



# ePRO-IoT: Optimizing Clinical Trials for Better Health

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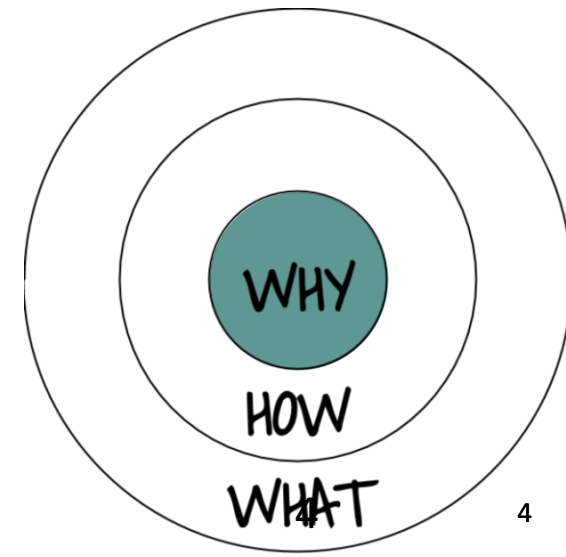
# Overview

- Digital transformation in clinical research
- ePRO-IoT solutions
- Technology acceptance: the eWALL case study
- Clinical Research 2.0

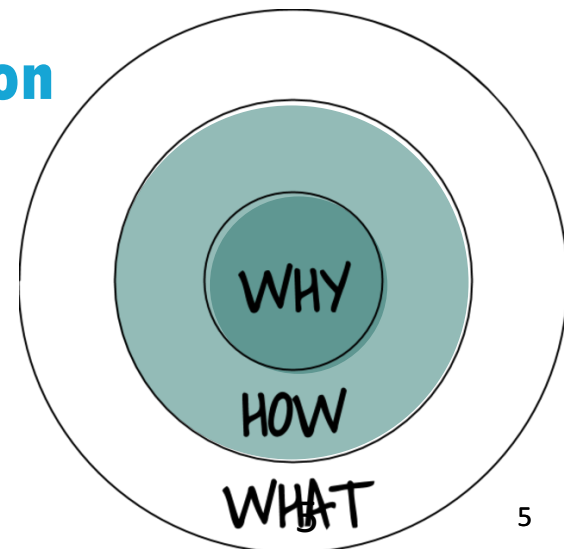
# Digital transformation in clinical research

# WHY - Digital Transformation

To embrace the **Digital disruption** happening in healthcare and implement the **Vision** to become a Data-driven company, performing better clinical research services and transforming digital disruption to opportunities and increased revenues.

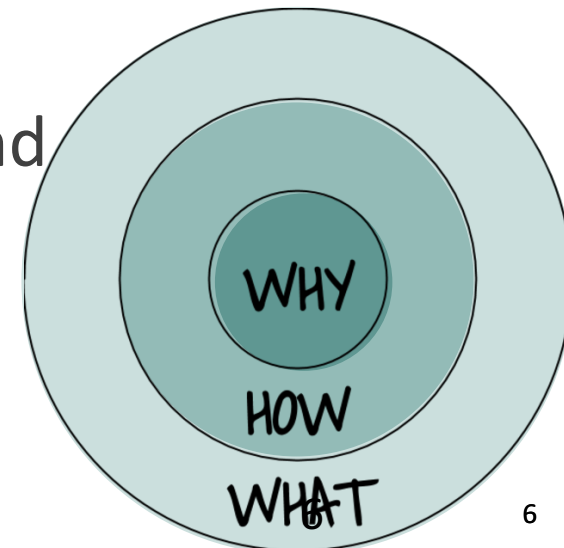


# HOW – Actionable Transformation



# WHAT – Features & Technologies

- Cloud technologies and Io(M)T
- Coaching through advanced reasoning and AI
- Engaging UI and UX
- Blockchain technologies for patients data
- Health Big Data analytics
- Business Model Innovation for new revenue streams and data monetization



# ePRO-IoT solutions

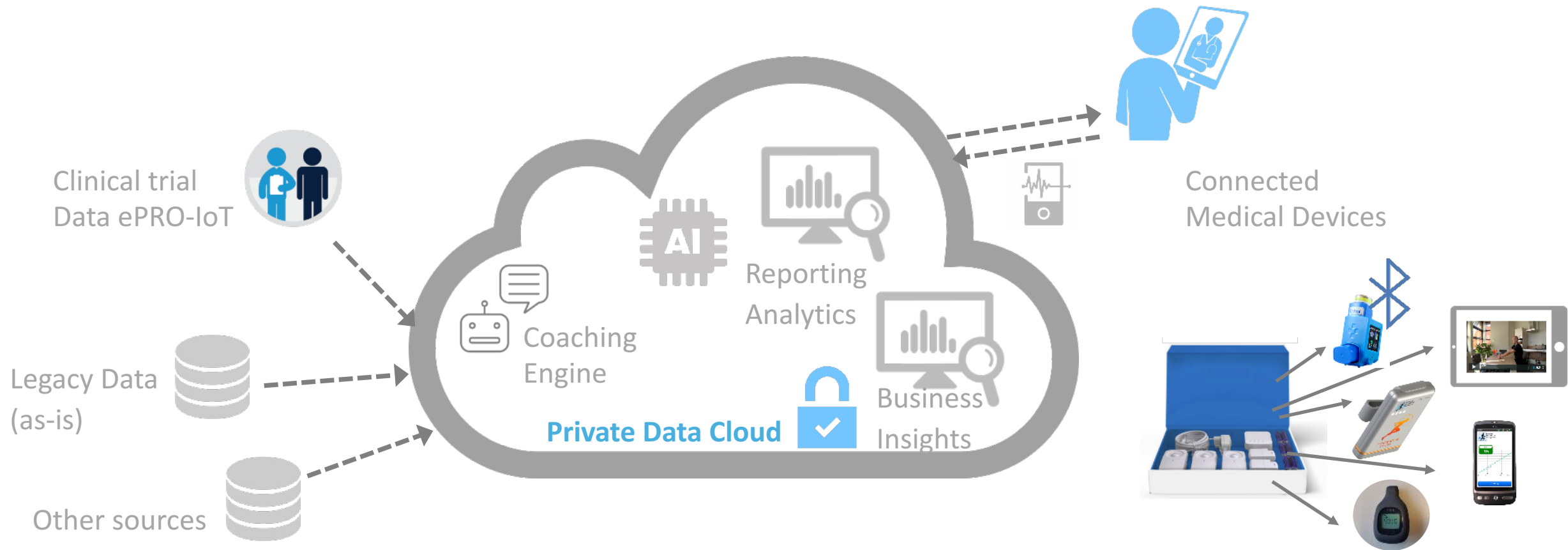
# ePRO-IoT objectives

- Increased efficiency of the study
- Reduce costs
- Evaluate lifestyle patterns and correlate with results
- Big Data analytics
- Rich datasets/outcomes

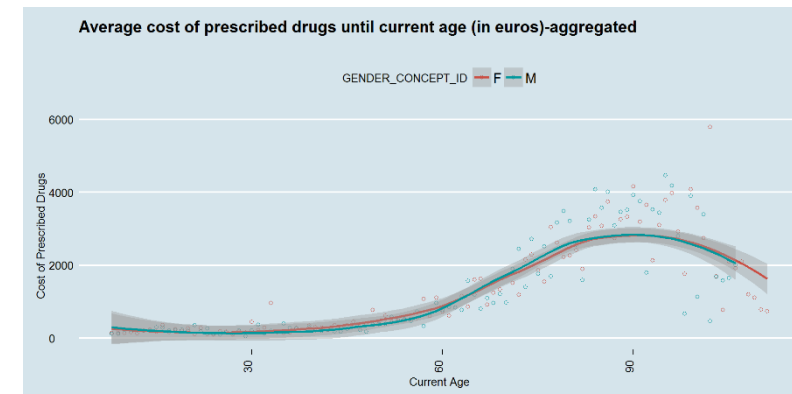
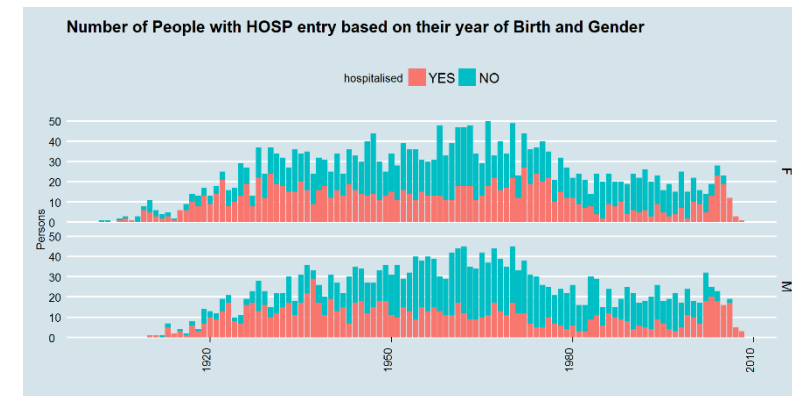
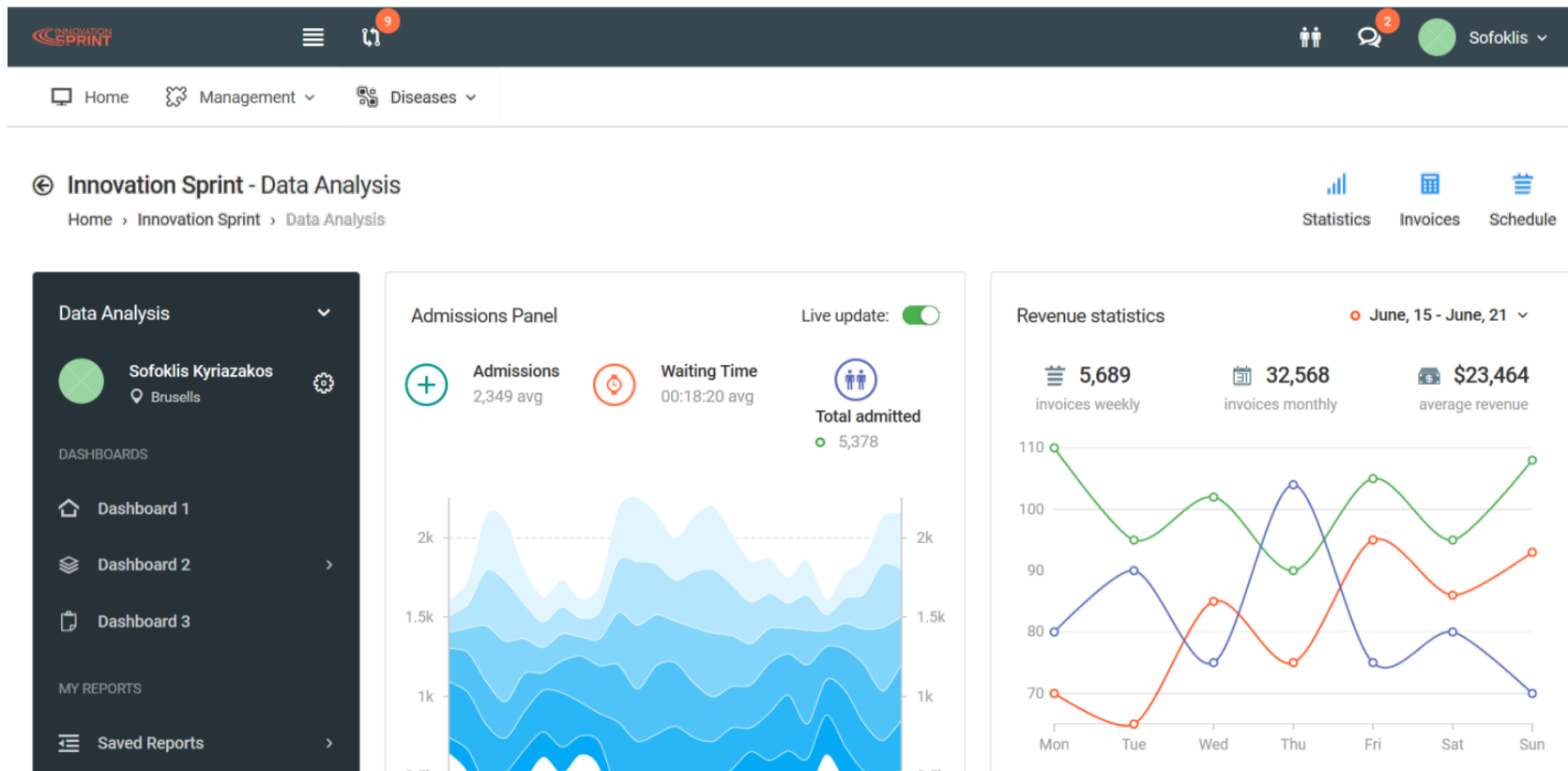
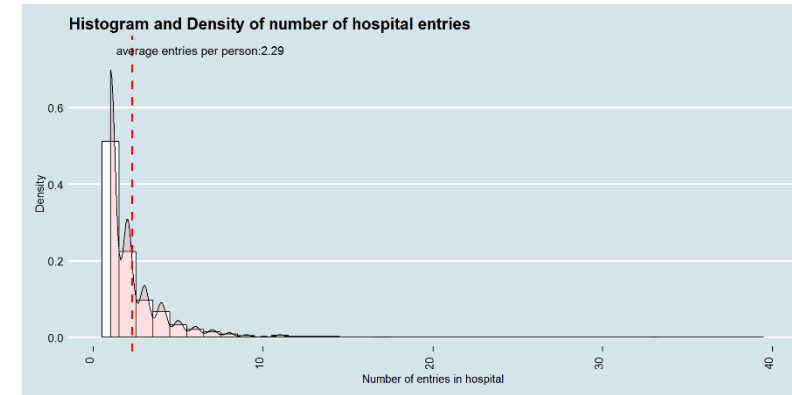
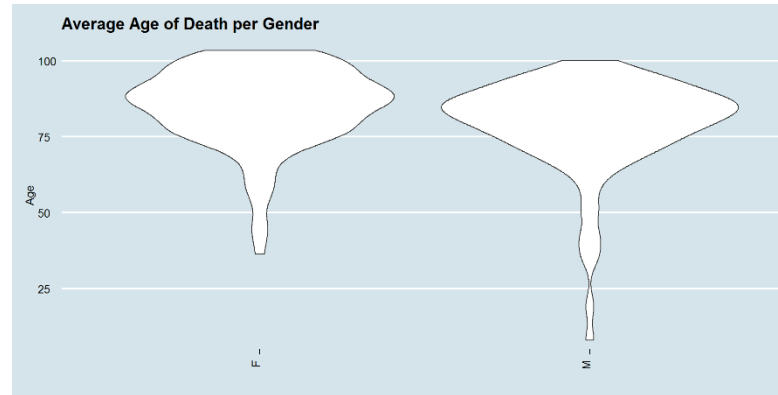
# ePRO-IoT challenges

- Study compliance and certification
- Reliability, privacy & data integrity
- Technology acceptance
- User engagement

# eRPO-IoT approach



# Big Data analytics



# Technology acceptance: the eWALL case study

*‘Addressing the difficult daily life of people with chronic diseases and frailty conditions’*

## The challenge

A group of 100+ researchers from 13 countries took up the challenge and invested about 9M€ over the past 4 years, in the project **eWall** in order to deliver a solution that could change the life of the people with **COPD, MCI** and **frailty conditions**.

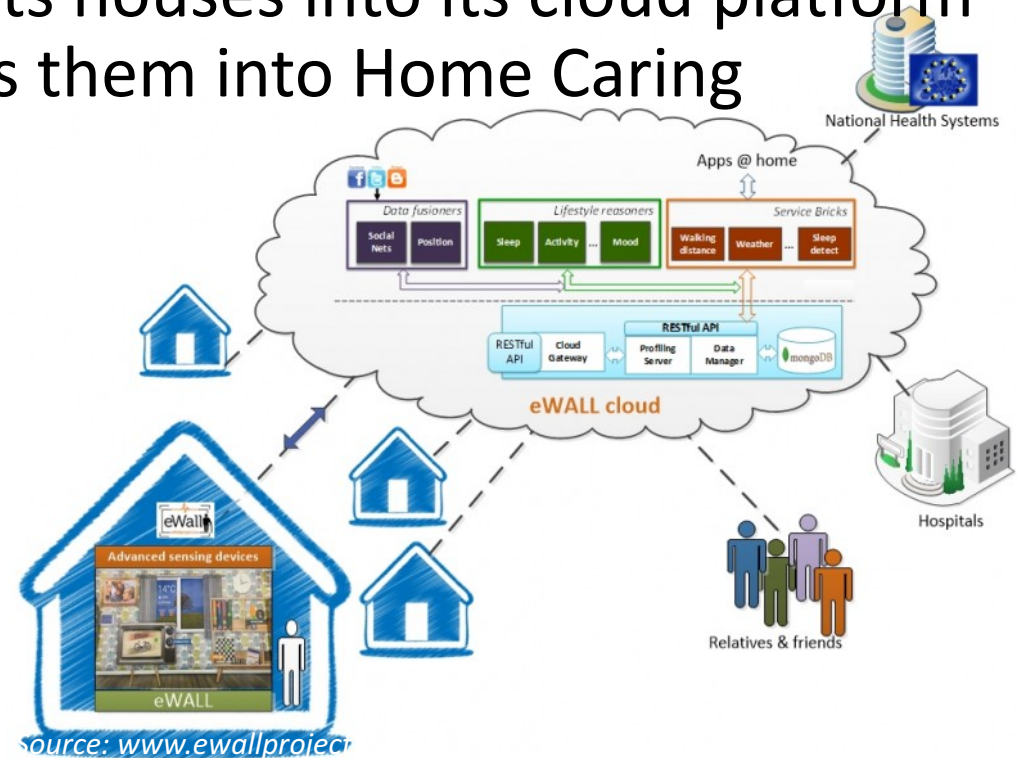
## The solution

- eWALL is a product designed specifically for people with chronic diseases or frailty giving them back a normal and safe life at home.
- eWALL is currently a mature platform that improved the life of more than 50 users during its validation phase.

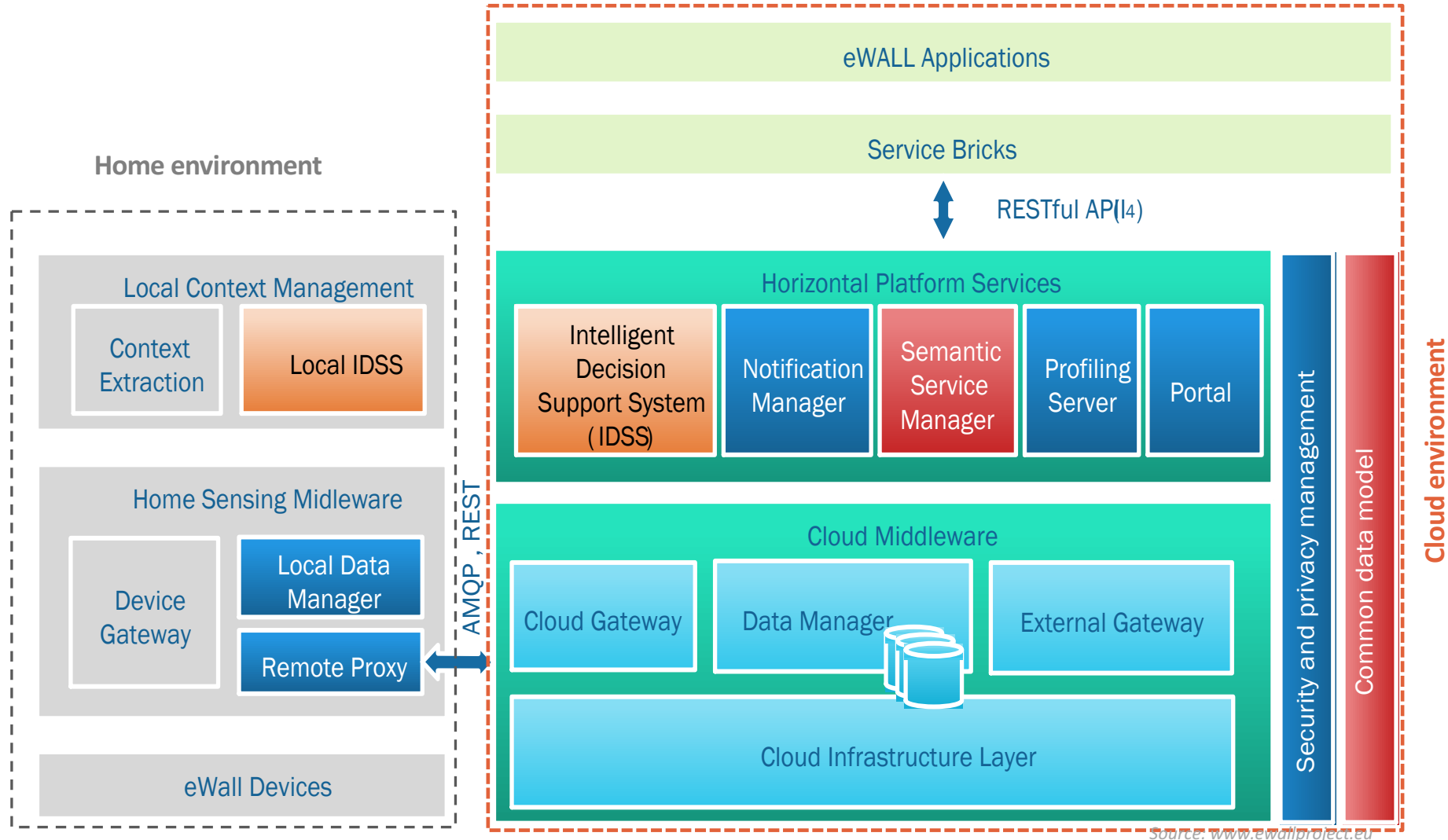


eWALL is leveraging best-of-breed future Internet technologies (cloud, IoT, BigData) to meet very demanding user needs; among them to be easy, unobtrusive and of course effective.

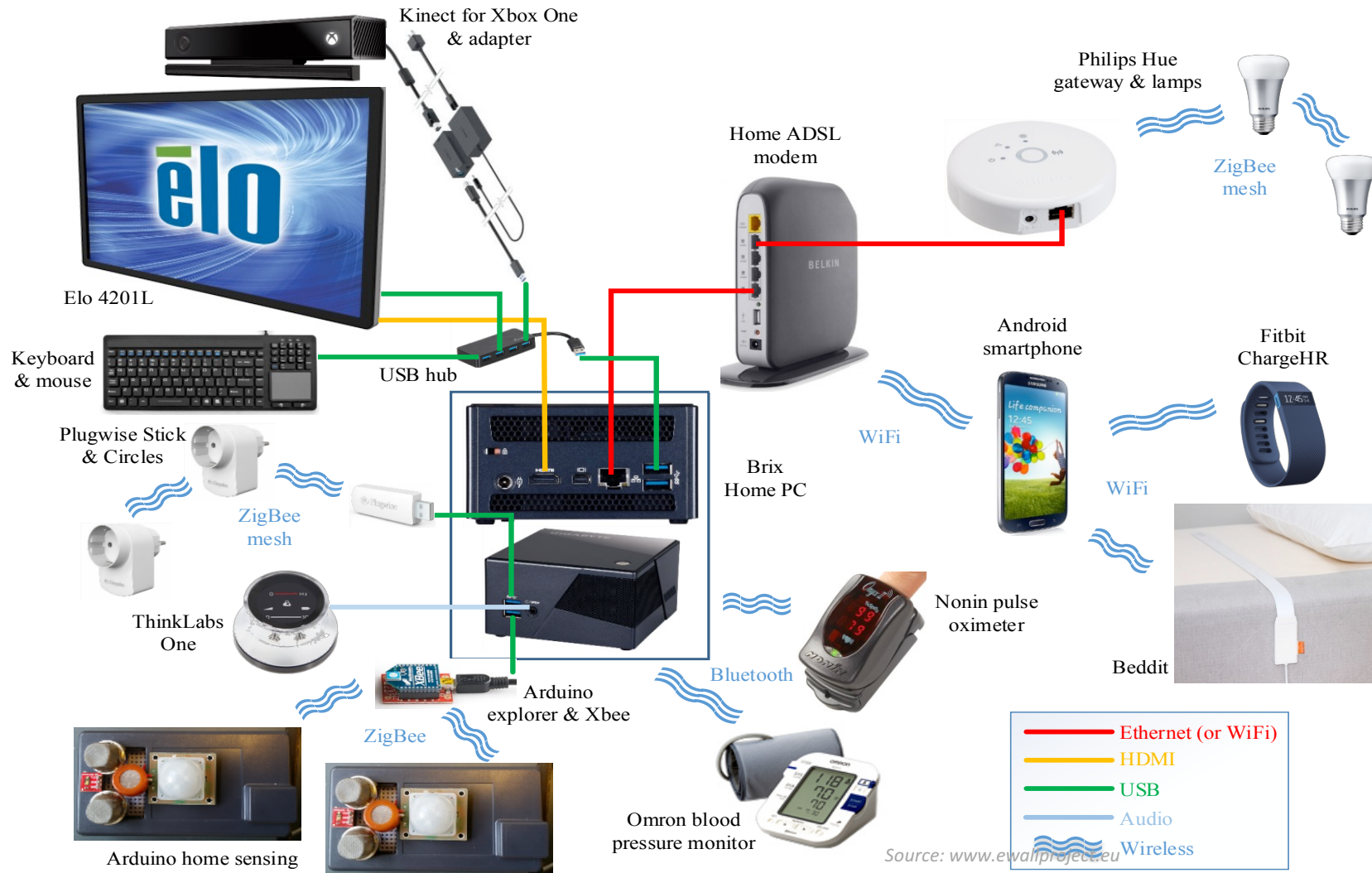
Based on an integrated sensing infrastructure, eWALL connects houses into its cloud platform and transforms them into Home Caring Environments.



# Architecture

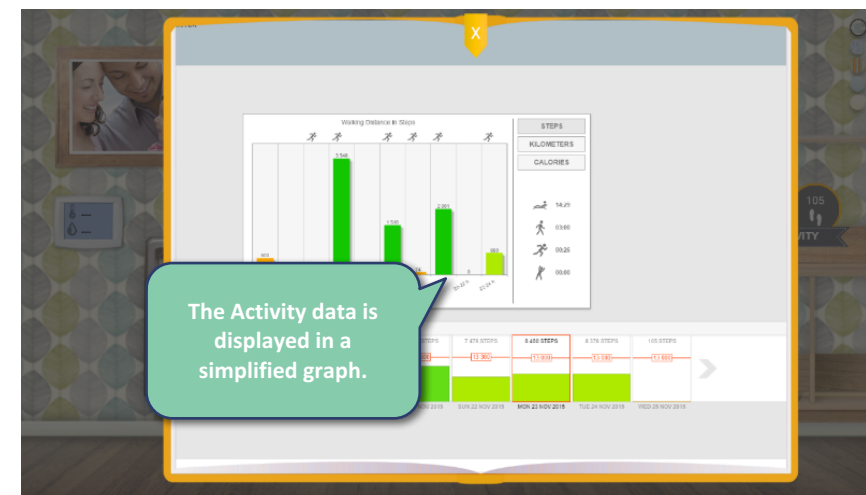


# IoT network

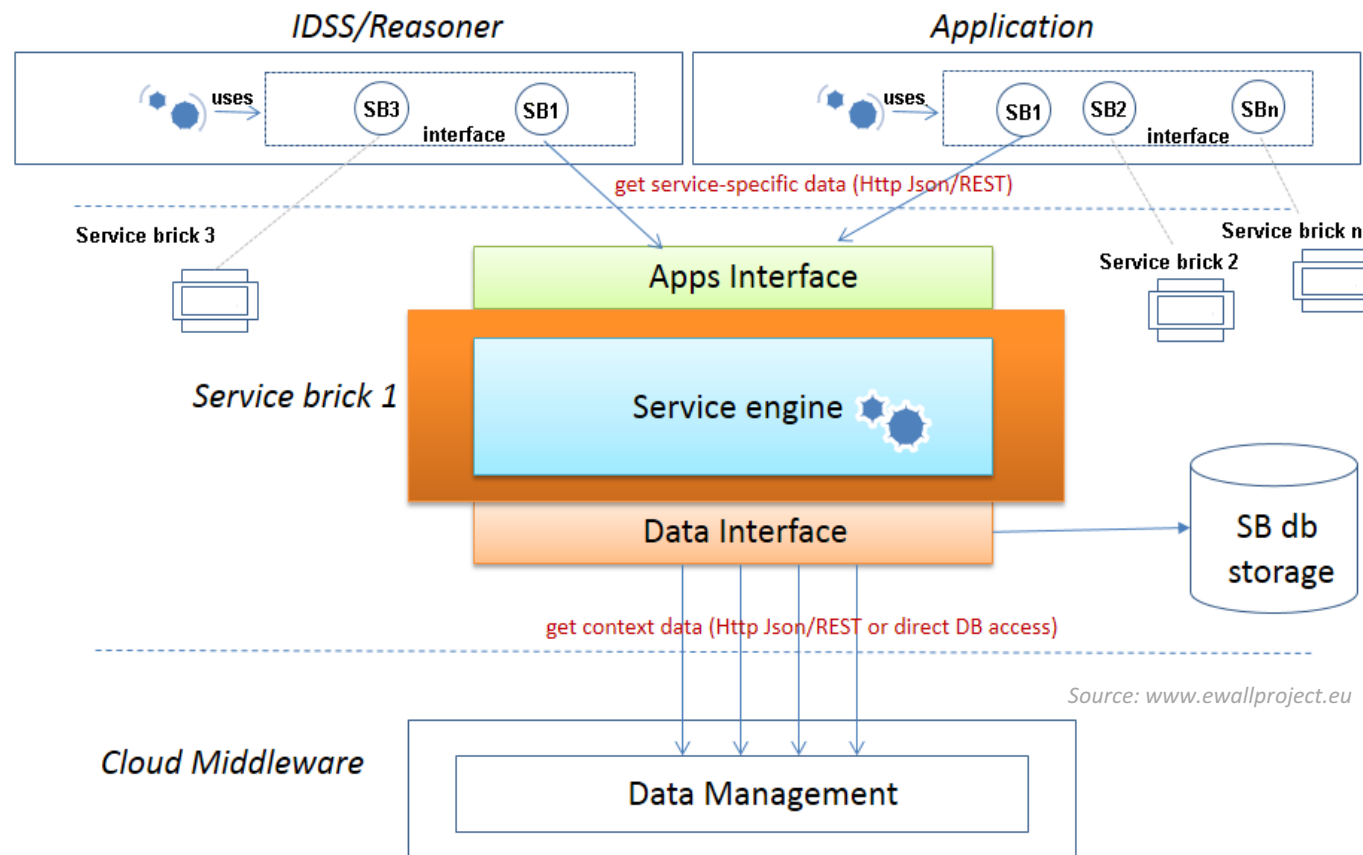


# Interaction interface





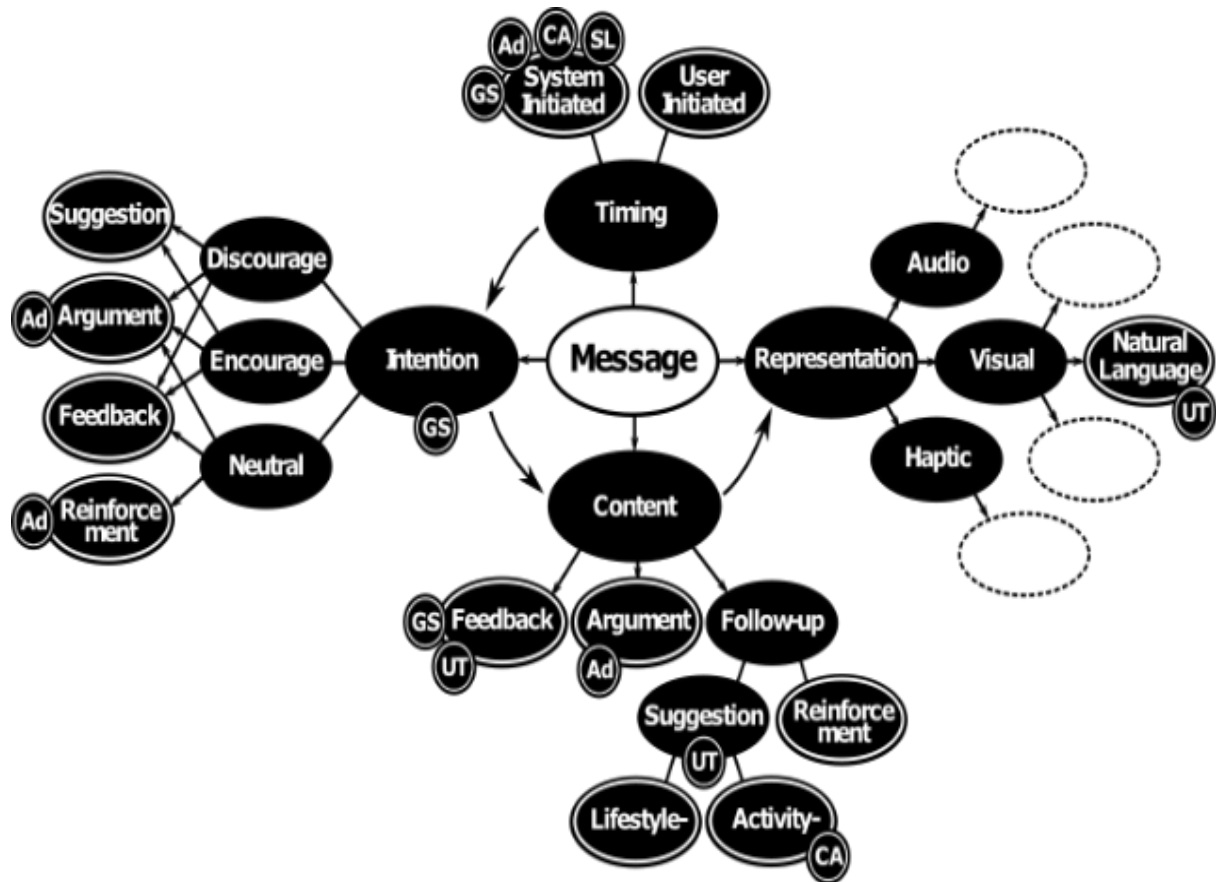
# eCoaching & intelligence



## Intelligent Decisions Support Reasoners for:

1. Automatic Goal-Setting
2. Exercise Schedule Generator
3. Sleep Anomaly Classifier
4. Oxygen Saturation Monitor
5. Fall Detection
6. Activity Coach
7. Wellbeing Ads

# eCoaching

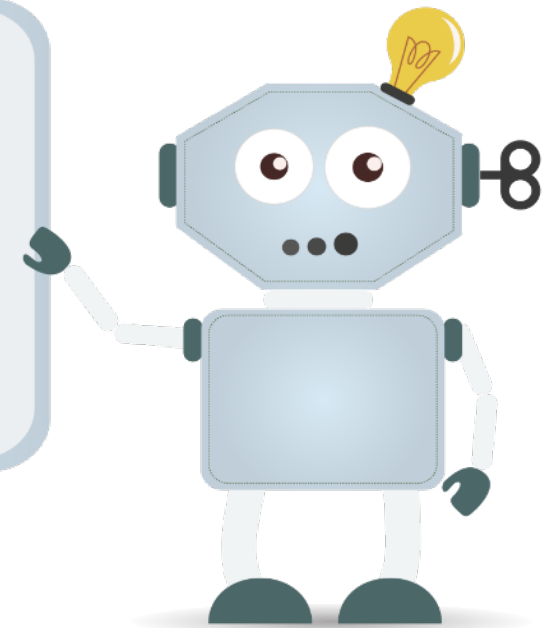


Good morning Bob!

You have done 3,427 out of 7,500 steps.

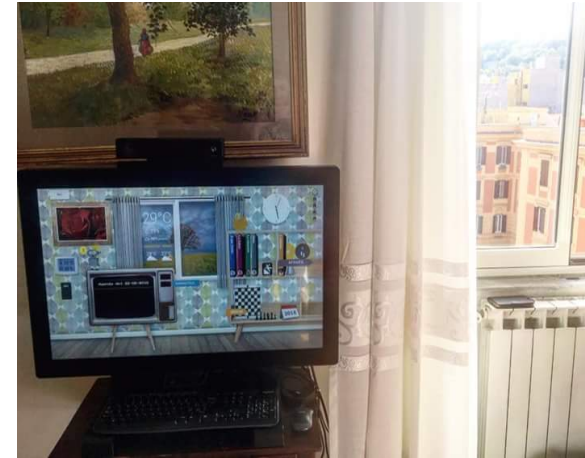
Try to reach your step goal everyday:  
healthy body, healthy mind!

The weather outside is nice, why don't  
you go cycling for a bit?



# Validation study

Large scale validation study was carried out during the eWALL project, involving subjects from 4 countries.



UTRECHT SDE, Utrecht, The Netherlands, 7th February 2018

Source: [www.ewallproject.eu](http://www.ewallproject.eu)

# Evaluation methods

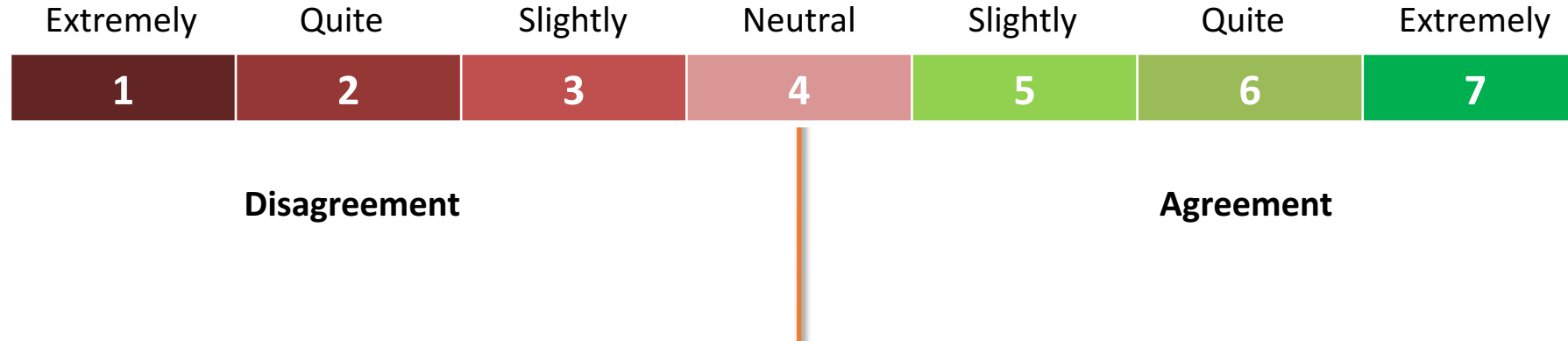
|                                                                      | T <sub>0</sub> | T <sub>1</sub> | T <sub>2</sub> | T <sub>3</sub> |
|----------------------------------------------------------------------|----------------|----------------|----------------|----------------|
| <i>User experience:</i>                                              |                |                |                |                |
| Questionnaire based on the Technology Acceptance Model (TAM+)        | X              | X              | X              |                |
| Interviews                                                           | X              |                | X              |                |
| <i>Potential clinical effect:</i>                                    |                |                |                |                |
| Quality of life (SF-36)                                              | X              |                | X              | X              |
| Instrumental Activities of Daily Living (iADL)                       | X              |                | X              | X              |
| Physical capacity (6 Minutes' Walking Test and Timed-Up-and-Go Test) | X              |                | X              | X              |

Source: [www.ewallproject.eu](http://www.ewallproject.eu)

- T<sub>0</sub> = Pre-measurement, the day of the system installation.
- T<sub>1</sub> = Mid-term evaluation moment (half-way during the trial period).
- T<sub>2</sub> = Post-measurement, final day and pickup of the system.
- T<sub>3</sub> = Follow-up measurement, 6 weeks after T<sub>2</sub>.

# User experience / TAM+

The agreement of responders to the 7 parameters assessed by the questionnaire were ranked according a **7 items scale**, with each subjects attributing a **score from 1 to 7**, meaning that he/she was extremely, quite, slightly, in agreement/disagreement with the assessment concerning the 7 parameters described above.

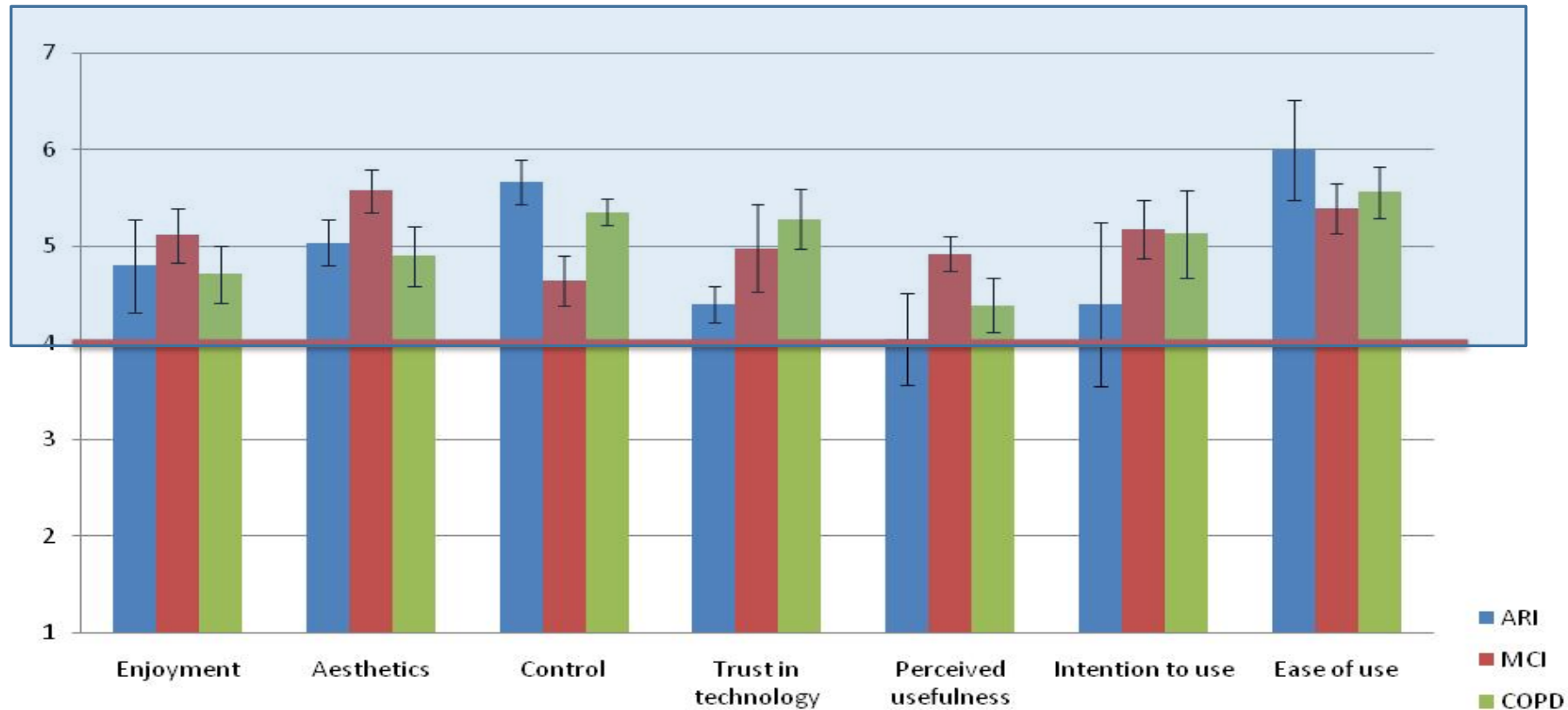


A score of 4 indicated that the subjects was indifferent to the question, and he/she had no clear opinion about that issue.

Source: [www.ewallproject.eu](http://www.ewallproject.eu)

# User experience / TAM+

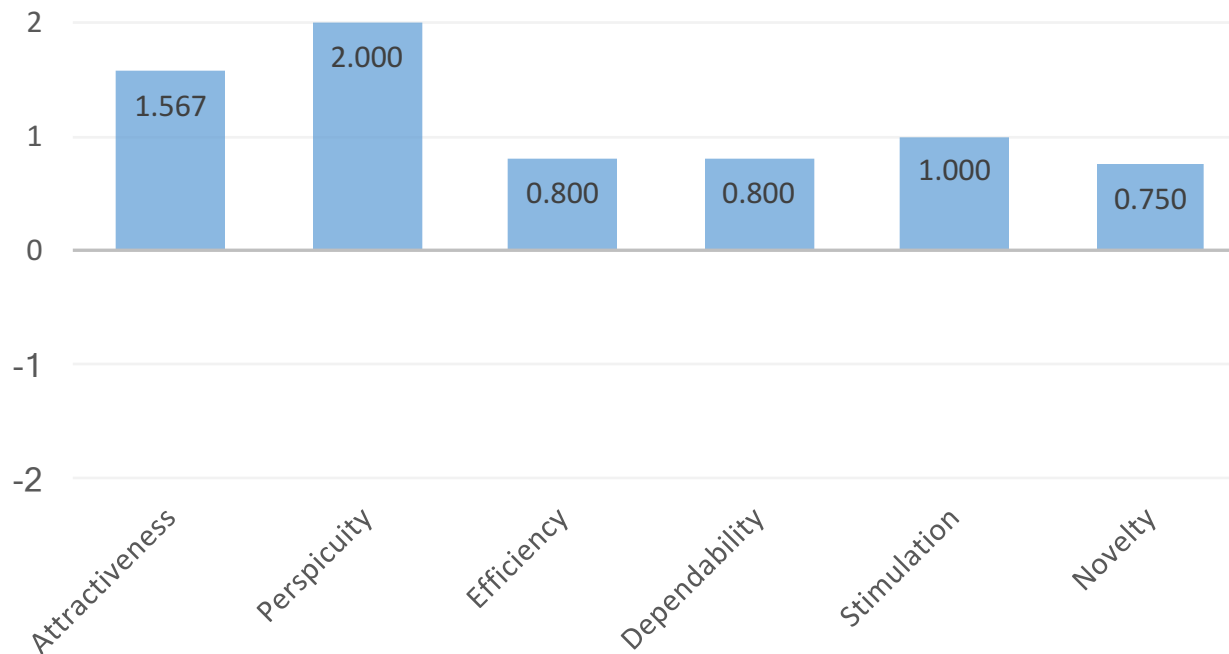
The analysis of the acceptance of the technology after using the system showed an **overall positive result over all three user groups**



Source: [www.ewallproject.eu](http://www.ewallproject.eu)

# User experience / TAM+

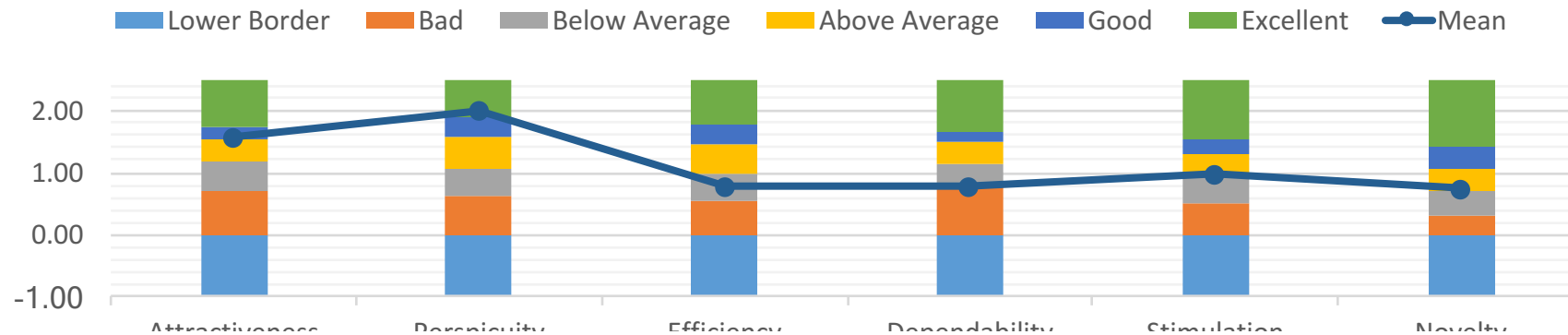
The system got a very good rating in all categories, especially for its perspicuity and attractiveness.



Source: [www.ewallproject.eu](http://www.ewallproject.eu)

# User experience / UEQ

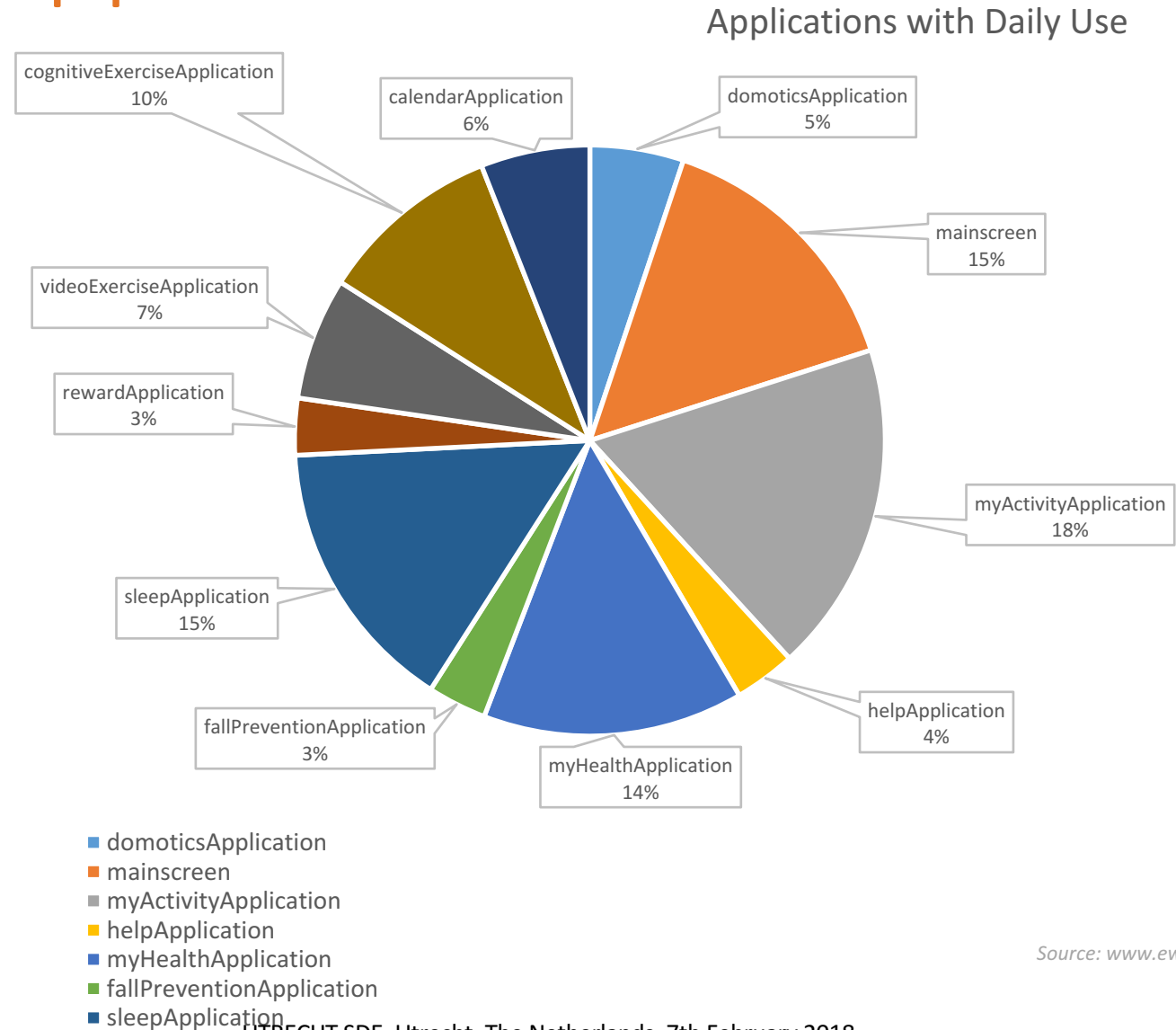
- The measured scale means are set in relation to existing values from a **benchmark data set** from 9905 persons from 246 studies concerning different products.
- The comparison of the results with the data in the benchmark allows conclusions about **the relative quality** compared to other products



- Results show an **excellent outcome for perspicuity**, meaning that it is very understandable and easy to learn.
- The participants rate the system as **very attractive, thus, pleasant and friendly**.

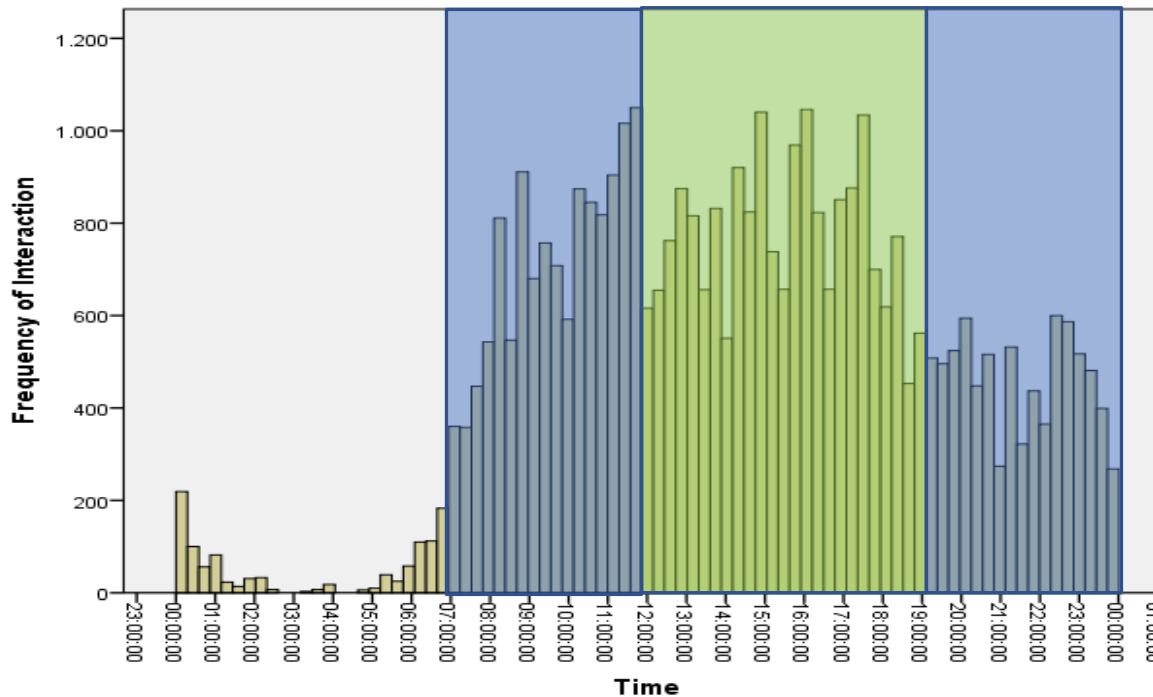
Source: [www.ewallproject.eu](http://www.ewallproject.eu)

# Use of applications



Source: [www.ewallproject.eu](http://www.ewallproject.eu)

# Use of applications during the day



Source: [www.ewallproject.eu](http://www.ewallproject.eu)

The analysis shows that interactions occur evenly over the day, picking up between 07:00 and 08:00 in the morning and showing a **stable number of interactions until 19:00** in the evening. The **evening period between 19:00 and 00:00** shows a **slightly lower, but again stable use**.

# Clinical Research 2.0

# eRPO-IoT approach



# Main User Interface



UI/UX has been validated for usability and technology acceptance in 4 countries with very positive results, using TAM+ and UEQ evaluations.

Adaptations or variations of the main UI, to meet needs of other user groups can easily be made, based on the technologies used.

# ePRO functionality

Fatigue

Indicate the degree of fatigue at this moment.

No fatigue Maximal fatigue

OK

Happiness

Indicate to what extent you have experienced the following emotions.

1 = not at all, 4 = moderate, 7 = very intense, or one of the numbers in between.

Happy, content

1 2 3 4 5 6 7

OK

Shortness of breath

Have you been short of breath?

☐ Normal

☒ A bit more than normal

☐ Clearly more than normal

OK

Finished

Thank you for answering the questions!

SLUITEN

Different  
types of  
surveys  
supported

# IoT measurements

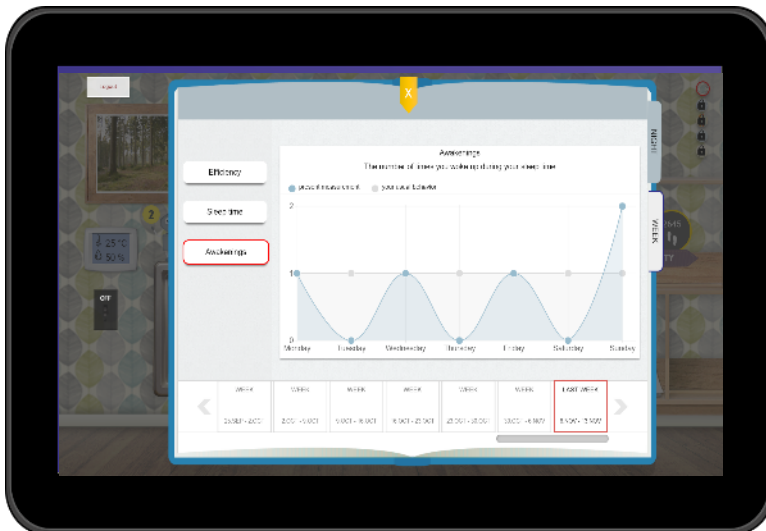
Activity tracking



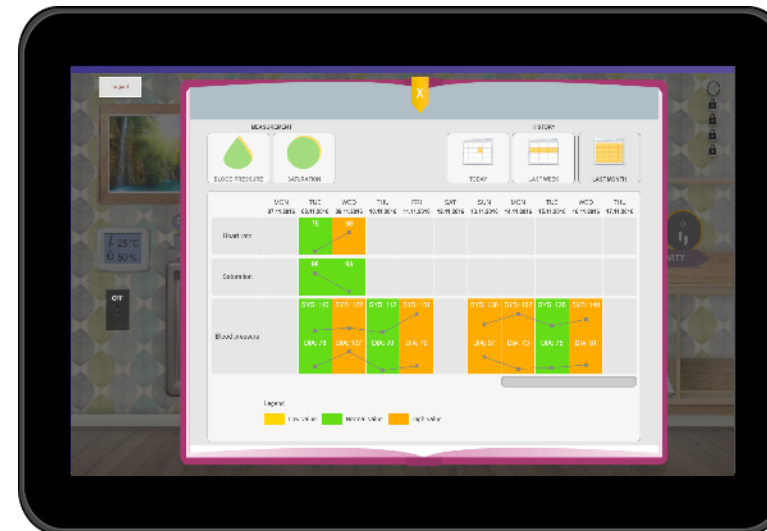
SpO2



Sleep behavior

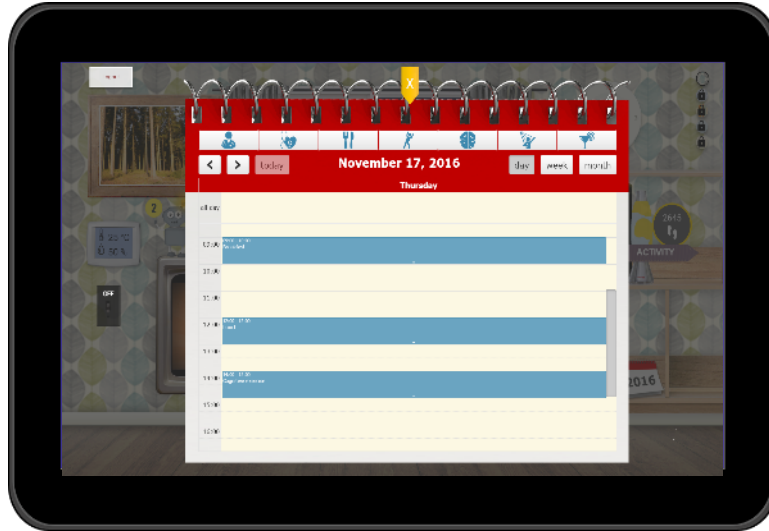


Blood pressure

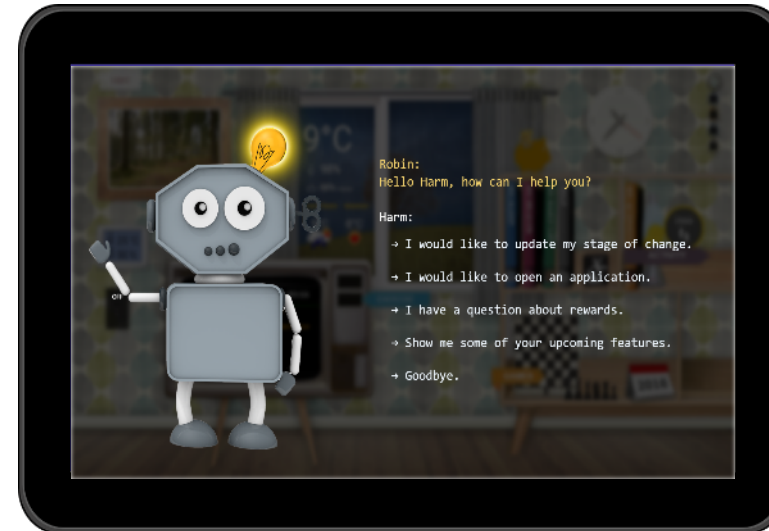


# other apps

Calendar app



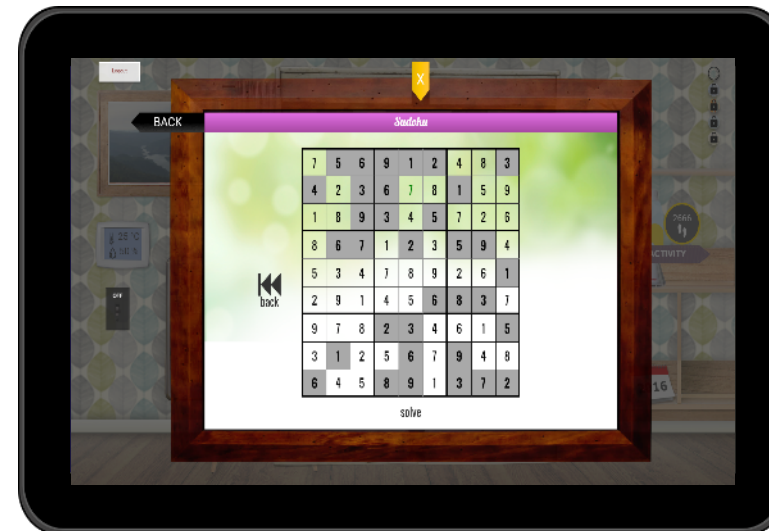
Virtual Coaching



Physical training



Cognitive games



Thank you