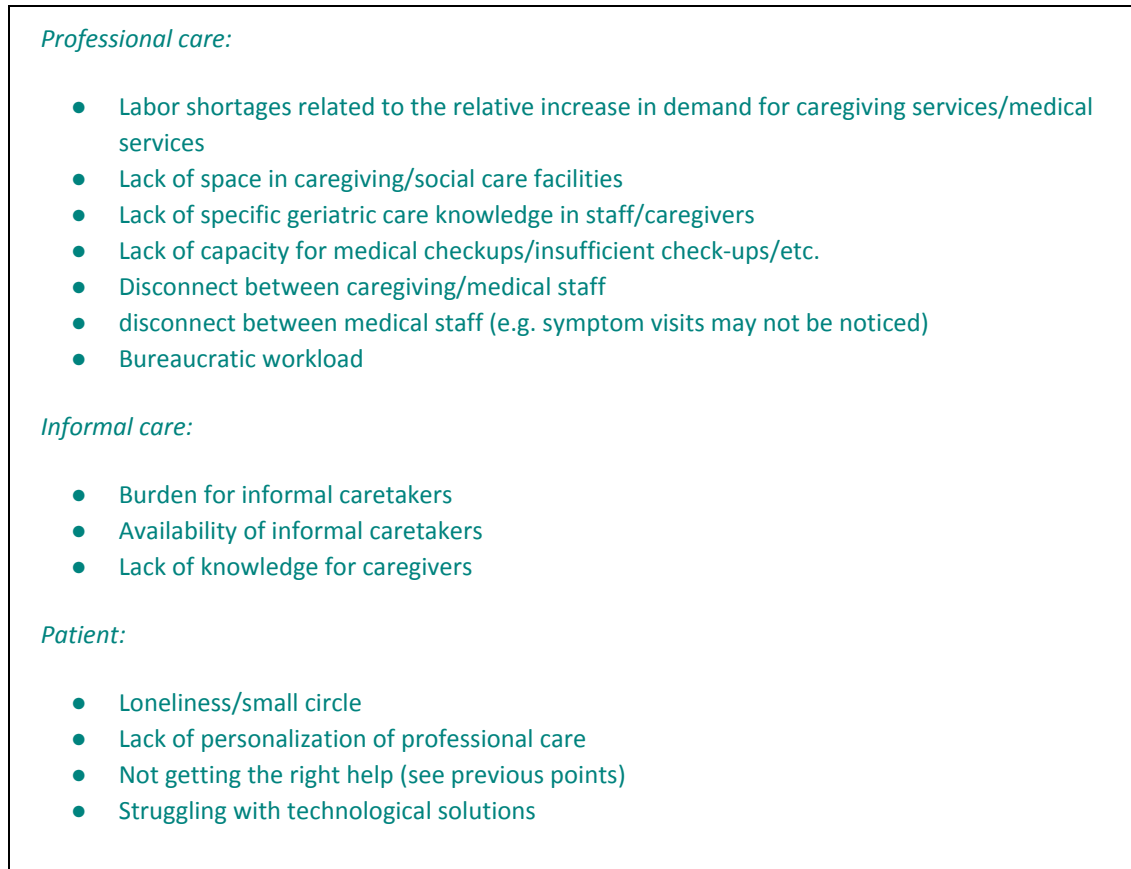


Figure 2: List of some of the various problems, found in literature and through interviews, that are faced by the three identified stakeholder groups.

As said, the group of geriatric patients is very diverse, and so are its challenges and needs. Next to this, various other stakeholders all also have their own problems, which again largely diverge for subsegments of the stakeholder groups, what patients they focus on, et cetera. Though Figure 2 only shows a limited overview, its breath shows that there are many aspects of geriatric care that could potentially be improved, and thus also many aspects where a technology-supported service such as what 3fs is looking for could be used. However, to think of meaningful solutions, we needed to limit our scope.



3.4 Defining our focus: Informal caregivers and dementia

After our research, we decided to focus on **informal caregivers** as our initial target group. This group was particularly interesting to us for a variety of reasons.

Firstly, It is a very large group: It is estimated that between 10 and 25 percent of the total population in Europe gives informal care, though estimates vary widely between (groups of) countries or how informal care is defined and measured (Zigante, 2018). Informal caregivers are critical to the quality of life for patients and is seen as a cornerstone of geriatric care. Furthermore, in the future, the need for informal caregivers will only grow, as labor shortages in professional care force elders to live at home longer. Thus, by facilitating informal care, the strain on professional caregivers can also be reduced indirectly.

Secondly, the importance of informal care currently often remains undervalued both socially and economically (Oliva-Moreno, 2019). There is little attention to the problems that this group has, and for initiatives that increase their position. Overall, this group thus remains underserved.

Thirdly, informal caregivers may be the group that is most receptive to technological solutions. Professional caregivers are a notoriously difficult group to target, as hospitals and other care institutions often take years to commit to technological projects, and have to deal with limited budgets and many regulations. Many patients themselves struggle with new technologies, making them a difficult group to target as well. Informal caregivers, however, are often younger, have less personal impairments, and more used to or capable of dealing with technological products.

Based on these factors, we (in consultation with 3fs) decided to focus on solutions aimed at informal caregivers.

There are many aspects of care that informal caregivers struggle with. The Canadian Institute for Health Information (2010) found that nearly one in six patients receiving informal care have had caregivers experience distress related to their role. They found various factors that influence the likelihood of caregiver distress; For example, higher numbers of hours of care correlates with more distress (for example, people with received over 20 hours of informal care were four times more likely to have distressed caregivers than those who receive less than 10 hours of care), as do factors like possible depression and medical instability. The most important factor that they found, however, was patients having cognitive impairments such as **dementia**, which we settled on as our patient group of focus.

These results are logical, as caring for someone with dementia poses a high burden on caregivers, which has been found in many studies (Brodaty & Donkin, 2009). Caring for patients with dementia is associated with long care hours and physically demanding caregiving. Two main difficulties in the care are the constant need for monitoring or attending the patient, a lack of knowledge about the disease and its evolution (Kucmanski *et al.*, 2016).

Next to being arguably the most difficult group to take care of, dementia care is also a very large market. Worldwide, almost 50 million people live with dementia (World Health Organization, 2019). This number is expected to grow to over 115 million by 2050, possibly making it the most expensive disease of our society (Boots *et al.*, 2014). Currently, the majority of people with dementia still live in the community,



and for 75% of them, informal care is provided (Brodaty & Donkin, 2009). Considering this, solutions that help these patients to stay at home longer are highly sought after.

To get more insight into problems caregivers face and how technology can assist them, we conducted interviews with five informal caregivers that give or gave care to patients with dementia.



4. Root causes

4.1 Underlying problems of informal caregivers for people with Dementia

After completing interviews with informal caregivers who had to take care of their loved ones with dementia and our market research, the following are the problems we identified:

- Monitoring: A need to monitor the elder's location, whether the elder is doing their tasks, for example, if they are taking their medication
- Lack of social contact: During this condition, the elder lose social contact over time and stop talking with their peers and their family, as they feel secluded by their condition
- Not taking initiative anymore: The elderly stop taking the initiative of doing tasks, going out over the course of the condition
- Not knowing how to deal with dementia: The informal caregivers do not know how to deal with elderly who have dementia, e.g. when they keep repeating themselves and the situation gets worse
- Living far away from family members: Many times, the caregivers of these elderly live far away due to their jobs or their studies and cannot be there to take care of their parents at their home
- The burden of informal care, frequent need to check up on patients: This leads to the fact that, due to work and other commitments, they are unable to check up on the elderly frequently
- Lack of insight into disease progression: The informal caregivers do not have any insight into the various levels of dementia and do not have a means by which they can monitor the cognitive health of the elderly
- Patients' struggle with new technology: There is a real struggle to educate the elderly about new technology, especially, existing solutions that need elderly to interact with smartphones, which is a very steep learning curve for them, especially, given their ailment
- Covid-19 pandemic: Especially during these exceptional times, there is a need for means of taking care of the elderly remotely



4.2 Settling on the field of solution

After identifying these problems, we felt like the best field of solution to tackle the mentioned problems would be through “Smart Home Monitoring”, as it tackles these problems head-on, and also the fact that 3fs already has professed in implementing IoT solutions means that it would almost be a relatively easy solution for them to implement.

4.3 Field of smart home monitoring

The field of Smart Home Monitoring is the use of devices in the home that connect via a network, most commonly a local LAN or the internet. It uses devices such as sensors and other appliances connected to the IoT that can be remotely monitored, controlled, or accessed and provide services that respond to the perceived needs of the users. The technology was originally developed by IBM and was referred to as Predictive failure analysis (Computer Hope, 2018). The first contemporary Smart home technology products became available to consumers between 1998 and the early 2000s. Smart home technology allows users to control and monitor their connected home devices from smart home apps, smartphones, or other networked devices.

We felt like this technology would be perfect for monitoring and further diagnosis of elderly with dementia because it is so versatile and also the fact that the data from these sensors can be used for further diagnosis by medical professionals as well as be handled with care and security by 3fs, given their profess in IoT software and Data Security.

4.4 Competitors

The market is saturated with many products focused on smart home monitoring, but there are very few and far between, focused on solutions for the elderly. Main competitors (Startus-Insights, 2020) include:

- Justchecking (<https://justchecking.co.uk/>): A United Kingdom based startup that is working on smart home monitoring, specifically tailored to track the location of the elderly within the house, i.e, which room of the house at the current moment. They also work on products related to movement monitoring. Although it is tailored to elderly, it is just one product and not a versatile solution.
- Lorex (<https://www.lorextechnology.com/>): A Canada based video surveillance company that has many products tailored for smart video surveillance and monitoring including high resolution cameras that can output night vision/thermal vision, wireless DVR systems. Although this company produces products related to smart home monitoring and these products can be tailored for use related to monitoring of elderly, it is not focused on their needs.
- Grandcare Systems (<https://www.grandcare.com/>): A US (Wisconsin) based company that works on “Home Monitoring System For Elderly” that includes wireless health devices, activity monitoring and social engagement. They are mainly focussed on the Senior Homes/Community



market. Although their solution is quite comprehensive, it requires a lot of education on the part of elders, which is especially difficult in the case of dementia.

- TrueSense (<https://mytrusense.com/>): A US (Ohio) based company that focuses on passive monitoring for the elderly and does have quite a comprehensive solution that is focussed on motion sensor based tracking of elderly in the senior home, and also brings water and temperature sensors into the mix for further monitoring. But, it is a solution that is not dementia-focused.
- Carepredict (<https://www.carepredict.com/>): A US (California) based company that develops Tempo, a wrist-worn bracelet with a microphone and speaker, along with sensors that detect activities of daily living (ADL). It uses Artificial Intelligence algorithms to sense ADLs such as eating, bathing, grooming, tooth-brushing, walking, sitting, sleeping, etc. and to communicate wirelessly with beacons in order to pinpoint the rooms, where the activities are occurring. Although this solution is quite comprehensive, it requires the elderly to wear a wearable each and everyday of their life and elderly are not very receptive to new technology and making it part of their daily habits. This solution is also not really focussed on addressing the problems of elderly with dementia.
- CanaryCare (<https://www.canarycare.co.uk/>): UK based Canarycare is the one competitor to watch out for, offering sensor and monitoring packages based on needs of patients and caregivers. But, one major gripe is, they still focus on old age homes as their main market, rather than informal caregivers, and are not dementia-specific.
- Howz (<https://howz.com/>): Another UK based company that offers smart home monitoring solutions tailored towards the informal caregivers worried about self-isolation of the elderly they take care of. Their kit works based on the data received from door sensors, motion sensors and smart plug. While this solution is tailored to the right audience, it is not domain specific and not as versatile.
- Telekom Slovenije (<https://www.telekom.si/zasebni-uporabniki/ponudba/e-oskrba>): Major Telecom company in Slovenia, Telekom Slovenije, that is aimed at providing a more independent living at home for the elderly and focuses on a system that enables the elderly to call for help. This support is given by the telecom company and aims to monitor smoke and water detection at the elderly's home. It is not a comprehensive solution for the problem it addresses.

After doing some good Desktop research on the current competitors in the market, we found that there are quite few competitors, in North America, Europe, even one in Slovenia. But, we found that all of these solutions were either:

- Not focused on dementia-specific needs
- Not versatile
- Overcomplicated products
- Needed education of elderly
- Not a comprehensive solution



4.5 Identified market gap

This means that, if implemented well, 3fs's new solution would be the most versatile solution tailored to Dementia patients and caregivers.

Our research into Dem@Care (Dem@Care, 2020), a research initiative funded by the European Union gave us a lot of insight into how IoT can be used for the further good of elderly facing dementia. The objectives of this project are to determine a prioritized list of feasibility and functional specifications to enable the identification and development of valuable services to people with dementia as well as to provide personalized behavior interpretation with the use of intelligent analysis and dynamic knowledge structures, correlating and semantically integrating results of the multi-sensor analysis with clinical and personal knowledge.

This project perfectly illustrates how Smart Home Monitoring and IoT when done correctly can act as a loop for people with dementia and their informal caregivers to monitor and assess their cognitive and behavioral status as well as a loop for dementia clinicians to provide objective observations regarding the health progression of the person with dementia and medication effectiveness, warn about trends closely related to dementia.

This brings us to how we shaped our solution, which will be covered in the next section.



5. Main proposal for a potential solution

We recognized that many of the existing solutions that are provided are lacking the understanding that the context in which their products will be placed vary widely case by case, and can change a lot over time with the progression of the patient's dementia. Therefore, any form of solution that does not allow personalization will remain unadopted or just partially adopted by their potential customers.

With this consideration in mind, we decided that our solution would focus on decreasing the gap between the elderly and the caregiver, by providing a communication tool, a *Smart Mirror*, and multiple sensors to enable the caregiver to keep track and receive updates about the health and daily activities of his relative. These devices and the mirror constitute a starter kit focused to help caregivers of the elderly: the ***Dementia Monitoring Starter Kit***.

To provide assistance and remote help, this ecosystem of devices is connected to an *Elderly Support* that would be available to the patient as well as to the caregiver. The binding node between sensors, *Smart Mirror*, *Elderly Support*, and the caregiver is the *Caregivers App*: through this app, the caregiver will be allowed to get insights about his relative's conditions as well as communicate with the support.

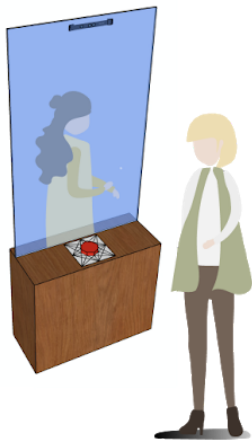
The key differentiator from already existing solutions is the focus on the **adaptability of the system**: specific trackers (such as movement or vital parameter trackers) allow the ecosystem to be personalized by the client without having to understand the technicalities related to tracking systems and local networks. The ecosystem (Figure 3), albeit modular, will have a direct connection between the different nodes of the service. The design of the service is imagined so that each part of it can be a standalone product: as Apple's ecosystem of devices thought to the tech world, a flawless service has every touchpoint optimized as such that every one of it can work by itself but, once a device is able to interact with an ecosystem, the user experience becomes terrific.





Figure 3: Schematization of how the system works: data from home sensors is provided to the app and to the support; the caregiver can call the Smart Mirror as well as receive calls from it. If the caregiver does not answer the call from the Smart Mirror, the call is redirected to the support.

5.1 The Smart Mirror



The central node of the solution would be the *Smart Mirror* (Figure 4). This device allows the caregiver to have an always-on video connection to the patient's house in order to be able to check upon his relative without requiring any interaction from the patient. Furthermore, if interaction is desired, the caregiver can video-call the patient through the mirror, or send messages from the app.

The only possible interaction that the patient can have is a single press of a button: by pressing it the mirror will directly call his relatives and, in case of no response, would connect the elderly with the *Elderly Support*.

Figure 4: The Smart Mirror



5.2 Sensors

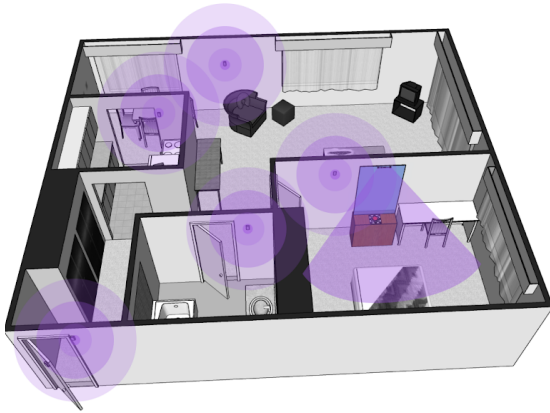


Figure 5: Example of how the sensor could be placed in the patient's house.

Once the Smart Mirror is placed in a crucial location in the house, the home sensors (Figure 5) will be allocated in key places of the house.

The exact number and type of sensors depends on the needs of the caregiver and patient. Certain sensors will likely provide value for almost any patient. For example, body sensors that track movement, sleep patterns, and health parameters will provide information about the routine and the present activity and health conditions of the patient. Other sensors can be added to the kit in case this is desired. For example, for patients that need medication for other health issues but tend to forget to take this due to their dementia, sensors that check if they have taken their medication can be added.

This data, of which the patient will be the owner, will be provided, at need, to the medical personnel by the *Elderly Support*.

5.3 Caregivers App

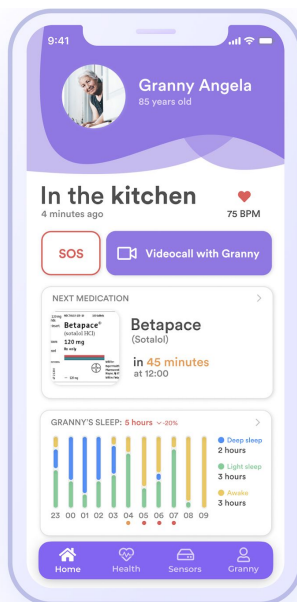


Figure 6 (left): Home Screen of the Caregiver App

To get in contact with the relative and allow them to interact and visualize the data, the informal caregiver will be provided with a smartphone app (Figure 6). One of the actions pointed out to the user will be the possibility to video-call to the *Smart Mirror*; data from the installed sensors will be computed and provided for the caregiver to assess the general health status of the patient. The Information Architecture of *Caregivers App* is structured such that in the Home screen the user is able to quickly scan through the most recent data; in the other sections of the app, the user will be able to have a deeper look into the health data, the measures from the sensors, and the patient's personal profile.

To make sure the caregiver does not need to constantly check the app to keep updated on how the patient is doing, the app analyzes the incoming data with an AI system. This system learns what normal behavior of the patient is, and can detect when something out of the ordinary is happening, which would alert the caregiver. For example, if a patient starts to get up and walk around the house in the middle of the night, or has forgotten to take their medication, this would prompt a message to the caregiver. Regarding this latter example: A burden that many caregivers have to carry is taking care of the medication schedules: thus, we thought of including the *medication tracking* feature. The AI system also tracks the progression of the patient's health and can provide suggestions about actions that need to be taken or if the situation should be discussed with a healthcare professional.

5.4 Elderly Support

As mentioned previously, elders that cannot reach the caregiver when pressing the call button will be connected to *Elderly Support*. This help desk can help the elder by asking what they were calling for. If the elder simply wanted to call their caregiver, this message will be relayed. If medical advice or emergency care is needed, the support can connect the elder with their doctors or emergency services. The help desk employees will be specifically trained to deal with patients with dementia, so that the caregiver can be sure that if the button is pressed and they do not pick up, the elder will still be in good hands.

5.5 Business model and go-to-market strategy

The revenue model we thought of is based on a subscription to the service. The price would vary based on the sensors needed by the single client. The idea here is that, because dementia is a progressive disease, caregivers may want to add more sensors as time progresses. However, similarly, if at some point the burden of the care becomes too high and the patient starts making use of professional home care or gets transferred to a caring facility, sensors could be taken away as well. Dementia can change in unpredictable ways, and with the subscription model we aim to adapt to this. Furthermore, clients can get started for relatively low prices, especially if they choose for just a few sensors at first, which makes the kit attractive to try out: An advantage for novel tech products.

Although the first needs that could drive the caregivers to adopt the solution proposed are different, the secondary needs tend to be uniform. As the caregivers meet their first need in the care of their elderly relatives, such as the need of checking up their health or making them company remotely, 3fs will leverage secondary needs by providing additional value with *upselling strategies*. Given that the needs of caregivers are different we think that a possible way to approach the market should come from multiple channels: starting with the digital, the *Caregivers App* represents an optimal way to start creating the user base to which the sensors and the *Caregivers Support* can be upsold. The app functionalities that can work without the use of sensors (such as the *Medications Schedule*) open the possibility for 3fs to gain a direct connection to those who could need the Starter Kit services. As 3fs has already approached the telecommunication market, the *Smart Mirror* could be considered as a single standalone product for caregivers in need of remote connection to elderly people. By selling it as a single product, the sensors and the service could be later upsold during the use of the mirror. Next to



this, as mentioned previously, a user that starts with a kit with few sensors can be upsold to a more comprehensive kit easily due to the subscription model.

5.6 Future possibilities

As we imagine our solution to be adopted widely, engaging the medical professionals will be the next step towards building an integrated system. Firstly, the initial development should engage doctors, to make sure that the gathered sensor data can be presented to doctors in a way that is useful for them, as current experience shows that doctors often do not know how to deal with such third-party data. Thinking further ahead, we can see that standardized healthcare records are spreading and public health services all over Europe are embracing the digitalization of medical data; we imagine our ecosystem to be able to provide useful information and be integrated into the national health records. This will need an open dialogue regarding data ownership and privacy matters that, as of now, are still in a gray area. We would eventually like to see that medical services such as the Dementia Monitoring Starter Kit can become full-fledged integrated aspects of the healthcare systems. We think that 3fs's expertise in healthcare management records and their knowledge on data privacy will facilitate them in achieving this together with healthcare professionals.

To further extend this integration, similar to the Maternity Package distributed by the Finnish government (Kansaneläkelaitos, 2020), we envision a possible partnership with local and national governments that could issue our Elderly Starter Kit, and potentially also provide funding for this. Current subsidies and grants by the EU and various governments imply that there could be potential for funding for this initiative. This formalized distribution of the kits would be a way for the government to further extend their elderly population's independence, reduce the strain of the healthcare system, and increase urban resilience.



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