



D6.2 Cost Benefit Analysis

ehcoBUTLER Project

Version: 1.00
March 30th, 2022



This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement 643566

DOCUMENT CONTROL

Title: Cost Benefit Analysis
Date: March 30th, 2022
WPL responsible for the deliverable: ASBAR
Author(s): YDATA
Contributor(s): IDEA, INTRAS, CIBER, CLALIT, VIDAVO
Reviewer(s): ASBAR, NTT DATA
Distribution: All partners

Project: ehcoBUTLER (GA 643566)
Filename: ehcoBUTLER_D6.2 Cost Benefit Analysis_v01r00f

DOCUMENT CHANGE RECORD

Date	Version	Author	Change Details
29/01/2022	0.1	YDATA	ToC, Flow charts and KPIs
30/01/2022	0.2	INTRAS, ASBAR, AIMA, TME	Data provision from pilots
15/02/2022	0.3	YDATA	Further improvements and first draft of CBA
14/03/2022	0.4	INTRAS, TME, CLALIT, NTT DATA	Comments and revisions
18/03/2022	0.5	YDATA	Final draft
24/03/2022	0.6	INTRAS, EVERIS, TME, NTT DATA	Comments and revisions
30/03/2022	1.0	YDATA	Final version

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1 INTRODUCTION

1.1 Purpose of this document

The purpose of this document is to report the results obtained after the development of each Pilot, following the assessment protocol that was defined in “Task 2.6. Pilot and validation planning” during the whole pilot implementation.

The specific purposes of deliverable *D6.2* are to:

- Include a summary of the business models of ehcoBUTLER solution;
- Explain the logic models of the pilots implemented;
- Present the Cost-benefit analysis performed on the implemented pilots' data;
- Underline the main results from an economic and a non-economic point of view.

1.2 Intended audience

This document is oriented to:

- ehcoBUTLER consortium partners, especially Pilot Partners.
- EU Commission members related to the H2020 programme.

1.3 References and applicable documents

Reference documents

- **R1.** Grant agreement no: 643566 for the ehcoBUTLER Project
- **D2.5** Pilot Site Assessment Protocol and Procedure
- **D2.6** Pilot and validation framework
- **D5.1** Pilot recruitment and training guideline
- **D5.3** Final evaluation pilot outcomes

2 GENERAL INFORMATION OF PILOTS

2.1 Transversal Conditions for the pilot

2.1.1 Introduction / Pilots sites description

As indicated in deliverables *D2.5 (section 4 "Pilot Site Business Models")*, *D2.6 (section 2.2. "Business Models and Pilot sites")* and *D5.1 (section 2.1 "Transversal Conditions for the pilot")*, the different **Business Models** that were indicated in the DoA have been refined. Consequently, the pilots run according to three different Business Models:

- **Business Model based provision of Wellbeing Services (BUSINESS MODEL A):** AIMA, ASISTEL, and INTRAS.
- **Business Models based on provision of Care Services (BUSINESS MODEL B):** INTRAS, CLALIT and ASBAR.
- **Business Models based on Technological Service provision (BUSINESS MODEL C):** TME and VIDAVO.

2.1.2 Inclusion/Exclusion Criteria

The **inclusion and exclusion criteria** of each final user are defined on deliverables *D2.6 (section 2.3 "Inclusion/Exclusion criteria")* and *D5.1 (section 2.1.2 "Inclusion/Exclusion criteria")*.

The changes in the inclusion/exclusion criteria were discussed with the European Commission and approved by the PO Mrs. Sevasti Skeva on May 21st 2021. All the scientific justification is described in the document "*Diagnosis Criteria for the MCI*".

Information on **exit strategy** is described on deliverable *D5.1 (section 5.5 "Exit Strategy")* and complete information on this issue can be found on deliverable *D1.16*.

2.1.3 General Recruitment

To recruit older people with mild cognitive impairments (MCI) or very mild cognitive impairment (VMCI) to carry out the pilots have taken place in two ways as have been defined on deliverables *D2.6 (section 2.4 "Recruitment of the sample")* and *D5.1 (section 2.1.3 "General Recruitment")*.

2.1.4 Pilot Timeline

The research study of the ehcoBUTLER platform started in June 2020 (the pilot test execution started on November 2020) and finished in January 2022. The pilot test has been performed and completed in 4 pilot sites (INTRAS - Spain -, TME - Spain -, AIMA - Italy - and ASBAR - Spain -). The other pilot sites (CLALIT – Israel - and VIDAVO / ALZHEL – Greece -), that were delayed due to the impact derived from COVID 19, have faced more serious issues that have impeded them to start on time, but they have remained active members in the project.



ASISTEL – Serbia – has had several difficulties in remaining engaged in the usual project activities.

2.2 Specific Conditions for the pilot

2.2.1 Modules per pilot

After consultation with stakeholders and end-users, and after inventory and feasibility of modules requiring professional involvement (such as dieticians or therapists) the modules of most interest for each pilot have been identified. All this information has been shown on deliverable *D5.1 (section 2.1.3 "Specific Conditions for the pilot")*.

2.3 General Research Procedure

The ehcoBUTLER study follows the standards of the Helsinki declaration and the international Good Clinical Practice (GCP) guide. The ethical principles of RESPECT for the person, BENEFIT (minimizing risks and always seeking the well-being of the person) and JUSTICE (equal participation of all candidates for a research study) are taken into account. These international standards of ethical and scientific quality are applicable not only to the design, execution and data recording, but fundamentally to the process of communication and explanation of the study to the participants who will finally be selected.

The ehcoBUTLER general research procedure comprises different phases:

- **Phase 1: Recruitment**
- **Phase 2: Pre-evaluation**
- **Phase 3. Training**
- **Phase 4. Pilot Study**
- **Phase 5. Post Evaluation**

All this information has been described in detailed on deliverables *D2.6 (section 2.6 "General Research Procedure")* and *D5.1 (section 5.1. "General Research Procedure")*.

3 RESULTS OF THE EHCObUTLER PLATFORM

3.1 Results of Non-Economic indicators

All data obtained by each pilot site have been integrated and analyzed. The initial sample was composed of 1,070 elderly people with mild cognitive impairment (MCI). Data collection is explained in deliverable “D2.6. Pilot and Validation Framework”.

The ehcoBUTLER study has finished with a final sample of n=500 participants recruited and 491 participants involved in the pilot (441 participants in the experimental group and 50 participants in the control group), with mild cognitive impairment (MCI) and very mild cognitive impairment (VMCI) from Spain (TME, INTRAS and ASBAR) and Italy (AIMA).

The main goals of the statistical analysis are:

- A. **A pre-post-test intraindividual comparison** (Key Performance Indicators about efficacy), to obtain the significative differences between the punctuations in the pre- and post-intervention state. We will measure the following pre-post-tests:
 - Mini Mental State Examination (MMSE): evaluation of the cognitive function variation.
 - Clock Drawing Test (CDT): evaluation of the cognitive function variation.
 - Geriatric Depression Scale (GDS): evaluation of the mood state variation.
 - Multicultural Quality of Life Index: evaluation of the subjective quality of life variation.
 - Lubben Social Network Scale – 6 (LSNS-6): valuation of the social support variation.
- B. **Intergroup pre-post-test comparison.** In the total sample, there are three business models to which users are assigned. The main goal is to find out if there are differences in the pre-post test scores obtained in the three groups:
 - Business Model based provision of Wellbeing Services (BUSINESS MODEL A).
 - Business Models based on provision of Care Services (BUSINESS MODEL B).
 - Business Models based on Technological Service provision (BUSINESS MODEL C).
- C. **Matrix Correlation between sociodemographic variables:** Age, level of studies and gender and a) pre-post-test efficacy, b) frequency of use in total and in each module, c) the usability and acceptability and d) previous use of new technologies (6 initial questions of the participant form).
- D. **Usefulness of the system.** Correlation analysis between modules that are considered most useful and friendly in the participant form with the frequency of use of each module (computer scientists analyze usage variables). Analysis of the differences between the formal and informal caregivers' questionnaires with the final user

questionnaires: correlation between the scores obtained by caregivers and the elderly regarding the usefulness and friendliness of the modules and the real use.

- E. **Willingness to pay.** Analysis of the differences or not about the final price of the system from final users, informal caregivers (IC) and formal caregivers (FC).
- F. **Country differences.** Analysis of the significant differences in the price, initial level of skills for tics uses, results of the pre-post study and frequency of use.

Currently, the statistical analysis of non-economic indicators has been carried out. The results of this statistical analysis are presented in deliverable “D6.1 Report on ehcoBUTLER project impact evaluation”.

3.2 Logic model of the project Pilots and the set of CBA indicators assessing the impact of ehcoBUTLER solution

3.2.1 Wellbeing services providers

ASISTEL and AIMA were the pilot partners in ehcoBUTLER which mainly provide services for well-being. Their services consist of social assistance to patients, relatives, and caregivers at patient’s home and/or at their centres. The patients do Training (memory exercises, physical training) and Caring (social activities such as painting and knitting) with the support of specialists (therapists) of these Alzheimer Centres. Anticipating the results of the interviews conducted with the responsible of the Centres, ehcoBUTLER solution provides a digital support in stimulating patients in their mental and physical exercises and as well as in the dietary plan that can significantly help therapists in increasing the frequency of care contacts with the same patient as well as the number of patient’s visits in a period. In the following sub-paragraph, we describe the logic model of AIMA and to what extent it could be modified by the introduction of ehcoBUTLER services. Unfortunately, in the case of ASISTEL, the pilot has not been run. Finally, a list of impact has been defined to assess the impact of the proposed solution during the pilot stage.

3.3.1.1 AIMA logic model of the provided services

According to the above methodology we have defined the logic model of the service provided by AIMA. The following Actors/Processes matrix shows the current process flow.

AS IS HIGH LEVEL LOGIC MODEL (WITHOUT ehcoBUTLER)	ACTORS						
	Potential patients at risk of dementia	Relatives	Patients with MCI diagnosis; with Alzheimer disease and low cognitive state	AIMA personnel	Formal caregivers	AIMA Therapists	Specialist (neurologist)
Training at AIMA home		Parents have to bring patients with dementia to AIMA centers to receive assistance	Patients have to go to AIMA centers to be assisted	Provide assistance to patients and their relatives at AIMA centers	Provide assistance to patients	Provide assistance to patients at AIMA centers	Periodic clinical monitoring
Training at Parents/Patient home		Parents assist patients and receive the AIMA personnel at home	Patients receive assistance at home		Provide assistance to patients	Provide assistance to patients at home	Periodic clinical monitoring
Caring at AIMA home		Parents have to bring patients with dementia to AIMA centers to receive assistance	Patients have to go to AIMA centers to be assisted	Provide assistance to patients and their relatives at AIMA centers	Provide assistance to patients		Periodic clinical monitoring
Caring at Parents/Patient home		Parents assist patients and receive the AIMA personnel at home	Patients receive assistance at home		Provide assistance to patients		Periodic clinical monitoring
Early diagnosis							

The high-level logic model of AIMA is divided in four processes: (1) training at AIMA home; (2) training at relatives/Patient home; (3) caring at AIMA home; (4) caring at Relatives/Patient home. To carry out these activities, 6 typologies of actors are engaged: (a) patients; (b) relatives; (c) AIMA personnel; (d) formal caregivers of the patients; (e) AIMA therapists; (f) Specialists (neurologists).

Crossing Actors and the streamlines in the above figure are highlighted the main activities that the various Actors do for AIMA.

According to AIMA personnel interviewed during the design of the streamlines of the organization, we have identified the possible contribution of ehcoBUTLER to the AIMA services.

The following figure reports the possible changes in AIMA streamlines due to the use of the ehcoBUTLER services.

AS IS HIGH LEVEL LOGIC MODEL (WITHOUT ehcoBUTLER)	ACTORS						
	Potential patients at risk of dementia	Relatives	Patients with MCI diagnosis; with Alzheimer disease and low cognitive state	AIMA personnel	Formal caregivers	AIMA Therapists	Specialist (neurologist)
Training at AIMA home		Less Parents have to bring their familiars with dementia to AIMA centers to receive assistance	Less Patients have to ho to AIMA centers to be assisted	Less personnel Provide assistance to patients and their parents at AIMA centers	Provide assistance to patients	Less Therapists provide assistance to patients at AIMA centers	Periodic clinical monitoring
Training at Parents/Patient home		More Parents assist the patients and receive the AIMA personnel at home	More Patients receive AIMA assistance at home		Provide assistance to patients	More Therapists Provide assistance to patients at patients/parents' home with periodic checks through ehcoBUTLER with the therapist in the care center	Periodic clinical monitoring
Caring at AIMA home		Less Parents have to bring their familiars with dementia to AIMA centers to receive assistance	Less Patients have to ho to AIMA centers to be assisted	Less careworkers Provide direct assistance to patients and their parents at AIMA centers	Provide assistance to patients		Periodic clinical monitoring
Caring at Parents/Patient home		More Parents assist the patients and receive the AIMA personnel at home	More Patients receive assistance at home	More AIMA careworkers Provide indirect assistance to formal caregivers, patients and their parents through ehcoBUTLER at AIMA centers	Provide assistance to patients		Periodic clinical monitoring
Early diagnosis	Potential patients at risk of dementia receive an early diagnosis through ehcoBUTLER			Manage risk mitigation pathways and services plan to mitigate the risk of dementia provided by the specialist	Provide assistance to patients	More Therapists Provide assistance to patients at patients/parents' home with periodic checks through ehcoBUTLER with the therapist in the care center	Diagnosis using ehcoBUTLER services and clinical monitoring and mitigation thatways formulation

First, a new streamline can be foreseen, such as: (5) early diagnosis. According to AIMA professionals, this is one of the major advantages for the organization provided by the ehcoBUTLER solution. As a matter of fact, the use of the software would help specialists (neurologists) to early identify patients at risk of dementia and then provide to them specialized assistance with AIMA therapists at patients' home, and to support AIMA personnel in better manage mitigation action plans for reducing risk of dementia in potential MCI patients.

Another improvement due to the use of ehcoBUTLER solution is the possible increase of the efficiency of AIMA care workers in providing assistance to formal caregivers, patients and relatives. Thus, thanks to ehcoBUTLER, a single AIMA care worker would assist a higher number of individuals at the same amount of time. Similar situation can be foreseen in case of AIMA therapists providing assistance at relatives/users' home.

3.3.1.2 KPI for AIMA logic model



The following table shows the KPIs that we have identified together with AIMA staff to assess the CBA of AIMA services underpinned by ehcoBUTLER.

	ACTORS						
	Potential patients at risk of dementia	Relatives	Patients with MCI diagnosis; with Alzheimer disease and low cognitive state	AIMA personnel	Formal caregivers	AIMA Therapists	Specialist (neurologist)
Outcome indicators	# of average years per persons without dementia gained through ehcoBUTLER early risk detection						
Outcome indicators			Δ of average # of years per patient with a less severe diagnosis				
Outcome indicators					Δ of # of formal caregivers having provided a positive evaluation of the AIMA service at home (after the trial)		
Outcome indicators		Δ of # of patients and/or relatives having provided a positive evaluation of the AIMA service at home (after the trial)					
Outcome indicators	# of potential patients having adopted the risk mitigation pathways during the trial						
Output indicators			Δ of patients treated at home instead of going at AIMA centers				
Efficiency measures							Δ of # of periodic monitoring made in a day
Efficiency measures				Δ of average cost per patient of the AIMA service provision			
Effectiveness measures	# of potential patients identified						
Effectiveness measures	€ saved per person for having had an early diagnosis reducing the average number of years with dementia						
Effectiveness measures		€ saved per patient for having a less severe dementia disease having reduced the average numbers of years with severe dementia					
Effectiveness measures		Δ of average out of pocket money (if any) paid for caring the patient with AIMA services					
Effectiveness measures				Δ of # of patients assisted per day			
Effectiveness measures							Δ of # of early diagnosis of risk of dementia made per day
Effectiveness measures						Δ of # of patients threatened per day (or per therapist going at patient's home)	

Four types of KPI have been identified:

- Outcome indicators:** which measures the benefits that patients can have using the ehcoBUTLER solution in the AIMA assistance processes. For example, a better service to patients due to MCI early risk detection and mitigation actions of AIMA personnel and therapists would increase the number of years without dementia or with less severe diagnosis gained by the patients. This means a reduction of costs for assistance in charge of public health care and families as well.
- Output indicators:** which measure the direct results of the project activities. For example, thanks to ehcoBUTLER we would expect to assist a higher number of patients at home instead of at AIMA center. This is even more important in this long period where all the population is affected by COVID-19 pandemic risk.
- Efficiency indicators:** these measures assess the capability of the project to help in providing services that allow to increase participation in the intervention by removing barriers, i.e. he need to expend more effort. For example, thanks to the project solution, we would expect that AIMA personnel could reduce the time for assisting each patient by maintaining the same level of service; or that the specialist could increase the number of visits per day due to efficiency gains obtained by using ehcoBUTLER.
- Effectiveness indicators:** these measures are still “outcomes measures” and aim at assessing the effectiveness of the project to provide direct benefits to final users. For

example, in the case of AIMA services, the final users are patients/relatives/informal caregivers. The above table shows which would be the most important expected direct benefits of the ehcoBUTLER solution for them.

3.2.2 Care services providers

CLALIT, ASBAR and INTRAS are the three Care Services Providers that were identified for testing the ehcoBUTLER solution. In the following subparagraphs we describe their high-level logic model in assisting patients with mild cognitive impairment. According to the interviews conducted with the reference professionals of each provider, ehcoBUTLER solution would be a very powerful tool for use during patients' leisure. Thanks to the proposed solution, patients can exercise memory and perform coordination activities independently, even without the assistance of an attending professional. This would increase the time spent by the patient in practicing him/her selves reducing the period of inactivity and may delay the onset of more severe cognitive decline. In the following sub-paragraph, we discuss the logic model of CLALIT as example of the way in which this group of project's pilots aims at adopting ehcoBUTLER solution in their daily practices and which are the main CBA indicators to measure the expected impact.

3.2.2.1 CLALIT logic model of the provided services

According to the above methodology we have defined the logic model of the service provided by CLALIT who provides national primary, secondary and tertiary health services. The following Actors/Processes matrix shows the current process flow that would be affected by ehcoBUTLER solution. In yellow we identified the new services that would be introduced thank to ehcoBUTLER.

MACROACTIVITIES	AS IS HIGH LEVEL LOGIC MODEL (WITHOUT ehcoBUTLER)	Relatives	Patients with MCI diagnosis; with Alzheimer disease and low cognitive state	CLALIT personnel	CLALIT Therapists	Specialist (neurologist)
	Leisure and Training at Care Center	People can assist their parents affected by alzheimer and interact with them at Care Center premises	Patients are hosted at the center for a given period according to the relatives' choice	Provide assistance to patients and their relatives	Provide assistance to patients	Periodic clinical monitoring
	TO BE HIGH LEVEL LOGIC MODEL OF CLALIT SERVICE (WITH ehcoBUTLER)	Relatives	Patients with MCI diagnosis; with Alzheimer disease and low cognitive state	CLALIT personnel	CLALIT Therapists	Specialist (neurologist)
Leisure and Training at Care Center	Parents can more actively interact with the patients playing together with ehcoBUTLER solution	Patients spent more time in leisure and training activities thanks to ehcoBUTLER	Thanks to ehcoBUTLER solution therapists can reduce the time per visit per patient and then increase the number of patients visited in a day.	Thanks to ehcoBUTLER solution therapists can reduce the duration of the time per visit per patient and then increase the number of patients visited in a day.	Periodic clinical monitoring	

According to CLALIT, the proposed solution would be used to increase the effective use of the patients' leisure time. In fact, thanks to ehcoBUTLER solution, patients during their leisure period can have the chance to also use ehcoBUTLER solution that should help in stimulating mental activities and coordination actions. Caregivers/family members can also interact with patients through ehcoBUTLER solution and thus they can make more added value activities with their loved-ones. At the same time, CLALIT professionals might dedicate less time per patient since the use of ehcoBUTLER solution would reduce the pressure on them for unplanned visits. Thus, more time could be dedicated to planned quality visits. In addition, during periods such as a pandemic or lockdown/isolation for any other health or social crisis, the patient can continue complete the cognitive exercises independently from home.



3.2.2.2 KPI for CLALIT logic model

The following table shows the KPIs that we have identified together with CLALIT professional team to assess the CBA of CLALIT services underpinned by ehcoBUTLER.

		ACTORS			
		Relatives	Patients with MCI diagnosis; with Alzheimer disease and low cognitive state	CLALIT personnel	CLALIT Therapists
IMPACT INDICATORS	Outcome indicators		Δ of average # of years per patient with a less severe diagnosis		
	Outcome indicators	Δ of # of patients and/or relatives having provided a positive evaluation of the CLALIT service (after the trial)			
	Efficiency measures			Δ of average cost per patient of the CLALIT service provision	Δ of average cost per patient of the CLALIT service provision
	Effectiveness measures	€ saved per patient for a less severe dementia disease having reduced the average numbers of years with severe dementia			
	Effectiveness measures	Δ of average out of pocket money (if any) paid for caring the patient with CLALIT services			
	Effectiveness measures			Δ of # of patients assisted per day	
	Effectiveness measures				Δ of # of patients threatened per day (or per therapist going at patient's home)

Three types of KPI have been identified:

- Outcome indicators:** which measures the benefits that patients can have by using the ehcoBUTLER solution in the CLALIT care processes. For example, increasing the time spent by the patients in quality leisure activities even together their caregivers/family members, would increase the number of years without dementia or with less severe diagnosis gained by the patients. This means maintaining a stable level of social capital and reducing costs for assistance in home care facilities/residential care and for co-payment for families as well.
- Efficiency indicators:** these measures assess the capability of the project to help in providing services that allow for increased activity time for memory exercises, physical activity, etc. and reducing barriers such as motivation and effort expended while also preventing loneliness. For example, thanks to the project solution, we would expect that CLALIT professional team would make more efficient use of the time for assisting each patient by maintaining the same level of service; or that the specialist can increase the amount of quality time allotted for each appointment due to efficiency gains obtained by using ehcoBUTLER.
- Effectiveness indicators:** these measures are like outcome measures and aim at assessing the effectiveness of the project to provide direct benefits to end users. For example, in the case of CLALIT services, the final users are patients/caregivers. The above table shows which would be the most important expected direct benefits of the ehcoBUTLER solution for them.

3.2.2.3 INTRAS logic model of the provided services

In the same way, we have defined the logic model of the service provided by INTRAS. The following Actors/Processes matrix shows the current process flow that would be affected by ehcoBUTLER solution.

MACROACTIVITIES		ACTORS				
		Potential patients at risk of dementia	Relatives	Patients with MCI diagnosis; with Alzheimer disease and low cognitive state	INTRAS personnel (neuropsychologist, psychologist, gerontologist...)	Formal caregivers / Informal caregivers
MACROACTIVITIES (WITHOUT EHCUBUTLER)	Activities related to treatment, intervention, cognitive trainings... at INTRAS center	Patients have to go to INTRAS centers to be assisted	Relatives have to bring their familiars to INTRAS centers to receive assistance	Patients have to go to INTRAS centers to be assisted	Provide assistance to patients and their relatives at INTRAS centers Periodic clinical monitoring	Provide assistance to patients
	Activities related to treatment, intervention, cognitive trainings... at Relatives/Patient home	Patients receive assistance at home	Relatives assist the patients and receive the INTRAS personnel at home	Patients receive assistance at home	Provide assistance to patients at patients/relatives' home Periodic clinical monitoring	Provide assistance to patients
	Early diagnosis					
MACROACTIVITIES (WITH EHCUBUTLER)	Activities related to treatment, intervention, cognitive trainings... at INTRAS center	Less patients have to go to INTRAS centers to be assisted	Less relatives have to bring their familiars to INTRAS centers to receive assistance	Less patients have to go to INTRAS centers to be assisted	Less INTRAS personnel provide direct assistance to patients at INTRAS Periodic clinical monitoring	Provide assistance to patients
	Activities related to treatment, intervention, cognitive trainings... at Relatives/Patient home	More patients receive INTRAS assistance at home	More relatives assist the patients and receive the INTRAS personnel at home	More patients receive INTRAS assistance at home	More INTRAS workers provide remote indirect assistance to users at users/relatives' home with periodich checks through ehcoBUTLER Periodic clinical monitoring	Provide assistance to patients
	Early diagnosis	Potential patients at risk of dementia receive a potential early diagnosis through ehcoBUTLER (GRADIOR evolution reports provides an alert to the therapist)			Manage risk mitigation pathways and services plan to mitigate the risk of dementia provided by the specialist More Therapists provide indirect assistance to patients at patients/relatives' home with periodich checks through ehcoBUTLER with the therapist in the INTRAS center Diagnosis using ehcoBUTLER services and clinical monitoring and mitigation pathways formulation	Provide assistance to patients

As in the previous cases, in grey we indicate the changes in INTRAS activities due to ehcoBUTLER introduction, while in yellow we indicate the new ehcoBUTLER services introduced in the INTRAS logic model.

As we can see, the introduction of ehcoBUTLER improves the ordinary management processes of INTRAS users, allowing INTRAS professionals to reduce the visits on-site and increase the possibility of monitoring them at home, reduce the time for assisting each patient while maintaining the same level of service quality. This generates an improvement of general conditions of life for users and their relatives/informal caregivers, also generating important financial savings. At the same time, the introduction of ehcoBUTLER allows to increase the possibility of INTRAS professionals to provide indirect remote assistance, ensuring an almost continuous monitoring: this would increase the possibility of early diagnosis of dementia, given the constant activity recorded by the ehcoBUTLER platform and the GRADIOR evolution reports that provides alerts to the INTRAS therapists.

3.2.2.4 KPI for INTRAS logic model

The following table shows the KPIs that we have identified together with INTRAS professionals to assess the CBA of INTRAS services underpinned by ehcoBUTLER.

		ACTORS				
		Potential patients at risk of dementia	Relatives	Patients with MCI diagnosis; with Alzheimer disease and low cognitive state	INTRAS personnel (neuropsychologist, psychologist, gerontologist...)	Formal caregivers / Informal caregivers
MEASUREMENT INDICATORS BEFORE AND AFTER THE TRIAL AT INTRAS	Outcome indicators	# of average years per persons without dementia gained through ehcoBUTLER early risk detection				
	Outcome indicators			Δ of average # of years per patient with a less severe diagnosis		
	Outcome indicators					Δ of # of formal caregivers having provided a positive evaluation of the INTRAS service at home (after the trial)
	Outcome indicators		Δ of # of patients and/or parents having provided a			
	Outcome indicators	# of potential patients having adopted the risk mitigation pathways during the trial				
	Output indicators			Δ of patients treated at home instead of going at INTRAS centers		
	Efficiency measures				Δ of average cost per patient of the INTRAS service provision	
	Effectiveness measures	# of potential patients identified				
	Effectiveness measures	€ saved per person for having had an early diagnosis				
	Effectiveness measures	€ saved per patient for having a less severe dementia				
Effectiveness measures	Δ of average out of pocket money (if any) payed for					

Four types of KPI have been identified:

- Outcome indicators:** which measures the benefits that patients and caregivers/family members can have by using the ehcoBUTLER platform in the implementation of INTRAS services. Basically, increasing the time spent by end-users in quality leisure activities even together their caregivers/relatives, would increase the number of years without dementia or with less severe diagnosis gained by the patients. This means a reduction of costs for assistance in charge of public health care and families as well, while maintaining the same level of service quality.
- Output indicators:** which measure the direct results of the ehcoBUTLER project activities. For example, thanks to ehcoBUTLER INTRAS professionals would expect to assist a higher number of users assisted at home (remote indirect assistance) instead of at INTRAS center (direct assistance). This is even more relevant nowadays, with the COVID-19 pandemic still in place and the health restrictions and/or lockdowns.
- Efficiency measures:** these measures assess the capability of the project to help in providing services that allow to increase participation in cognitive and physical intervention while overcoming some difficulties (efforts spent, motivation, engagement to cognitive therapies, avoiding unwanted loneliness and social isolation...). For example, thanks to the project solution, INTRAS professionals could reduce the time for assisting each patient by maintaining the same level of service quality; or the professionals could increase the number of visits per day due to efficiency gains obtained by using ehcoBUTLER.
- Effectiveness measures:** these measures are still “outcomes measures” and aim at assessing the effectiveness of the project to provide direct benefits to final users. We can refer to early diagnosed MCI patients, monetary savings for early diagnosis and/or less years with severe dementia and less out-of-pocket costs.

3.2.2.4 ASBAR logic model of the provided services

In the same way, we have defined the logic model of the service provided by ASBAR. The following Actors/Processes matrix shows the current process flow that would be affected by ehcoBUTLER solution.

Elderly people of this model live in apartments, managed by the local council. They are people living alone or with their relatives in individual apartments. The apartments do not include specific services for elderly people, but only cleaning services. There is a social worker who manages the apartments and oversees the needs of people, but there are no additional social or healthcare services. In this model, the use of the ehcoBUTLER system, allows us to monitor all users physically, cognitively, affectively, and socially. A cognitive assessments can be performed to detect cases of cognitive impairment, perform cognitive stimulation to prevent impairment, detect depressive states, and improve the physical status and social relationships.

Thanks to the use of the system, a comprehensive screening can be implemented and treatments can be comprehensive, while without ehcoBUTLER in this service, users do not have any follow-up.

	ACTORS	
	People with mci and vmci living autonomously in apartments for the elderly	Coordinator of the service from the municipality/Social Services
Activities related to treatment, intervention and cognitive trainings at home	No clinical services provided for the elderly in the apartments	Provide follow up to people living at home
Activities related to treatment, intervention and cognitive trainings at home	Access to cognitive training, physical activities, social relations, follow up of the health stage of the elderly.	Follow up of clinical assistance with the ehcoBUTLER platform. People living in their apartments have access to new tools under the supervision of clinicians.
Early diagnosys	Detection of the decrease of the cognitive functioning thanks to the platform ehcoBUTLER.	Improvement of the detection system of incidents related to the health of the elderly provided by the system. Better follow-up of the patients.

3.2.2.4 KPI for ASBAR logic model

The following table shows the KPIs that we have identified together with ASBAR professionals.

	ACTORS	
	People with mci and vmci living autonomously in apartments for the elderly	Coordinator of the service from the municipality/Social Services
MEASUREMENT INDICATORS BEFORE AND AFTER THE TRIAL AT ASBAR	Outcome indicators	# of new diagnosis with dementia
	Efficiency measures	# of hours saved for a clinician for the follow up of the patient
	Efficiency measures	Less people sent to a public nursing home
	Effectiveness measures	Improvement of the mood
	Effectiveness measures	Improvement of the cognitive function
	Effectiveness measures	Improvement of the quality of life
	Effectiveness measures	Improvement of the social relationships

Three types of KPI have been identified:

- Outcome indicators:** they measure the direct results of the ehcoBUTLER project activities. The use of the system in this logic model allow to offer to elderly people living alone in the apartments a comprehensive evaluation and intervention service. It can be measured as new early diagnosis of dementia.
- Efficiency measures:** ehcoBUTLER allows to offer services to older people living alone, centrally, regardless of their location, and to decrease the number of hours for a clinician for the follow-up of them, and, thanks to early diagnosis, to avoid derivation to a public nursing home, and keep the elderly person in their own home as much as possible.
- Effectiveness measures:** The effectiveness of the platform for the elderly can be measured in terms of improvement of the cognitive, mood and social status of the elderly, thanks to the use of ehcoBUTLER. The global quality of life can be improved and measured through a questionnaire to elderly people and caregivers.

3.2.3 Technological services providers

TME and VIDAVO are the two Technological Services Providers that have tested the ehcoBUTLER solution. In the following subparagraph we describe their high-level logic model in assisting patients with cognitive impairment. According to the interviews conducted with the reference personnel of each provider, ehcoBUTLER solution would be a very powerful tool for assisting patients with MCI at home. Thanks to the proposed solution, patients can exercise memory and making coordination activities even without the assistance of informal caregivers or relatives. This would increase the time spent by the patient in practicing him/her selves reducing the period of inactivity and might be postponing condition of more severe cognitive decline. At the same time, informal caregivers and/or relatives can afford more effectively and with higher quality the time dedicated for the assistance of the patients as well as they can have more quality time for themselves reducing the sense of loneliness and fatigue that the assistance to such patients can produce. The following sub-paragraph, we discuss the logic model of TME as example of the way in which this group of project’s pilots aims at adopting ehcoBUTLER solution in their daily practices and which are the main CBA indicators to measure the expected impact.

3.2.3.1 TME logic model of the provided services

According to the above methodology we have defined the logic model of the service provided by TME. The following Actors/Processes matrix shows the current process flow that would be affected by ehcoBUTLER solution.

According to TME and VIDAVO as well, the ehcoBUTLER solution would be provided on line at the patient’s home for training and leisure. It can support and sometimes substitute the assistance made by relatives and informal caregivers. Thus, they can have more quality time to spend for assisting patients and for themselves. Moreover, the patients that can make more mental and coordination training can slow down the progression of cognitive impairment, having more quality time to spend with their loved ones.

		ACTORS	
MACROACTIVITIES	AS IS HIGH LEVEL LOGIC MODEL (WITHOUT ECHOBUTLER)	Patients with mild cognitive impairment	Informal caregivers and relatives as caregivers
	Training at Patient home		Provide assistance to patients
	Caring at Patient home		Provide assistance to patients
		ACTORS	
	TO BE HIGH LEVEL LOGIC MODEL OF TME SERVICE (WITH ECHOBUTLER)	Patient with mild cognitive impairment	Informal caregivers and relatives as caregivers
	Training at Patient home	MCI patients can make more quality mental and	They can have more quality time for assisting the patient
Caring at Patient home	MCI patients can make more quality mental and	They can have more quality time for assisting the patient	

3.2.3.2 KPI for TME logic model

The following table shows the KPIs that we have identified together with TME personnel to assess the TME services underpinned by ehcoBUTLER.

Two types of KPI have been identified:

- **Outcome indicators:** which measures the benefits that patients can have using the ehcoBUTLER solution with TME services. For example, the connection of TME ehcoBUTLER service would increase the time spent in mental and coordination exercises as well as the number information received for a diet that better fits with the patient health conditions. Positive evaluation of these services made by patients, relatives and informal caregivers should provide evidence of the achievement of such outcomes.
- **Effectiveness indicators:** these measures are still “outcomes measures” and aim at assessing the effectiveness of the project to provide direct benefits to final users. For

example, in the case of TME and VIDAVO services, the final users are patients/relatives/informal caregivers.

The above table shows which would be the most important expected direct benefits of the ehcoBUTLER solution for them.

	ACTORS	
	Patients with mild cognitive impairment	Informal caregivers and relatives as caregivers
Outcome indicators	# average of times/per week patients are connected the ehcoBUTLER service	
	Δ of average # of years per patient with a less severe diagnosis	
		Δ of average # of quality time for caring the patients
		Δ of average # of quality time for themselves
		# of informal caregivers having provided a positive evaluation of the service at home (after the trial)
	# of patients having provided a positive evaluation of the ehcoBUTLER service at home (after the trial)	
	# of potential patients having adopted the risk mitigation pathways during the trial	
Effectiveness measures	€ saved per patient for having a less severe dementia disease having reduced the average numbers of years with severe dementia	
	Δ of average out of pocket money (if any) payed for caring the patient with TME services	
	# of potential patients identified	
	# average of times/per week patients are connected the ehcoBUTLER service	
	# average of hours/per week patients are connected the ehcoBUTLER service	
	# average of features used by patients when connected to the ehcoBUTLER service	

3.3 Results of Economic indicators

The ehcoBUTLER project aims to develop a methodology and an ICT technological platform with the objective of improving the independence and quality of life of elderly, especially those with mild and very mild cognitive impairment, and promoting their good health from several angles and points of view. To this end, as said, the project has been implementing a set of pilots in which the methodology and technological solution are applied with real patients. In order to assess to what extent the methodology and solutions have been successful, the research team has been checking its impact in the quality of life of users, including bridging their digital gap, social inclusion as well as its impact at cognitive levels. In that regard, the objective of the exercise is to measure the differences between costs and benefits that are available with the new ehcoBUTLER processes and/or new cost/benefit due to the new processes induced by the ehcoBUTLER. Therefore, the research team needs to understand to what extent and how the current processes are replaced by adopting the ehcoBUTLER services.

To this end the research team has been carrying out a cost-benefit analysis to measure differences between costs and benefits that are available with the new (ehcoBUTLER processes) and/or new cost/benefit due to the new processes induced by ehcoBUTLER. The foundation of such CBA is the definition of specific Key Performance Indicators (KPIs), which are instruments to measure performances of processes that have to be tailored to the specific business processes that are those related to each pilot. As a best practice, KPIs have to be defined as follows:

- S(pecific): they need to be clearly defined;
- M(easurable): measurements should be easily quantifiable;
- A(chievable): obtaining the measurements should be realistic and KPIs should be implementable;
- R(elevant): measurement should be practical and pragmatic;
- T(imely): measurement should be implemented at a sensible time.

As already mentioned in the D2.5, the ehcoBUTLER pilots operate according three main categories of business models:

- **Business Model based provision of Wellbeing Services.** This model is operated by the organisations ASISTEL and AIMA, which mainly provide social services to their clients, consisting of support activities (telecare), memory houses, training (e.g. tablet training), and social activities (painting, knitting). According to this model, public funding provided by local, regional and national public subsidies are complemented with payments from the customers;
- **Business Models based on provision of Care Services.** This model is operated by CLALIT, ASBAR and INTRAS, which mainly offer services related to care. Such services consist in providing medical interventions to their clients by employing formal carers and medical staff such as nurses, physicians, occupational therapists and administrative staff. Such services can be either private or public: INTRAS and ASBAR are privately funded, while CLALIT is publicly funded;

- **Business Models based on Technological Service provision.** This model is operated by the organisations VIDAVO and TME, which offer technological solutions to the health sector. Specifically, TME offers healthcare and wellbeing services at large scale, while VIDAVO is a technological company that provides technological solutions to the healthcare sector. TME offers services in the modalities B2C and B2B, while VIDAVO concentrates in the B2B set-up;

The business process for each model has been defined according to the following steps:

- Definition of the actors (e.g. patients, families, formal caregivers including medical staff, informal caregivers, employees);
- Definition of the sources of funding (public/private);
- Definition of the logic model of the services provided
 - Services provided (e.g. wellbeing services such as training or care services) and description of their flow before introducing the ehcoBUTLER solution (AS IS), including a description of the various actions provided (e.g. visits and checks) and the places where they have been provided (e.g. care centres);
 - Description of the flow of services after introducing the ehcoBUTLER solution (TO BE), including a description of the various actions provided (e.g. visits and checks) and the places where they have been provided (e.g. care centres);
 - Once the services are described, then their flow can be formalized in a flow chart to be used for the analysis.

Furthermore, the steps for the collection of data informing the KPIs are as follows:

- The AS-IS and TO BE processes, which have to be represented in an Activity-Actors matrix;
- Possible KPIs already used for monitoring Activity/s or the whole process should be provided.

3.3.1 Business Models based on provision of Care Services

In the first business model, only two pilots have been implemented (INTRAS and ASBAR). Therefore, we consider data generated by these pilots in the estimation of the cost-benefit analysis for this business model.

In particular, in the table below, we sum up the average costs/benefits obtained by the two pilots actually implemented for a total of 195 people monitored with ehcoBUTLER. The indicated amounts are considered per participant.

	Costs/Savings (€)
Costs	
Training	820
Equipment	300
Yearly subscription fee (EhcoBUTLER would be sold as SaaS solution)	20
Yearly pay per use	180
Additional Yearly internet cost (if any)	108
Savings	
€ saved for additional healthy years (public health money)	483.68
€ saved for more MCI years (public health money)	483.68
€ saved for additional healthy years (out of pocket money)	150
€ saved for more MCI years (out of pocket money)	280
Patient families' travel costs saved for online assistance	720
Organization's travel cost saved for online assistance instead of patient's home assistance	1,152
Savings for avoided adverse events due to an increase of adoption of risk mitigation pathways	1,200
Out of pocket savings for avoided adverse events due to an increase of adoption of risk mitigation pathways	1,200
Savings of out of pocket money due to the use of EhcoBUTLER	-
Personnel costs avoided due to the use of EhcoBUTLER	2,560

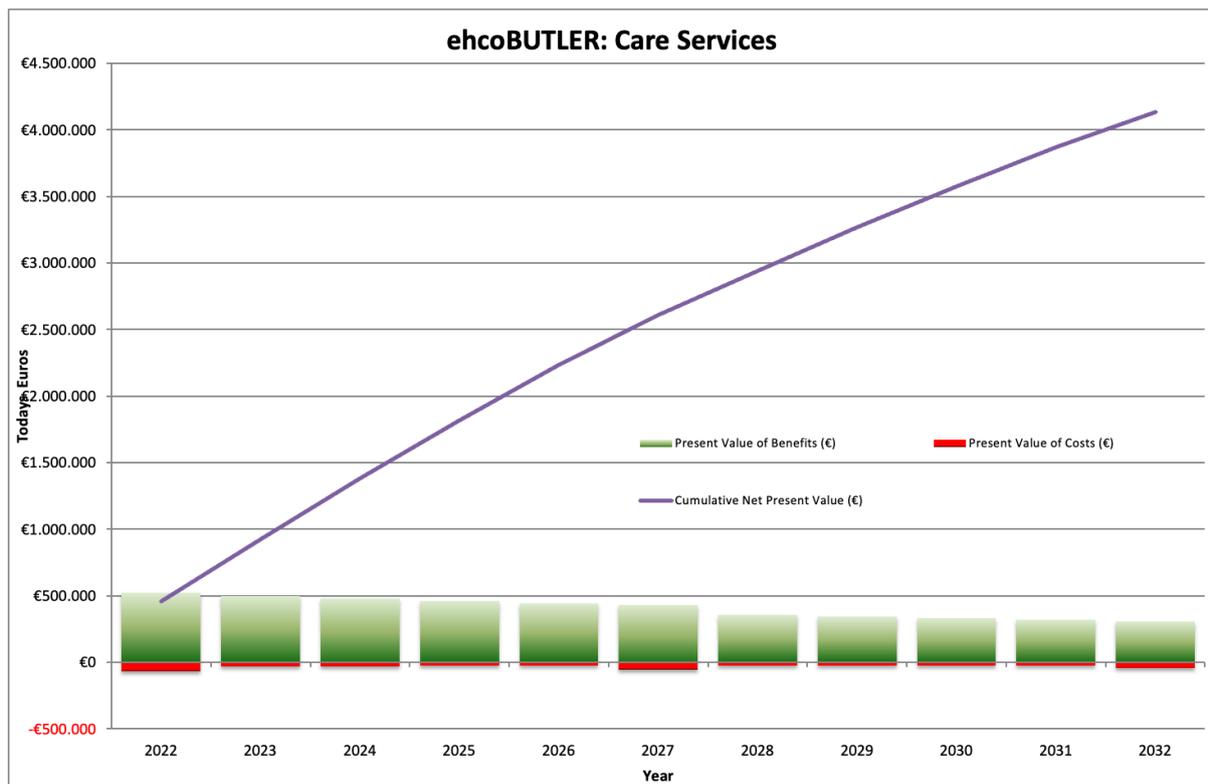
Then, we used the obtained data to build the cost-benefit analysis (CBA), based on the following assumptions:

1. All the costs/savings have been multiplied by 100 patients, considering a hypothetical scenario with 100 people monitored by a company offering ehcoBUTLER solution;
2. From the pilots' execution, an estimation of 5 additional healthy years have been estimated thanks to the usage of ehcoBUTLER solution; in this case, in the CBA, we estimated those additional 5 healthy years to the 50% of monitored people;
3. Savings on personnel costs have been inserted in the model considering this amount every 20 people monitored;
4. The estimation is based on 11 years of timespan, considering a discount rate of 4%.

The table below reports the results obtained. As we can see, with a global investment of 90k euros, and considering a total of costs for a present value of roughly 360k euros, the present value of benefits is around 4,5 billion euros.

Summary of the Results of the Analysis:	
Capital Costs	90,000.00 €
Whole of Life Costs	441,100.00 €
Present Value of Benefits	4,492,070.35 €
Present Value of Costs	360,131.83 €
Benefit Cost Ratio	12.47
Net Present Value	4,131,938.52 €

In the graph below, we can see the evolution of the present value for costs and benefits for the timespan considered.



Based on these results, the sustainability of ehcoBUTLER solution is proven, assuming that benefits, both social and economic, are much greater than costs.

Although the pilot for CLALIT has not been run and a cost-benefit analysis cannot be implemented, some economic data have been estimated, showing that the implementation of ehcoBUTLER in the primary care setting would be cost-savings.

	Costs/Savings (€)
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Costs	
Training	1,140
Equipment	300
Yearly subscription fee (EhcoBUTLER would be sold as SaaS solution)	20
Yearly pay per use	0
Additional Yearly internet cost	0
Savings	
€ saved for additional healthy years (public health money)	240
€ saved for more MCI years (public health money)	240
€ saved for additional healthy years (out of pocket money)	N/A
€ saved for more MCI years (out of pocket money)	65
Patient families' travel costs saved for online assistance	450
Organization's travel cost saved for online assistance instead of patient's home assistance	N/A
Savings for avoided adverse events due to an increase of adoption of risk mitigation pathways	N/A
Out of pocket savings for avoided adverse events due to an increase of adoption of risk mitigation pathways	N/A
Savings of out of pocket money due to the use of EhcoBUTLER	0
Personnel costs avoided due to the use of EhcoBUTLER	4,320

3.3.2 Business Models based on provision of Wellbeing Services

In the second business model, only one pilot has been implemented (AIMA). Therefore, in this case, we need to consider data generated by a single entity for estimating this business model.

As in the previous case, in the table below, we consider the average costs/benefits obtained by the pilot actually implemented for a total of 146 people monitored with ehcoBUTLER. The indicated amounts are considered per participant.

	Costs/Savings (€)
Costs	
Training	640
Equipment	300
Yearly subscription fee (EhcoBUTLER would be sold as SaaS solution)	20
Yearly pay per use	50
Additional Yearly internet cost	58
Savings	
€ saved for additional healthy years (public health money)	50
€ saved for more MCI years (public health money)	50
€ saved for additional healthy years (out of pocket money)	200
€ saved for more MCI years (out of pocket money)	200
Patient families' travel costs saved for online assistance	480
Organization's travel cost saved for online assistance instead of patient's home assistance	480
Savings for avoided adverse events due to an increase of adoption of risk mitigation pathways	-
Out of pocket savings for avoided adverse events due to an increase of adoption of risk mitigation pathways	-
Savings of out of pocket money due to the use of EhcoBUTLER	640
Personnel costs avoided due to the use of EhcoBUTLER	-

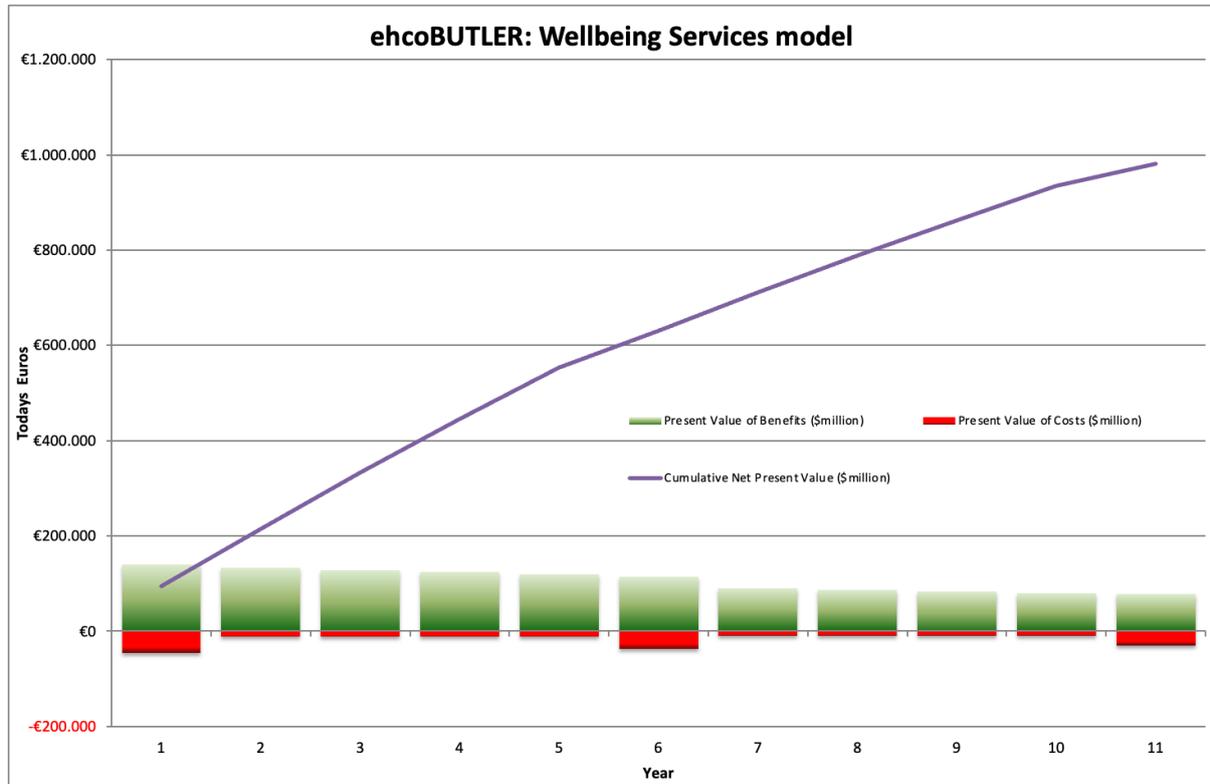
The assumptions for the estimation of this cost-benefit analysis are the same at the previous ones.

In this case, the results are less impacting. This model faces less costs, but also less benefits for ehcoBUTLER users. In any case, the advantages are clear also in this scenario, with a net present value of roughly 981k euros.

Summary of the Results of the Analysis:	
Capital Costs	90,000.00 €
Whole of Life Costs	240,400.00 €
Present Value of Benefits	1,178,923.09 €
Present Value of Costs	197,116.31 €

Benefit Cost Ratio	5.98
Net Present Value	981,806.78 €

The same patterns are confirmed in the graph below, in which we can see that the costs associated are a bit more important if compared to the previous business model.



3.3.3 Business Models based on provision of Technological Services' Providers

For the Technological Service provision business model, only data from TME has been considered. The VIDAVO pilot has not been implemented, due to COVID-19 outbreak. In the case of TME, as TME did not provide the services prior to the ehcoBUTLER pilot, previous “as is” costs information was not available. To solve this issue, data generated by other Spanish partners who did offer such services have been adapted to the Madrid context. The objective is to have a set of data that allows a cost-benefit analysis to be carried out in order to draw some conclusions. Therefore, all savings have been estimated considering the average of other Spanish partners’ data, while the costs have been derived by actual TME expenses for the pilot implementation.

The indicated amounts are considered per participant.

	Costs/Savings (€)
Costs	
Training	486
Equipment	453
Yearly subscription fee (EhcoBUTLER would be sold as SaaS solution)	20
Yearly pay per use	180
Additional Yearly internet cost (if any)	180
Savings	
€ saved for additional healthy years (public health money)	530
€ saved for more MCI years (public health money)	530
€ saved for additional healthy years (out of pocket money)	170
€ saved for more MCI years (out of pocket money)	320
Patient families' travel costs saved for online assistance	820
Organization's travel cost saved for online assistance instead of patient's home assistance	1300
Savings for avoided adverse events due to an increase of adoption of risk mitigation pathways	-
Out of pocket savings for avoided adverse events due to an increase of adoption of risk mitigation pathways	-
Savings of out of pocket money due to the use of EhcoBUTLER	2900
Personnel costs avoided due to the use of EhcoBUTLER	2900

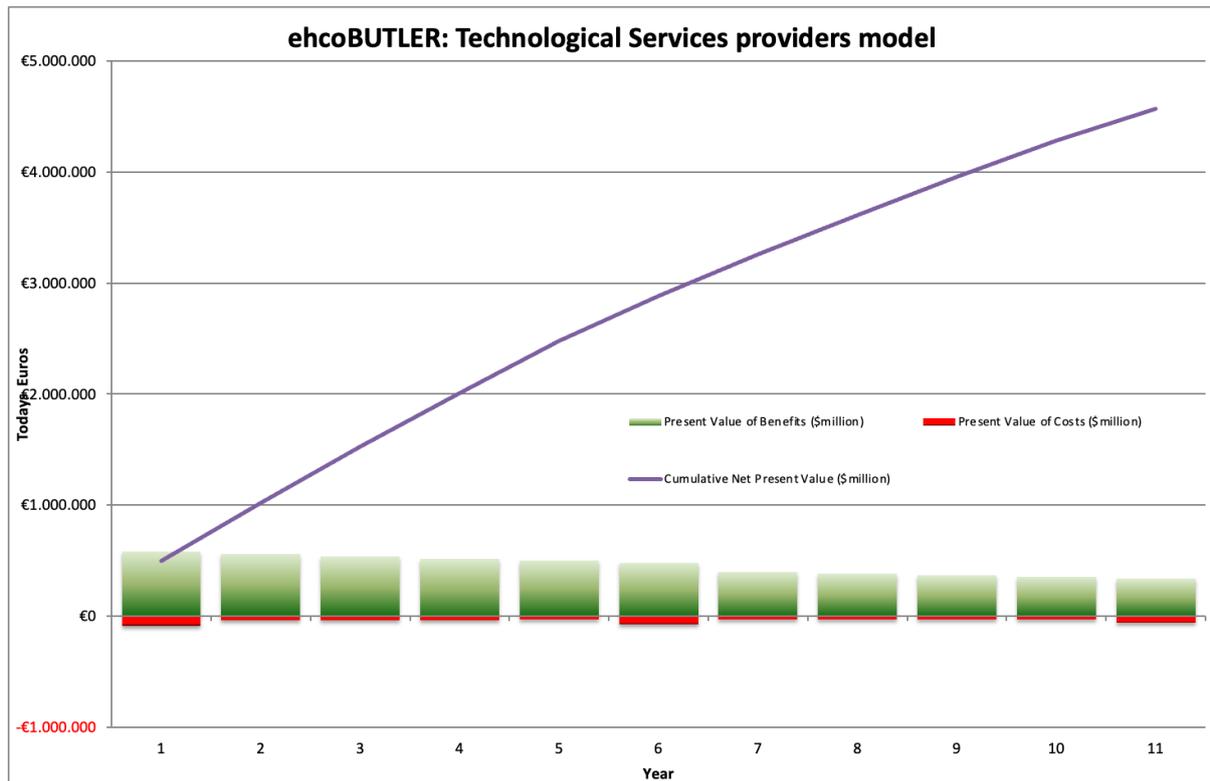
The assumptions for the estimation of this cost-benefit analysis are the same at the previous ones.

As we can see, the benefit-cost ratio is higher than the previous case, and 1 euro spent for the service implementation would generate benefits for 10 euros. The net present value, in this case, is 4,5billion euros.

Summary of the Results of the Analysis:	
Capital Costs	135,900.00 €

Whole of Life Costs	561,190.00 €
Present Value of Benefits	5,028,705.90 €
Present Value of Costs	458,578.20 €
Benefit Cost Ratio	10.97
Net Present Value	4,570,127.70 €

The same result can be seen in the graph below, showing the important benefits produced by TME pilot too.



3.4 Qualitative outcomes of ehcoBUTLER pilots

In addition to the previous quantitative results, ehcoBUTLER consortium also has some qualitative information from INTRAS, AIMA and TME pilots.

In the table below, we report the indicators based on the answers provided by ehcoBUTLER caregivers and end-users who answered to the two questions reported on a Likert-type scale that ranged from 1 (not at all) to 5 (a lot).

According to INTRAS informal caregivers, it seems that ehcoBUTLER solution has partially improved the daily life of informal caregivers and slightly improved their daily activity with MCI and VMCI users, due to the advantages of the ehcoBUTLER suite, mainly associated with the cognitive stimulation activities.

According to AIMA caregivers, it seems that ehcoBUTLER solution has partially improved the daily life of informal caregivers, in line with INTRAS' outcomes. Instead, it has had a greater impact on their daily activity with MCI and VMCI users, compared to INTRAS, reaching an average score of 3,2. In the case of AIMA, the first question has been asked also to users, reaching a slightly higher average score.

Finally, the same questions have been answered by TME users: according to them, the potential impact of ehcoBUTLER is even more relevant, reaching an average score of 4,1 (based on 12 users' answers), in the case of improving the daily life of caregivers, and 3,7 for the daily management of MCI and VMCI users. As we can say, the advantages of ehcoBUTLER services seem to be more relevant for users, indicating the possibility of improving their own lifestyle.

Questions	INTRAS	AIMA		TME
<i>Number of observations</i>	<i>6 informal caregivers</i>	<i>5 caregivers</i>	<i>5 users</i>	<i>12 users</i>
Q1.- To what extent the ehcoBUTLER services have improved your daily life?	2,67	2,4	2,6	4,1
<i>Number of caregivers interviewed</i>	<i>6 informal caregivers</i>	<i>5 caregivers</i>		<i>6 informal caregivers</i>
Q2.- To what extent the ehcoBUTLER services have improved your daily activity with MCI and VMCI users?	2,17	3,2		3,7

In addition, some questions have been addressed to clinical experts, for pilots implemented at AIMA and TME. Using the same Likert-type scale as above, according to AIMA experts, the usage of ehcoBUTLER platform would have a great impact on the reduction of severe MCI years for users; in particular, they think that it would decrease the number of severe MCI years on a range between 3 to 5. According to TME experts, instead, ehcoBUTLER solution would have less impacts on this aspect, with a reduction estimated on a range between 1 and 2 years.

Questions for Clinical experts	AIMA	TME
Q3.- In your opinion, ehcoBUTLER services will increase the number of less severe MCI years for users?	4	2,75
Q4.- How many healthy years will ehcoBUTLER help to increase for a user?	3 to 5	1 to 2

Finally, an additional aspect has been investigated among 6 TME informal caregivers: according to them, both their quality of time for caring users and their quality of time for themselves has been increased thank to the usage of ehcoBUTLER services.

Questions for Informal Caregivers	TME
<i>Number of observations</i>	<i>6 informal caregivers</i>
Q5.- In your opinion, ehcoBUTLER services have increased your quality of time for caring your users?	4,3
Q6.- In your opinion, ehcoBUTLER services have increased your quality of time for yourself?	4,5

4 CONCLUSIONS

As we have seen, given the evaluation of the economic and non-economic indicators collected during the pilots, it is possible to say that ehcoBUTLER solution is effective on the improvement of living conditions of elderly people.

In addition, the cost-benefit analysis clearly draws a scenario that appears to be sustainable, as further detailed by the business plan presented in D6.3.

Although the difficulties encountered by the project, especially due to COVID-19 outbreak, that prevent some of the pilots' implementation, an overall significant number of activities have been carried out, confirming the satisfaction both of elderly people and of caregivers for the ehcoBUTLER solution.

Three business models have been identified by the Consortium: Care services, Wellbeing and Technological service providers.

From the cost-benefit analysis, the most promising business models are the Care services and the Technological service providers, for which the estimations ensure a good ratio between benefits generated and costs undertaken.