IANVS

USER ASSESSMENT AND EVALUATION
PLAN

D4.1 USER ASSESSMENT AND
EVALUATION PLAN

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IANVS Consortium

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1.0 Executive Summary

The IANVS system aims to provide elderly people with a platform based on IoT (Internet of Things) 3D sensor technology that enables them to live independently, safely and with quality of life. This is achieved by installing an Elderly Care platform which monitors wellbeing of the elderly client in a privacy-respecting manner and results in a better utilization of the professional care services.

This is achieved by locating elderly people in their living environment in real time by means of the exchange of radio signals between a portable device and the infrastructure installed in the home. In the same way, both involved nursing staff and home help services are located and registered too. This improves the health, comfort and wellbeing of older people, giving them security and peace of mind even when their personal needs grow with them. At the same time, the nursing staff and domestic helpers become more efficient as they are greatly relieved in the planning and administrative implementation. This reduces costs and leaves more time for the person being cared for.

The realistic testing of the IANVS system is an essential part of the co-design phase. In two field test phases, this will be thoroughly validated in test households in Switzerland. This realistic testing will also include knowledge of the daily routines and routines of the elderly, which ultimately must be recognised by the IANVS system. To this end, the terzStiftung has conducted extensive research, interviews and workshops. The results of this evaluation are significantly incorporated into the test runs and are described in detail in the following.

Moreover, this document also addresses various questions concerning ethical issues linked to the trial and especially user experiences and data security.

2.0 Introduction

Well-prepared field tests are indispensable and a prerequisite for further successful product development and ultimately also for successful market placement. These practical field tests serve to identify current weaknesses of the system, advantages and creative ideas for additional aspects to be implemented in the technology.

Those field trials are divided into two different phases.

The first pilot after month 12 is focused at calibration work and early prototype testing and will be carried out with 10 households. As the monitoring and support of the households is more intensive in this first phase, the number of participating households is also limited to only 10 households. In the second trial after month 20, a total of 25 households should be included in the pilot tests, consisting of persons in need of care and their relevant caregivers.

The field tests in these two phases will last about two months each. The field tests will focus on seniors who are still living independently but who fear or expect that they will become dependent on care.

For these field trials, it is planned to track the test persons over the entire period. It is intended that the test participants should represent a good mix of people who are still living at home, supported by informal or formal carers, and those who have already moved into a retirement home or assisted living facility, but still living independently.

This field test phase is preceded by a very intensive co-creation process. From the beginning on the end-users have been heavily involved. The early integration of end-users into the solution development process is essential to ensure that the final solution is user-friendly and fully self-explanatory. Ultimately, end-users must accept and use the solution with full confidence. The IANVS system must be both problem-solving and appealing to ensure future purchase readiness.

In this extensive and intensive co-creation process, the needs and requirements of end-users were investigated by the terzStiftung through extensive research of existing studies, several workshops with end-users and interviews. These researches and evaluations are crucial for the further development process of the IANVS system. Some of them have already been directly incorporated into the further development and conception and thus preparation for the test runs.

In accordance with this procedure, this document first deals with the preliminary phase of the field tests and the direct preparations. Subsequently, the details of the field tests and their progress are described once again in an overview.

3.0 Development cycles

M 1	M 12	M 20	M 24
March 2019	**February 2020**	**October 2020**	**February 2021**
Co-Creation Phase		**Field Test Phase / Pilot Phase**	
Online Survey End-User Workshops Interviews Evaluation of Studies and external literature – state of the art		Field Test 1 / Pilot 1	Field Test 2 / Pilot 2
		10 Households	25 Households
		Calibration Prototype test Technical / conceptional check	Pilot with more sophisticated prototypes

figure 0 - Overall process / scope / contents of the co-creation phase and pilot phase

3.1 Co-Creation Phase

The co-creation phase is of crucial importance for the overall IANVS project and the development for IANVS System. Therefore, the end-users are already involved in this first development cycle. End-users are the primary source of feedback and evaluation in all cycles of the IANVS project development process. The co-creation phase runs from M1 to M12 and its results have a direct influence on the subsequent pilot or field test phase.

3.2 Pilot Phase / Field Trial Phase

The pilot / field test phase immediately follows on the co-creation phase. The pilot/field test phase consists of two test phases. The pilot/field test phase 1 starts with M12 and ends with M19. The pilot/field test phase 2 starts with M20 and ends with M24. The field test phase serves primarily to improve the product and make it ready for the market.

4.0 Co-Creation Phase

Immediate involvement of the right target group of end-users in the co-creation process, who will ultimately benefit from the IANVS system, is crucial. The consistent and well-founded determination of the needs and wishes of the target group is therefore so crucial, as the IANVS system must be accepted by the target group with full conviction and approval. This is ultimately also the prerequisite for a successful and beneficial market launch and market presence. The requirements and wishes and feedback from end-users are of primary importance throughout the entire development process.

The main group of primary end-users will be the elderly between 70 and 85 years of age, those who are about to make the transition to an assisted living or nursing home. As a result of the workshops, research and interviews, a further focus is on the customer segment of prospective customers, tenants and buyers of apartments for senior citizens with services.

In addition to the previous workshops in November 2019 and December 2019 and their results, the terzStiftung organised another end-user workshop on 28th of January 2020, which focused specifically on the younger age group (50-65 years) as a target group. The objective of this complementary workshop was to identify and further explore the needs, requirements and desires of that IANVS system's "initial" target group.

4.1 Online survey with end-users

The co-creation process began with the online survey by the terzStiftung. The survey was titled: Age-appropriate living in your own four walls - equipment, support and the role of modern technologies. The online survey was conducted between 7th of May 2019 and 20th of May 2019 with 1274 participants and was completed with an enormous response rate of 33.5%. 89% of the participants are in the age group between 65 – 85 years. At this point we will highlight some of the main findings and results of this online survey.

Main findings and main results:

- It is astonishing that 85% of the participants are very regular using some smart devices at least once a week.
- A lack of information concerning existing solutions is especially present in the areas of emergency access, home automation and remote control, burglary (security systems) such as infrastructure for health monitoring and assistive technologies.
- 61% more than once over the past six months seriously thought about preparing themselves for age-appropriate living in the future. Additional 13% express that they are already fully prepared and «ready for the future».
- Nearly 50% of the participants dealt with the topic of age-appropriate living as a preventive measure. Another 15% did this in the context of a change of residence. It stands out that about 14% do not have dealt with the topic yet and have given no answer.
- 77% do have a desire to grow old in their existing living environment. Nearly 80% of them do have a large or very large desire to grow old in their existing homes. Only around 10% of all participants do not have that kind of desire.
- Two expectations do have clear priority for the seniors. The equipment in the age-appropriate home should meet current needs but be fully convertible for future requirements (38%) and the home must be barrier-free but at least fundamentally prepared for future needs concerning to the seniors possible future age restrictions (31%).
- There are five emotions which are mainly associate with the age-appropriate conversion of the home or moving to an age-appropriate apartment: release, satisfaction, relief, safeness and peace of mind. With a big gap these five emotions are the most succinct ones.
- Seniors got used to the implementation of sensors in their environment. More than ¾ of the consulted participants do feel comfortable when sensors take over control of equipment. At least 16% are undecided and have given no answer.
- Nearly ¾ of the seniors are not worrying about electrical or magnetic emission (electro smog) in their personal households using electronics. Only ¼ of them do have concerns or have no opinion about that topic.
- Only ¼ of the seniors are not willing that sensors document their fitness status / activities at home. Exactly ¾ of them are open for an implementation of sensors for documenting reasons. Especially in case of illness or physical frailty (45%) and if that helps others to take care of them (22%) they are willing to use sensors. Another 17% are open for the use of sensors at any time.

The complete evaluation with all results is attached to this document as **Appendix 8.1**.

4.2 Interviews with real estate and nursing homes

Based on the action plan of the kick-off meeting in Hasselt, the second part of the co-creation phase was tackled: Interviews with the target group REAL ESTATE and NURSES / NURSING HOMES based on the research agendas that was compiled at the Kick-Off meeting:

Research agenda target group « REAL ESTATE »

- Can we implant CORY (the system) as revenue source?
- Is there added value in having care institutions as a partner?
- Are there current logics of technology integration? Use of apps > service model?
- How much do buyers / renters influence the design of apartments?
- Do landlords also have interest in managing the services?
- Are there collaborations with service providers / health care? Trusted partners?
- Are there any incentives (especially public incentives) for private landlords to implant the system?
- What are the possibilities for integration in smart home infrastructure (e.g. key cards) + standards, APIs etc.?
- Can the system be integrated in the house increasing rent value?
- Should the system work independently or completely integrated in your (real estate) software solutions?

Research agenda target group « NURSES / NURSING HOMES »

- Because of all the current paperwork. Will they commit and how will they commit to the processes?
- How do they assess "the pain" of patient screenings on visits?
- What activities (IANVS System is able to track) are they interested in to track for the purpose of gaining time through that information?
- What current technology, software (time tracking, planning) are they already using?
- Do they already have any experiences in activity tracking? Is that a posteriori?
- Are they allowed and willing to trust the tracked info?
- Are there differences and accordance's of activities between nurses and household services?
- What are the differences and accordance's?

terzStiftung contacted several highly competent experts and organisations in Switzerland and Germany. Especially those experts in Germany have a very deep insight and a sound and recognized expertise in the area of smart home and AAL-Projects. One of the experts is working for German government authorities with the background in whole Europe and re-sponsibilities for nearly all AAL-Projects. terzStiftung also is in contact with the leading German real estate organization in Berlin.

Concerning the interviews partners in the nursing home area terzStiftung contacted several nursing homes and nursing homes leaders and interviewed them in regard of the research agenda.

Regarding both survey groups, the terzStiftung prepared a catalogue of questions based on the specifications of the share plan of the kick-off meeting. Those listing of questions is part of the **Appendix 8.2** of this document.

The interviews with the interview partners in the area of «real estate» were all be done by telephone. The questions for this target group were put together in a question form and were filled in by the interviewer during the phone calls.

Concerning the interviews with the interview partners in the area of «nurses / nursing homes» the interviews carried out in the form that the questions for that target group were asked during personal appointments which were done in combination with acquisition for nursing home surveys.

At this point we will highlight some of the main findings and results of those interviews:

Main results and key findings of the interviews:

- The aspect of having more safety is important for real estate, buyers, tenants and for residents and relatives but until now there is nearly no implementation of health monitoring systems based on sensors.
- There is no real implementation of complex monitoring systems yet.
- Already existing complex monitoring systems are often only used for demonstration purposes.
- There is no real interest of the real estate companies to bear responsibility to carry out the services of implemented AAL-systems by themselves.
- There are no empirical values concerning the interest of real estate companies for service packages of external providers.
- The implementation of monitoring systems into building projects very often failed because of high operating service costs and running costs. Especially high electricity costs for sensor-based products were criticized (e.g. sens@home).
- For both target groups the permanent operational readiness of the AAL-Systems must be totally guaranteed (electricity, maintenance, support). The non-existence of this permanent operational readiness was very often a « knock out » for projects / products in the past.
- Real estate companies and operators do not want to implant the data base of new implanted monitoring systems into their already existing IT-systems.
- Buyers and tenants often think that landlords collect all the data of all implemented systems for their own interest and because of that they assume that the landlords « know everything » (like big brother is watching you). This is a wrong assumption.
- Normally all providers of the different services collect their own data and use it for the purposes of « their » system / product.
- In both target groups the end-users of the systems / products may not have any reservations about privacy and use of data. Only without any reservation they are open to make use of the systems / products and benefit from it.
- Concerning the interests and demands of buyers and tenants related to using Smart home / AAL-infrastructure there is a distinction visible between applicants for nursing homes and assisted living in senior residences.
- Trends in the market regarding to changes and rethinking construction planning for both target groups are very difficult to estimate. Often there is a kind of hope connected with a generational change.

- In building design and construction planning for age-appropriate buildings most of the time simple AAL-technologies are demanded.
- systems with sensors are not scheduled or used. High-quality technologies are almost not used.
- For more safety concerning fall prevention in nursing homes there is only a demand for simple technologies e.g. by additional use of already present call systems which can only rudimentarily give safety in fall prevention.
- Real estate and planers observe that buyers are often well informed about products and possible applications.
- On the other hand, they realize there is often a lack of interest in technical solutions and their possible applications due to lack of technical interest. When this is the case that very often prevents and blocks the use of the systems.
- The implementation of high-quality systems for security and health monitoring in nursing homes often fail due to the costs especially the follow-up costs. As already pointed out more simple technologies and systems are used. Very often only already existing systems are expanded for additional use.
- Property developers and planers of nursing homes and age-appropriate living facilities shrink back for the costs to implement high-quality systems for security and health monitoring.

The complete evaluation with all results is attached to this document as **Appendix 8.2.**

As a complementary result of the interviews, a list of possible stakeholders for the implementation of the IANVS system is available (see also **Appendix 8.2.).**

4.3 External literature / state of the art

Caused in the research for the preparation of the online survey and the interviews with the two target groups «real estate» and «nurses and nursing homes» (see supplementary evaluations of the interviews in **Appendix 8.2**) and out of the personal interviews terzStiftung became attentive to different external studies. Three of those studies were examined by terzStiftung in more detail. All three studies examine the topics and backgrounds of « the use and implementation of AAL-systems / smart home technologies in the real estate and housing industry» and give an important insight into the real estate sector against the background of the extended orientation and objectives of IANVS.

Study No. 1

Feierabend-Studie March 2017
"Ambient Assisted Living: Zuhause 4.0 statt Altersheim"

Background of the study:
- 1.540 members were asked in whole Germany
- the members were asked in an online survey
- timespan of the survey: 03rd – 24th of February 2017
- 93% of the participants were in the age of 60 – 90 years

A selection of some meaningful results and key findings:

- Home sweet home: best agers (69,42%) would stay in their familiar living environment if possible – only 15% of them with use of technical assistance technologies.
- Greater satisfaction with AAL-systems: Seniors are interested in Ambient Assisted living and agree that digital technologies increase the quality of their lives.
- No fear of technology: Generation 60plus move with the times. Only 9% do are afraid of digital technologies – only every 10th senior. The biggest concern is data protection.
- Ready to invest: Almost 2/3 of the seniors are willing to spend up to 100 € monthly for the use of smart home technology.
- Big potential: The seniors think that technical equipment and assistance systems for health and safety issues are useful. But they hardly use those technologies yet.
- Top 5 of the most useful devices: mobile emergency call, motion detector and presence simulation, alarm system, automatic control of the heating system and medical assistance systems.

Which kind of devices and services do seniors find useful?
- 79,3% mobile emergency call
- 66,4% motion detector
- 56,8% crash sensors / fall prevention
- 44,1% medical assistance systems
- 33,8% support systems for taking medication
- 31,5% telemedicine / tele diagnosis
- 28,0% vital monitoring in the apartment

Conclusions:

There is a big difference between the number and the kind of technologies and services the seniors already use and their idea of which technologies and services they find useful and would love to use. The seniors put their main emphasis on the area of health and safety. There is an extensive potential which is unexploited.

Study No. 2

Studie 2015
«Smart Home- und AAL-Technologien in der Immobilien- und Wohnungswirtschaft»

Background of the study:
500 participants took part. 60% out of the area of "co-operative housing companies", 32% out of the area of "municipal and public housing companies" and 8% from the area of "private and ecclesiastical housing companies". 80% of all participants manage more than 500 residential units and about 2/3 of the companies manage more than 1.000 residential units.

A selection of some meaningful results and key findings:

- 50% of the companies already implanted at least one Smart home/AAL-system
- 2/3 of the companies are convinced about the efficiency of the available systems
- More than 50% express criticism concerning the price-performance ratio
- easy operation and low maintenance are the main criteria for investment
- more than ¾ of the companies would implant smart home/AAL-technology in connection with new constructions or renovations
- only 12% consider smart home/AAL-technology in planning of new buildings
- 60% do not consider the implementation of smart home/AAL-technologies in their planning
- Almost 60% of the companies do not feel adequately informed
- 80% are not planning to build up an inhouse smart home/AAL-competence. They prefer external partners. More than 60% see these partners in architects, planners and specialized consulting companies
- Most of the companies want to tie tenants and buyers to themselves by investing in smart home/AAL-technology. For 85% of the companies this is the primary motive.
- the willingness to invest is low. ¾ of the companies are willing to invest 20€ per square meter
- in the coming years the companies expect that up to 30% of the tenants will ask for age-appropriate living
- the companies see the biggest challenge in the development of sustainable business models, in a lack of technology acceptance of the tenants and the selection of suitable partners for the implementation of smart home/AAL-technologies

Conclusions:

"Big potential but also great need for qualified information". The planers in real estate business have recognized the potential of networked and smart home/AAL-technologies. In the future the companies will implant more modern technologies to save energy, to solve climatic problems in apartments and to increase the safety of the residents. On the other hand, there is a lack of qualified information givers. This is a chance for specialized consultants and consulting companies. Prior to the implementation of smart home/AAL-technology sustainable business models are to be developed and the acceptance of technology by the tenants/buyers must be increased. These concerns are to be pronounced and cleared with real estate companies. Real estate companies do need those solutions to tie tenants and buyers to themselves by investing in smart home/AAL-technology – their primary motive for investment in smart home/AAL-technology.

Study No. 3

Studie 2013
«GdW Branchenbericht 6 – Wohntrends 2030»
The key findings and results in many areas of the study matches with the results of the other two studies. Because of that in this study terzStiftung mainly set the focus on the additional aspects, findings and conclusions. Only in some respects some confirming findings are repeated:

These are the key findings and results:

People will make use of technical progressions more effective and intense. Based on a high-performance infrastructure for data transmission information will be generated and networked automatically. Smart home/AAL-technologies will work with that for supporting people in daily life. More technology integrated services for life support, care and health will be used. For real estate business there is bigger a chance for customer loyalty and to create new business areas. To offer service and network services directly on the company homepage is recommended. Because the change in classical health services new digital technologies will be used. Services for monitoring of vital data, telemedicine / tele diagnosis and medical assistance systems. Active health management for residents and prevention of dangerous situations and their impact are required. The income situation of seniors is changing and bear more risk poverty. Long-term and market-oriented business models must consider those low-income seniors. Most of the seniors will stay in their familiar living environment. More seniors are willing to change their residential location especially because of a better social integration and security of supply. By reason of the change in national care systems care residential communities and age-appropriate living will increase in number as alternative to inpatient care. Solutions which adapt to the changes of health needs of the residents are required. Real estate companies will become central providers of services. The cooperation with external service providers will expand. Supply contracts for lifelong living become the alternative to ordinary rental contracts. The living environment than grows with the need of support. The residents will pay for a basic package which can be adjusted. Across from the group of low-income seniors there will be another group of seniors who are financially strong. In form of a "service provider for living" or "residential partner" housing companies will be "the" central contact person. The responsible handling of "Big data" will open new business areas and will help to extend customer loyalty and customer satisfaction.

The complete evaluations of those three external studies with all detailed results and key findings are attached to this document as **Appendix 8.3.**

4.4 End-user workshops

4.4.1 Preparatory end-user workshops November 2019

In previous end-user workshops on 28th of November 2019 at the terzStiftung in Berlingen, Switzerland, most of the participants of the following end-user workshops on 4th and 5th December 2019 were prepared. In these preparatory workshops the end-users worked out the daily activities and daily routines to be recognized by IANVS. At the same time, they assigned these daily activities and routines to the individual premises regarding their execution. This was an excellent starting point for the two workshops on 4th and 5th December 2019.

figure 1 - This photo of the whiteboard shows an overview of the daily activities and routines developed in the preparatory workshops in relation to the course of the day.

4.4.2 End-user workshops December 2019

A strategy meeting was held at the terzStiftung in Berlingen, Switzerland on 25th and 26th of June 2019. Representatives of the terzStiftung as well as MagicView and its contractual partners took part. The content of the meeting included a three-phase plan for the IANVS system, the creation of the IANVS introductory video and the end-user workshops.

The IANVS introductory video was the basis for the end-user workshops in December 2019. This introductory video comprises three main application phases: "smart home / comfort", "monitoring" and "security" which directly are also connected to three consecutive age ranges:

Phase 1 – Smart home / comfort (age group 50-65 years)
Phase 2 – Monitoring (age group 70-80 years)
Phase 3 – safety (age group 80+ years).

The two end-user workshops were held at terzStiftung, Berlingen, Switzerland on the 4th and 5th of December 2019. In both workshops 6 participants took part each. Nearly all participants were long-standing "terzExperten" (end-users) from terzStiftung. Those "terzExperten" (end-users) are trained and qualified seniors, aged between 50 and 85 years, took part in their role as mature end-users and critical, informed customers.

The main goals of these two workshops can be summarized as follows:

Workshop UNIT 1 (4th of December 2019)
1. General assessment of the 3-phase concept for the implementation of IANVS
2. Validation of the 3-phase concept - smart home / comfort, monitoring and security
3. Validation of the value proposition in the IANVS introductory video

Workshop UNIT 2 (5th of December 2019)
4. Detailed analysis of phases 2 + 3 (monitoring and security)
5. Data collection and data transfer on individual problems that should be recognized and solved by IANVS

The whole workshop was split into two units. The participants of both units were different. No participant took part in both units. The participants of the first unit (4th of December 2019) were very well "prepared" and sensitized to the main topics because they also took part in another end-user workshop on 28th of November 2019. That workshop mainly was about the daily activities and daily routines of the same target group as in IANVS. These are the activities and routines that will be monitored by IANVS-system.

There was a "third unit" that was build-in between the two units with the end-users. The third unit was a very intense exchange between terzStiftung (presented by deputy general manager Mr. Stefan Kroll and project manager Mr. Jörg Niessen) and the technical staff of the other consortium members which simultaneously met in Steckborn. That exchange of the results of the first unit of the workshop took place in the afternoon of 4th of December 2019. The results of that exchange were integrated into the second unit of the workshop on 5th of December 2019. There was a constant "flow" of putting together results and evaluations of the main goals of the whole end-user workshop. With this overall concept of the end-user workshops, the terzStiftung has fully met the wishes of the project coordinator and the technical team. The consistent implementation of the concept has resulted in a significantly increased efficiency of the workshops.

DAY 1 – Unit 1 (4th of December 2019)

Background
Because nearly all present participants also took part in the preparatory workshop of the end-users on 28th of November 2019 (see above) the workshop started with a short recap of the previous workshop. That was very helpful to the participants "to quickly be back" in the main topics which are now decisive for the evaluation of the IANVS introductory video .

Directly after watching the "IANVS introductory video" the participants were asked to give their first unfiltered overall impressions and to have an open discussion about that. That un-filtered first impressions are particularly desirable and valuable because as mentioned nearly all participants took part in the end-user workshop on 28th of November 2019. Most of the worked-out end-user requirements and solving approaches of that former workshop are cov-ered with the possibilities of IANVS system.

Overall impressions and open discussion - results

- The system must be flexible
- The question of cost is decisive
- High starting price for installation of the basic infrastructure
- Long lead time from project phase to concrete implementation
- Total user dependency in phase 1 – danger of incapacitation!
- What is perceived as negative in phase 1 can be positive in phases 2 + 3
- Fast pace of technology / sensors - «Keep up» from development to implementation
- Paternalism = no go!
- "User" absolutely has to want to do it himself - not «to put it on the "user" »
- Too little future-oriented and independently thinking – danger!
- Danger of relying unhealthily on the system
- What is necessary - what do I need now
- Only implement what is necessary, not implement what is feasible!
- Raising awareness of actual needs – system always tailored to current needs

- Competitor products already on the market? Reference to other AAL products / projects
- Surveillance - what level of surveillance for which emergency
- System should only act in emergency situations, otherwise run in the "background"

Following the complete viewing of the introductory video without interruption, the end-users watched the video again in single sequences. These sequences correspond to the three phases and age periods already mentioned in which IANVS can be implemented for the various applications of each phase. After watching each video sequence (partially repeated) the participants had an open discussion concerning the exceptional aspects and presented solutions of each sequence:

Phase 1 – Hans und Vera - **Smart home / comfort** (age group 50-65 years)
Comfort functions: light control, heating control; TV Control

Impressions and open discussion – results to phase 1

- To have more interested parties with the basic package "comfort" the costs must be kept low
- Is perceived by most of the participants as superfluous to negative - Could also be omitted!

Phase 2 – Gyp - **Monitoring** (age group 70-80 years)
Activity tracking, information transfer to caregiver / doctor / nursing staff

Impressions and open discussion – results to phase 2

- Make sure to include health measurements
- Include more monitoring functions
- Target group-oriented individuality in the monitored activities
- Main approach also fall prevention
- Focus on monitoring - of the 3 phases, phase 2 is considered the most pronounced. See also Clustering Whiteboard (**see *figure 10***)

Phase 3 – Piet and Michel - **Safety** (age group 80+ years)
Fall monitoring, correction of false alarms, registration of nursing staff and aids

Impressions and open discussion – results of phase 3

- Nursing staff may not be completely replaced due to the reporting obligation - legal reasons (objection of a nursing service management)
- Systems / sensors must be waterproof to monitor the risk of falling shower, tub
- Use / adaption according to the disability or restriction of the user
- Modular design of the system - must be individually applicable / adaptable
- Subsequent implementation in existing apartments should be possible
- Retrofitting in old buildings possible
- Costs must be affordable - everyone who wants should have it / can afford it
- Foreign control should be avoided
- Cost absorption by health insurance companies etc. possible? - especially in case of subsequent implementation
- Acceptance by target group - the person concerned must absolutely be willing
- In old age more withdraw from technology, could be contrary to openness to system
- Assessment for target persons - Needs analysis

- Support must also be personal - it is important who informs and educates about the possibilities of the system (trust)
- Communication between the suppliers of the individual product components is important
- Education in society must be much stronger - still too little
- The system must be made accessible to all those in need
- Security (Phase 3) most important - most important reason for implementation!

In the preceding end-user workshop on 28th of November 2019 the participants elaborated and analysed the daily activities and daily routines of the IANVS target groups that will be monitored by IANVS-system. An overview of the daily activities and routines developed in the preparatory workshop in relation to the course of the day is shown on *figure 1* of this document.

In this context, the participating end-users particularly emphasized the flexibility in the execution of daily activities and routines. This flexibility of activities must be considered in addition especially in connection with the differentiation of alarms and false alarms for IANVS system:

- **Individuality** "every day is different, for example I don't get up at the same time every day. Anytime between 6:30 and 10:30. There are nights when I sleep well and nights I don't sleep well and so I get up doing something."
- **personal routines and habits** (rinsing out the cup before putting it under the coffee machine)
- **daily** activities (toothbrushing) vs. **periodically recurring** activities (doing the housework)
- Activities within a **loop**
    - "Is the loop completed?" → "which activities are still missing?"
    - E.g., Do the laundry: sort the laundry > wash the laundry > hang out the laundry > take the laundry off the line > iron > put the clothes into the wardrobe > wear clothes > sort the clothes for washing
- **time-dependent** (morning toilet) and **time-independent** activities (doing the laundry) The system should consider that even time-dependent activities are not always carried out exactly at the same time, but have a certain flexibility
- applicable for **room-dependent** (cooking, showering) as well as **room-independent** activities (drinking, turning off the lights)

In this context the end-users in the preceding workshop not only elaborated those daily activities and daily routines but as the next step they assigned these daily activities and daily routines to the individual living areas for which these are primarily relevant. The daily activities and daily routines shown in *figure 1* were allocated to the residential area's kitchen, dining room, washroom, bathroom, corridor/hall, living room and sleeping room. Daytime activities and daily routines that could not be clearly assigned to the individual living areas or that can be performed in several living areas were assigned to an empty room (multifunctional room).
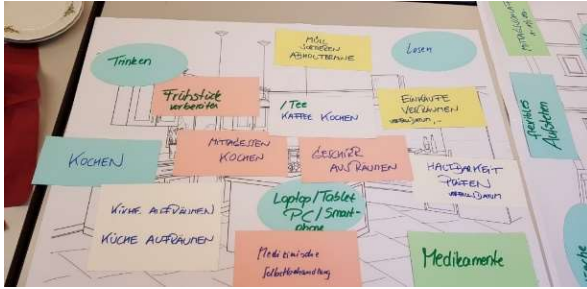
figure 2: primary activities in the kitchen
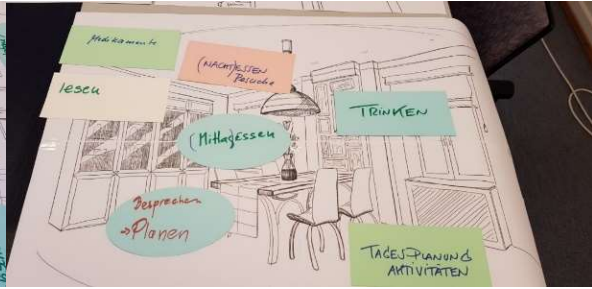
figure 3: primary activities in the dining room

figure 4: primary activities in the washroom
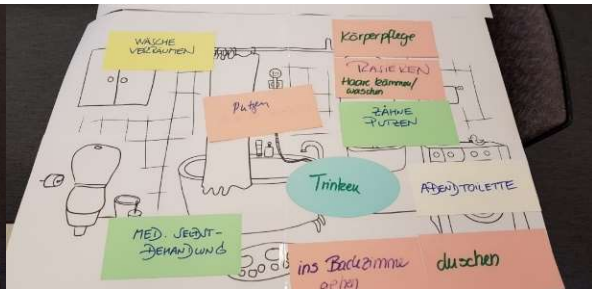
figure 5: primary activities in the bathroom

figure 6: primary activities in the corridor / hall

figure 7: primary activities in the living room

figure 8: primary activities in the sleeping room

figure 9: room-independent activities

The pictures of the allocation of activities and routines to the individual premises can be viewed in **Appendix 8.4** to this document in original size.

As final step of unit 1 of the workshop the participants assigned these daily activities and daily routines to the three phases of "IANVS introductory video": Smart home, Monitoring and Safety.

figure 10: Clustering the daily activities and daily routines into the three phases of "IANVS introductory video"

Final discussion – key findings and main results of unit 1

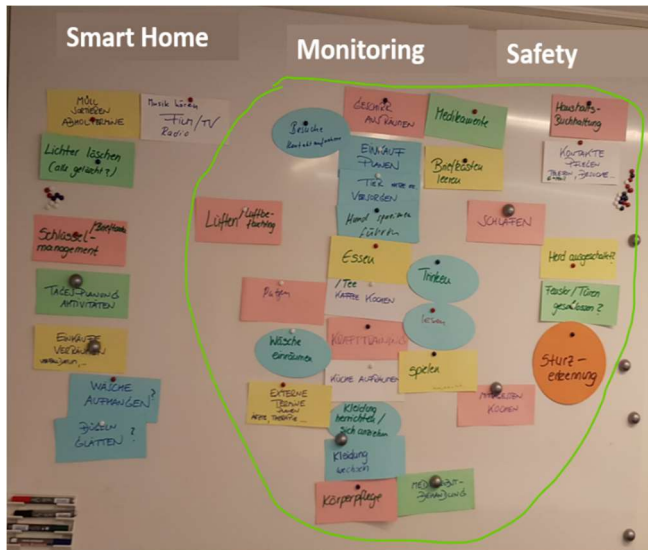To finalize unit 1 the participants had a final and very intense discussion and analysis of the already elaborated impressions, findings and results. They contemplate on all the elaborated facts so that besides the detailed results (see above) the following key findings were carved out:

- Security (Phase 3) most important - most important reason for implementation!
- Focus on monitoring - of the 3 phases, phase 2 is considered the most pronounced. See also Clustering Whiteboard **(see figure 10)**
- Costs must be affordable - everyone who wants should have it / can afford it
- Acceptance by target group - the person concerned must absolutely be willing
- Focus on people, not on the technical possibilities
- System must adapt to the user and not the user to the system
- Modular design of the system - must be individually applicable / adaptable
- System must "grow" with the personal needs
- Only implement what is necessary, not implement what is feasible!
- "As much as necessary, but not as much as possible"
- Fast pace of technology / sensors - «Keep up» from development to implementation
- Life span of technology / sensors
- Subsequent implementation in existing apartments should be possible
- Retrofitting in old buildings possible
- Support of skills instead of complete assumption of tasks

Supplementary results and findings of Unit 1 concerning "Prioritization of daily activities and daily routines" are detailed in **Appendix 8.4** of this document.

DAY 2 – Unit 2 (5ᵗʰ of December 2019)

Background

As already mentioned, a "third unit" was build-in between DAY 1 – Unit 1 (4ᵗʰ of December 2019) and DAY 2 – Unit 2 (5ᵗʰ of December 2019). That "third unit" was a very intense exchange between terzStiftung and the technical staff of the other consortium members. The results of that exchange were integrated into this unit 2.

Supplemented with the results from this exchange the unit 2 had a focus on two questions:

- Because phase 2 and phase 3 in "IANVS introductory video" were considered the most pronounced **(see *figure 10*)** the participating end-user did detail analysis and evaluation on those two phases.
- The participants also did detailed analysis and evaluation on data collection and data transfer for individual problems to be identified and solved by IANVS.

Method / Procedure

Since the participants of unit 2 as intended mainly not took part in unit 1 and in workshop on 28th of November 2019 started with a short recap of the previous workshops and their results. In connection with this the participants watched the "IANVS introductory video" without interruption.

Detailed analysis and evaluation of phase 2 (monitoring) + phase 3 (safety) of "IANVS introductory video"

In an open discussion phase 2 (monitoring) and phase 3 (safety) were elaborated especially by analysing the clustering of the daily activities into the three phases of "IANVS introductory video" in unit 1 **(see *figure 10*)** and the following questions:

- With whom do you already / would you share your information today (monitoring)?
- For what purpose do / would you share this information?
- Acceptance concerning technology, data collection and data transfer?

Results of evaluation and analyses
Results assigned to individual generic terms

Modular concept
- growing with the needs of the user (individual adaptability and individual starting point!) (defining extent of support / content / activities)
- provide only as much help as necessary, not as much as possible"
- fear of loss of control: «technology takes thinking out of my hand»
- the user should decide "What is necessary? What do I want?"
- the system should rather enable than taking over everything → because of the fear of speeding up the process of cognitive decline due to the complete takeover by the system and an associated loss of control over the personal life → NO paternalism!

Accessibility
- be easy to install / retrofit / extend / remove regardless of the spatial conditions
- caregiver should be able to change configurations according to the current user needs

Data protection
- deal responsibly and conscientiously with personal data "protection of personality rights"
- only data should be gathered for which there is a concrete purpose, or which is necessary to help the user with coping of daily life (recognizing dangerous situations of highest importance)
- data must be deleted immediately when they are no longer needed (preferably at the end of a day)
- trends/statistics concerning health issues are ok, but only as far as they are needed to optimize personal health

- There is great uncertainty regarding data abuse → local storage must be guaranteed, data transfer only with the consent of the user, no network access!
- The user should determine how data must be handled (daily automatic deletion of data or after a defined period)
- Only authorized access by third parties with agreement of the end-user

Technology acceptance
- **Sensors:** high acceptance
even if it is not (directly) part of IANVS – but it popped up immediately and highlights the use of sensors!
- **Cameras:**
  - No face capturing; preserve anonymity, is accepted if the data is stored only on a local server without external access
  - Cameras should only be used if the problem cannot be technically solved in another way
  - Uncomfortable feeling that someone is watching you
- **Smart bracelet:** widely accepted, visual appealing

Willingness to use the system
- Focus on assistance (Monitoring) rather than early adoption (Smart Home) → there is a tendency to use the system not before there is a need for assistance
- When help is needed regarding safety issues (medication intake, hydration)
- when health-related impairments affect daily life and I am aware of this and want help

Willingness concerning data collection and data transfer
What personal information would you be willing to share and with whom?

Profile information	Willingness to share
Personal information (name, first name, date of birth, gender, living/living conditions, family status)	Only as far as necessary
Current physical condition	As far as necessary for the treatment by the therapist / doctor
Current cognitive condition	As far as necessary for the treatment by the therapist / doctor
Family medical history	As far as necessary for the treatment by the therapist / doctor
Medical treatment/medication	Ok if it ensures the regular intake of medication
Personal habits (e.g. daily routines)	As far as necessary for the support of activities of daily living

- The sharing of information depends on the perceived benefits → the greater the personal benefit, the greater the willingness to share information
- Only data should be collected that the system absolutely needs to support the user with performing activities of daily living
- Support of vital parameter measurement and transmission is considered useful

Supplementary results and findings of Unit 2 concerning "data collection and data transfer" are detailed in **Appendix 8.4** of this document.

Final discussion – key findings and main results of unit 2

To finalize unit 2 the participants had a final and very intense discussion and analysis of the already elaborated impressions, findings and results. They contemplate on all the elaborated facts so that besides the detailed results (see above) the following key findings were carved out:

- internal information transfer to family members without problems
- external transfer of information only situational and to a person of trust
- results-oriented information transfer
- Data transfer depends on personal benefit
- Readiness for data transfer is phase-dependent, situation-dependent and usage-dependent
- depending on the health insurance model, data transfer to the family doctor is mandatory
- also important is the relation of costs to benefits / added value
- in general, users are not always aware that data is passed on (e.g. mobile phone, bank card)

4.4.3 End-user workshop January 2020

In addition to the end-user workshops in November 2019 and December 2019, the terzStiftung held another end-user workshop on 28th of January 2020.

In this supplementary workshop, some of the questions of the previous workshops were dealt with in greater depth. While the workshops in November and December 2019 covered the age group 70+ and 80+, this workshop consists of participants in the age group 50-65 years. The supplementary workshop was held at terzStiftung, Berlingen, Switzerland.

The reason for this supplementary workshop was two objectives:

First and foremost, the consortium partners wanted a supplementary, in-depth evaluation of the value proposition of Phase 1 "Smart Home / Comfort" of the IANVS concept and the IANVS introduction video. Secondly, a first "preliminary investigation" of the topic Quality of Life survey (SF-36) in connection with the IANVS system should take place. Since this second part of the workshop has no influence on the upcoming pilot/field test phases, this second part can be neglected here. So, workshop UNIT A is important as a completion of the co-creation phase:

Workshop UNIT A

Background / Preparation

The AAL project IANVS was presented by the workshop leader in short form and limited to the main outlines and contents. To complete and create the right basis for the in-depth workshop, a summary review of the previous workshops held in November 2019 and December 2019 was given. For this purpose, the workshop leader used a PPT presentation that presented the contents and results of the four previous workshop units in a compressed form.

Method / Procedure UNIT A

Right afterwards the participants directly watched the "IANVS introductory video" – first time without interruption. The "IANVS introductory video" shows applications of IANVS-system

divided in the different application phases. At the same time those three application phases are directly interconnected with three age groups:

Phase 1 – Smart home / comfort (age group 50-65 years)
Phase 2 – Monitoring (age group 70-80 years)
Phase 3 – Safety (age group 80+ years).

Directly after watching the "IANVS introductory video" the participants watched Phase 1 – Smart Home / comfort – again in detail.

With this in mind, the participants start an exchange and open discussion about their first spontaneous impressions.

Overall impressions and open discussion - results

- There is distrust / great mistrust of the use of a universal "remote control"
- There are fears of a loss of control or even the danger of incapacitation
- The danger of promoting comfort too much
- User moves less / too little
- Own initiative gets lost / more and more lost
- Fundamental mistrust
- Centralised surveillance
- Loss of autonomy
- Positive: support for absence simulation
- Positive: use of the system with immobile persons, after stroke etc.
- As personal needs for assistance and security grow, so does openness to the system
- The dignity of the user is touched
- The interest in technology and comfort is not strong enough for the implementation of the system
- Negative: existing devices can no longer be used in conjunction with the system

Immediately after the exchange and collection of the first, rather spontaneous impressions, thoughts and experiences, the participants entered an in-depth discussion and evaluation of the "Smart Home / Comfort" phase. To achieve this, the participants were asked the following questions:

- How do you feel as a user in the "Smart Home / Comfort" phase?
  What do you as a user feel in the "Smart Home / Comfort" phase?

- How do you feel about the value proposition of the "entry" phase of IANVS?
  What appeals to you about the value proposition of the "Smart Home / Comfort" phase?

- What personal experiences have you already had with Smart Home?

- Is the value proposition of the "Smart Home / Comfort" phase a welcome start for you?

- How do you otherwise imagine the "entry" into the IANVS system, which is growing with you?

Key findings and main results of the in-depth discussion and evaluation

- The entry and acceptance of IANVS is not age dependent
- A great fear is the total control by technology
- High demands are placed on system security and system reliability
- Dangers with data access and data use up to virus attack and data misuse (black-mailing by hackers)
- Practical implementation of the setting (basic setting) of the system
- Integration of already existing devices: is that even possible? How is this done? Who implements this?
- There are more and more devices in the household that are directly connected to the internet
- Through big data analysis the system is self-learning - this causes anxiety and dis-comfort
- What happens when the personal situation of the user changes?
- The willingness to invest decreases with age
- The end-users find the system very complex, with the risk of dealing too much with the issue of constant adaptation of the system: Which service, which app do I have to add now?
- The complexity of the system is perceived as negative, oppressive or even over-straining
- The whole subject around the system is very fast moving and subject to very con-stant changes (technical and personal)
- Fear that the individuality of each household cannot be represented and taken into account.
- Household appliances increasingly have their own comfort functions or autonomy
- Early entry or entry into the basic system in younger years is rather seen as ques-tionable, also because of the implementation of the own, existing devices
- The use of the system is seen by some participants rather in nursing homes, hotels, rehabilitation facilities, single households and business apartments - all services and functions optimally coordinated.
- The children's departure is seen as a good time to enter the system
- Additional benefits in the area of remote home monitoring during absence
- All functions that have the appearance of "player entry" are perceived as negative especially when retrofitting the system, there are great concerns about the equipment brought in by the user
- As need increases, so does the interest in entering the system
- Neediness is seen as the main criterion for entry into the system
- In principle, a local, autonomous network is preferred for the operation of the system. access to the web is negative and not all services should be networked.

Concluding remarks to UNIT A

The end-user group (age 50-65 years) does not differ significantly from the end-user age group (70+ and 80+) in its openness and basic attitude towards phase 1 of the IANVS introduction video - Smart Home / Comfort. The end-user age group 50-65 years also sees the entry into the IANVS system less as an age-related background and more as a reference to the needs of the individual user. Increasing comfort through Smart Home and the appeal of the technology are not enough driving forces for an early entry into the system. Loss of self-control and independence, up to perceived incapacitation and also the complexity of the system are named as reasons against an early start. This age group is also very concerned about data security, data use, data transfer and possible data misuse. The neediness and suddenly arising neediness due to accident, illness or other life circumstances are mentioned as main reasons for starting at "younger" years.

Remark - Explanatory note

The two project phases - co-creation and field tests - are by concept (DoW) inseparably intertwined. The end users are intensively involved in the process right from the start of the project until the very end. Ongoing review and reflection by end users also take place through workshops and interviews during the ongoing field test phases. End-users and field test participants are mutually involved in the validation and further development of the IANVS system. This deliberate strong involvement of formal and informal end-users both in the co-creation process and in the pilot phases is necessary as they will be the main users of the IANVS solution. The findings and results obtained in the co-creation phase serve as orientation and have a direct impact on the field test phase. The conceptual requirements of the IANVS system regarding usability, user-friendliness, reliability and system acceptance are thus permanently tested by the end users, thus ensuring that the final IANVS solution meets the requirements of the end users, convinces them and is accepted. Due to this interdependence of the two processes it is necessary to include the detailed co-creation process also in this deliverable.

5.0 Pilot Phase / Field Trial Phase

The pilot / field test is divided into two phases: pilot / field test phase 1 from M12 to M20 and the pilot / field test phase 2 from M20 to M24. These two sections differ in their requirements, scope and objectives. Both sections build on each other. To comply with the target groups, the main focus for the field tests will be with seniors still living independently (no full-time institutional care) but who expect or fear to become care dependent. The field tests in both sections will take place for approximately two months each as in line with the DoW.

5.1 Field trial PILOT 1 Overview

PILOT 1 starts immediately after the co-creation phase with M12. Pilot 1 will be conducted with a total of 10 households in Switzerland. The first pilot after M12 aims at calibration work and early prototype testing. Considering that a focus needs to be put on technical and conceptual aspects that require in-depth monitoring and assistance to the household, the number is lower than in the second round where more mature prototypes will be included.

5.2 Field trial PILOT 2 Overview

PILOT 2 starts with M20 and ends with M24. In the second trial after M20, a total of 25 households should be included in the pilot tests, consisting of person in need of care and the relevant caregivers (= Total of 50 persons).

5.3 Research Objectives

The objectives of the field tests are clearly defined. The objectives begin with the assessment and testing of the basic functionality of the system and the individual system modules. The basic functionality in practical use must be determined. Questions such as e.g. "Does the system function reliably?" Or, "does the system work in different households,

household sizes etc.?" Another focus of the objectives is the user-friendliness and usability of the system. "How do the users handle the system?" "Do the users understand how the system works in terms of personal benefit, not the technical background?" One of the most important, if not the most important objective is to examine the acceptance of the system and the technology associated with it. Additionally, the system's learning algorithms, their effects and end-user's perceptions of these will be put to the focus. At this point, it is especially important to get a better understanding of the accordance of the system's adaptation to user behavior and the end-user's opinion on the efficiency. Directly linked to the system learning algorithms is the further objective of investigating in detail the detection and assessment of false negatives and false positives system messages. The aim is to achieve a very high level of reliability and thus added value for the system.

Overview research outcome parameters

- Functionality of system features / System integration
- System reliability (outside lab setting)
- Insights on learning algorithms
- Technology acceptance
- Usability
- Fit with user behavior and lifestyle (integration into daily routines, physical and social environments)
- Overall perception and satisfaction

5.4 Methodology

In order to achieve these goals, the field tests are divided into two phases, as described in the overview. In the first field test phase (Pilot 1), important calibration work is carried out on the system. The prototype tests in Pilot 1 are primarily used for technical and conceptual checks. Therefore only 10 households are involved in this first field test phase. The monitoring and support of the test households is of great importance in this phase, but also very complex (costs and time).

In the second field test phase, starting with M20, more sophisticated prototypes of the system will then be available and used. Therefore, 25 test households are involved in this second field test phase. The field tests will focus on senior citizens who are still living independently (do not require full-time care) but who expect or fear that they will need care. The two field test phases will last about two months each.

The IANVS system is installed and calibrated by a technician at each participants home of the two field test phases. This applies equally to both field test phases. The installation procedure with its individual steps is explained in detail in section 5.7. (Installation of the IANVS System).

Once installed, two personal interviews with the participating end-users will be conducted over the course of both pilot trials:

First, at the beginning of each test trial, in order to cover already existing experiences and personal background and to survey expectations on IANVS.

The second personal interview will be carried out after the test trial of about two months. All relevant aspects, e.g. user satisfaction, user-friendliness, usability, technical acceptance and acceptance of the IANVS system, will be prompted then. This interview structure ensures data collection of all relevant aspects and allows for the analyses of changes during the trial periods. Both interviews will rely on questionnaires designed by the end-user organization terzStiftung **(see Appendix 8.6 + Appendix 8.7).**

Additionally, to these two interviews, the participants will be provided with a voluntary diary. The main purpose of this diary is to collect daily information on the ease of use, general satisfaction with the system and to serve as an error log. The participants will be instructed on how to use the diary; besides general comments on satisfaction, types of activities, changes in personal behavior linked to the system and also the state of mood and special remarks are from great importance and should be written down. Likewise, problems identified by the participants which are linked to the functionality and the novel features of IANVS system, e.g. non-satisfactory adjustments to personal behaviors and flawed room policies, are relevant for the future improvement of the system. The entries of the field test participants in this field test diary are also important for the assignment of personal daily activities and routines to the identified hot spots. These entries can also be very helpful here for any necessary adjustments. This is particularly important in the first field test phase, as it allows important optimizations to be made to improve the hardware and the overall system for the second field test phase.

5.5 Equipment and Features

Throughout the two field test phases, the hardware prototypes used will be further developed. Pre-tests have already been conducted by the end-user organization terzStiftung with an original variant of the prototype of the sensors of the IANVS system. These pre-tests have yielded very important findings regarding the power supply of the sensors and thus the system's standby time. MagicView has already acted and the field tests will be carried out with an improved version of the sensors.

The core of the product proposition is an UWB ("ultra-wide band") IoT ("Internet of Things") infrastructure (based on the DW1000 from Decawave9), carried out as an Infrastructure fixed to the room(s) of the Client's residence. UWB is a radio technology that can accurately determine the distance between sender and transmitter, with a resolution of 10 cm, by determining the travel time of the radio wave (at constant speed of light). The Ring Conduit is designed for ease-of-installation and contains UWB nodes at fixed positions in space. Once installed, the fixed positions in space are determined using an automated "Autocalibration" algorithm, resolving the mutual distances of the nodes.

These fixed positions serve as an anchor to localize *wearable* UWB nodes, carried by the field test participants. Using TDoA (Time Difference of Arrival) multilateration, the position in 3D of these wearable nodes can be determined. To realize 10 cm location resolution always, Big Data algorithms are used to enhance the sensor data, e.g. to cope with reflections of the

radio signal or obstructions in the radio path, leading to longer radio travel paths and hence to localization inaccuracies **(see graphic below).**
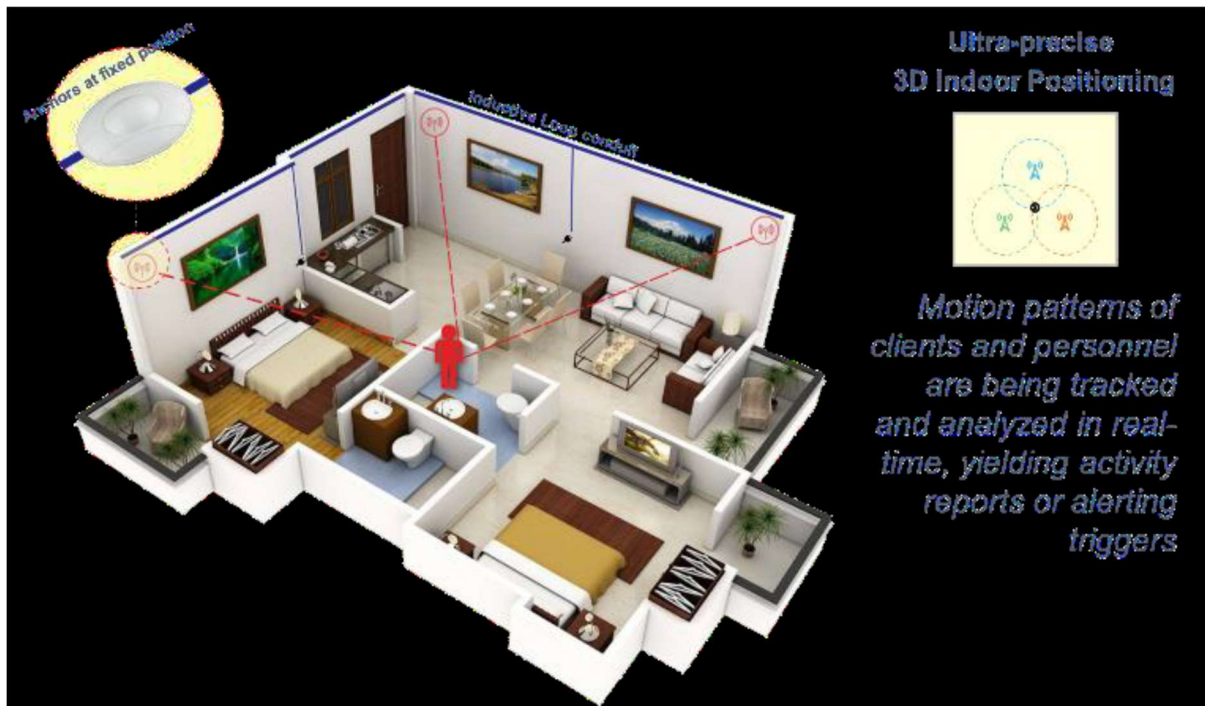
The wearable (portable device) worn by the participant gets the form factor of e.g. a necklace or an arm strap. By periodically assessing the client's position in the house using Big Data analysis, various incidents, such as falling, can be escalated in real time, i.e. an alarm cascade is activated, first calling the volunteer carers; if they don't respond escalating to emergency when needed. The wearable is tracked even if it is not used by the participant, e.g. is lying on the nightstand. This condition is detected by the Big Data analysis as well, triggering an incident on its own.

5.6 Recruitment of Participants

For the IANVS project, terzStiftung, Switzerland recruit participants who are willing to test the novel system in their own houses / apartments. The end-user organization terzStiftung has a broad network among older adults living independently at home or in apartments for senior citizens so that the IANVS system will be tested in realistic environments.

Since the IANVS system is suitable for rooms of any size, there are no restrictions on the number and size of rooms. However, for the experiments the user can choose to include only parts of his premises. It goes without saying that all rooms should be included to increase the significance of the field tests. Then the overall picture of the daily activities and routines of the participants can also be depicted and examined.

There are no real exclusion criteria for the selection of the field test participants. The only "exclusion criterion" is that the participating seniors are not in full-time care in an institution.

For the field tests, the terzStiftung will select seniors who are still living independently but who expect or fear that they will become in need of care.

An even distribution of the sexes is aimed for but is not of major importance for the field tests. The selected and participating test persons are tracked over the entire period of the test phases. An affinity for technology or a special understanding of technology is not required. An already existing personal interest in new techniques is certainly an advantage, but not a condition.

For the first field test phase (M12 - M20) the terzStiftung will recruit a total of 10 test persons with one accompanying person each and for the second field test phase (M20 - M24) a total of 25 test persons in need of care (no full-time care) with one accompanying person each.

As pointed out, the end-users are involved in the development process right from the start of the project. End-users must be integrated in the process of developing the solution in order to make sure that the final solution is fully user friendly and self-explaining . In the end, the end-users must accept this solution because it convinces them. It needs to be both problem solving and appealing, to guarantee future inclination to purchase. End-users are thus constituting the primary source for feedbacks and evaluations at all cycles of the development process. The end-users will be actively involved throughout the entire development process. This was done through workshops and interviews by the terzStiftung even before the field test phase begins. The end-users will continue to be involved by means of workshops during the two field test phases. This is in addition to the personal interviews that are conducted with the participating seniors at the beginning and end of the two-month field tests. The focus of the investigations is on the functionality and reliability of the system, data security, user-friendliness and usability, and in particular the acceptance of the system. Special emphasis will be put on considerations regarding technology acceptance – to make sure, that users believe and trust in the solution and that they are willing to integrate it into their daily life.

We therefore distinguish two levels of end-user integration. On the one hand, the end-users are involved in the entire co-creation process through these workshops, interviews, etc. and on the other hand through the field tests in the test households. These two stages run in parallel during the field test phases and practical tests in the households, as described above.

The recruitment of the test households is carried out by the end-user organisation terzStiftung. The aim here is to include both individual test households and apartments that are grouped together in a senior citizens' housing complex (no assisted living or nursing facility). In both cases it is guaranteed that the test persons fulfil the specified conditions. One of the preconditions is that these seniors live independently (no full-time care) but expect or fear that they will need care. The age of the participating seniors living in the test apartments will be between 70-85 years. Inclusion will not take place based on specific medical diagnoses, but on the requirement of dependency on care.

5.7 Installation of the IANVS System

The IANVS system will be installed in each participant's home. In the first field test phase, the installation will mainly be carried out by a technician from the consortium partner MagicView. The basic technical installation of the MagicView Indoor Localisation (TRL-6) forms the basic platform for the IANVS system. The technician will also carry out the necessary home topology assessment, deployment and calibration of the system.

To do so, several pictures of the interior of the various rooms from various angles will be taken, in order to compose the floor plan. A 3D CAD model will be obtained of the interior, and the infrastructure deployment will be added to the CAD model by the deployment planner. This results in clear instructions for the technician to mount the hardware, so that in-the-field deployment is as efficient as possible. Also, this results in a comprehensible floor plan which will be used for the monitoring and social alarming use cases. This is done using a simple web-based 3D sketching tool, whereby the floor plan is quickly defined by digitizing the contours and the main objects ("hot spots") are defined. This sketching tool should be usable for the inexperienced user and should complete the floor plan in less than 1 hour. The technician rolls out the hardware, featuring the fixed-position beacons.

An autocalibration procedure (already existing) determines the relative position of the beacons by examining the acquired distance between each pair of beacons. These relative positions are then correlated to the CAD model, by asking the technician to locate a set of known reference points in the CAD model, as prepared by the planner. After triangulating these reference points, the absolute position of the beacons can be established. In the first couple of weeks of operation, favourite locations will be assessed and mapped to the CAD plan. These hotspots can then be manually attributed ("couch", "kitchen sink", "bed", "nightstand"), to utilize in the social alarming tracking use cases (hotspot assessment). Important: Hot Spot assessment will be carried out based on the topology sketch tool, not the other way around.

At a later point in time especially in the second field test phase it is intended that the basic installation of the IANVS system will be carried out or supported by a trained employee (e.g. terzStiftung).

5.8 Field Trial procedure

For both field test phases, the participating households will be equipped with the IANVS system for a period of two months each. The installation of the system will be conducted by professionals from the IANVS technical team. The terzStiftung as end-user organization will inform the participants about the IANVS system and how it works. A personal in-depth interview with each participant will be conducted also by terzStiftung at the beginning and at the end of each field test. In the first weeks of the respective field tests, the favored locations, the so-called hotspots, are recorded. These hotspots can then be manually attributed ("couch", "kitchen sink", "bed", "nightstand"), to utilize in the social alarming tracking use cases and are shown in the CAD floor plan of the respective test apartment. At the same time, the daily activities and routines of the test persons are recorded by collecting

this big data. At the same time, the test persons keep the aforementioned diary in which they list their daily activities and routines with the key data.

After the trial period, the IANVS system is dismantled by an IANVS technician from the participant's home. The final in-depth interviews with the participants will be conducted through terzStiftung shortly after the removal of the system to guarantee fresh memory and valuable insights.

6.0 Ethical Issues

First of all, the basic attitude of the consortium must be noted:

The consortium partners are well aware of the very sensitive privacy issues involved with real-time location tracking. They pledge that they will be fully compliant to the recent EU GDP Regulations, which all consortium partners warmheartly support.

6.1 Declaration of consent

Before starting the trials, each participant (senior and all others involved) should sign an informed consent document **(see Appendix 8.5)**. The participants will receive written and oral information.
In this declaration of consent, all data that must be collected when participating in the field trials are specified. The overall project will be described in simple terms and in a way that is easy to understand for all participants. The test participants are also informed that they can withdraw from the test at any time and that they will not be disadvantaged in this case.

6.2 Monitoring and Support

Regular communication and monitoring of participants is key during these test periods; special attention will be put on informing the participants that they are testing a prototype and not a market-ready product. This ensures both highly qualitative feedback and reduces the potentially too high expectations of the test participants.
All information collected during the pilot tests that are personal will be used only in the scope of the project. In this way, the personal data of the participants of the field trials will be kept private. No personal data or other possible intrusive information will be accessible by others within or outside the project. All data regarding individuals" opinions and ideas regarding the project outcomes will be collected anonymously and on group level if possible.

6.3 Data storage and data protection

All security and privacy aspects of the personal data management and the implementation of the solution will be considered in the WP4 (co-creation phase and field test phase). The IANVS solution will ensure the anonymity and privacy of old adults and ensure the control of access to personal data.

The consortium will not use public hosting solutions like Amazon and others. Anonymized data will be accessed only by the IANVS consortium and it will be used to validate that the system is functioning correctly.

All information gathered during the requirements assessment and the technological readiness analysis will be treated strictly anonymous in good compliance with scientific standards and the GDPR. The server that hosts the data is situated in western Europe.

The end-user organisation terzStiftung will ensure that the national laws and regulations for working with the test persons are observed. Medical ethics committees will only be involved if necessary.

The consortium will especially observe the following rules and laws:

• The General Data Protection Regulation (GDPR) (EU) 2016/679 on data protection and privacy repealing the Directive 95/46/EC of 24 October 1995 on the protection of individuals regarding the processing of personal data and on the free movement of such data
• Council Directive 83/570/EEC of 26 October 1983 amending Directives 65/65/EEC, 75/318/EEC and 75/319/EEC on the approximation laid down by law, regulation or administrative action relating to proprietary medicinal products
• Directive 98/44/EC of the European Parliament and of the Council of 6 July 1998 on the legal protection of biotechnological inventions
• Helsinki Declaration in its latest version
• Convention of the Council of Europe on Human Rights and Biomedicine signed in Oviedo on 4 April 1997, and the Additional Protocol on the Prohibition of Cloning Human Beings signed in Paris on 12 January 1998
• Universal Declaration on the human genome and human rights adopted by Participants will consider the opinions of the European Group of Advisers on the Ethical Implications of Biotechnology and the opinions of the European Group on Ethics in Science and New technologies
• The Directive 2002/58/EC of the European Parliament and of the Council of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communications sector (Directive on privacy and electronic communications)
• The Directive 2009/136/EC of the European Parliament and of the Council of 25 November 2009 amending Directive 2002/22/EC on universal service and users' rights relating to electronic communications networks and services;
• The Charter of Fundamental Rights of the European Union.

6.4 Risk Analysis

The embedded nature of the IANVS system within the participants personal environment at home and its ability to recognize and adapt to situational contexts and habits, i.e. its ability to learn, affect the private life and personal data of the participants. State of the art encryption protocols will be used to secure the online connection of all IANVS devices.

The following table summarizes risks, including an estimate on the potential for occurrence and solutions for the problem. The following risks will be communicated to the test participants verbal and with the declaration of consent:

Potential Risk	Expected Probability	Solution
Damage to walls through (de-) installations	Low chance	Installation team will fix the damage in such cases
The sensors do not communicate with each other	Low chance	IANVS technical team will restore the connection
Participant is not wearing the portable sensor	Medium chance	Participant is contacted by carer or field test leader
Determination of the hotspots is not possible or sufficient in the first two weeks of the test	Medium chance	Period for data collection for hotspot analysis is extended
The sensors have no more energy for data transmission	Medium Chance	IANVS technical team or authorized instructor verifies the installation
Data transmission is disturbed for unknown reason	Low chance	IANVS technical team or authorized instructor verifies the installation
Other costs due to problems with the IANVS system	Low chance	IANVS consortium will account for such costs.

6.5 Exit Strategy

The participants will be informed about the duration of the field test to ensure that they are aware of the limited availability of the system. At the end of the test phase, the IANVS system will be uninstalled by IANVS technical team. The end-user organisation terzStiftung will contact the participants in time before the system is uninstalled to remind them again of the removal. This procedure ensures that the uninstallation of the IANVS system will not come as a surprise to the participants and that they will have the opportunity to mentally prepare for the upcoming removal. The duration of the field test will also be communicated to the participants during the recruitment phase as well as with the letter of consent and in the personal interview (at the beginning of the field test).

In general, however, no major problems due to excessive adjustment are to be expected. During the personal interviews with the participants at the beginning of the field test, the end-user organisation terzStiftung will also address the aspect of uninstallation and a possible early withdrawal of the participant from the test.

7.0 Evaluation and Processing of trial data

Two different types of data are collected during the two field test phases. First, cloud-based data from the IANVS algorithms will be available to assess system performance and reliability. Secondly, data collected from the test participants via interviews, diary (activity recording) and questionnaires will provide useful information on usability, accessibility and, most importantly, user satisfaction and system acceptance. All participants will be asked to keep diaries of their daily activities.

Both types of data will be analysed in order to draw generalisable conclusions. Besides these analyses, the end-user organisation terzStiftung will use the data from the two personal interviews and the diaries to identify important case studies. These case studies will be used to illustrate influential feedback from end-users in an anonymous form for the consortium's partners in product development.