

essense

Education Supporting
Smart Environments for
Seniors

Report on the Situation
and Evolution of Smart
Housing and AAL within
the BIM method: current
Knowledge, skills and
qualifications needs.

2nd Version



Erasmus+

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1. Introduction.

The **ESSENSE Project** aims to design and develop a **common curriculum and learning approach on Building Information Modelling (BIM)** towards the design, construction, and management of public and private environments for older adults. This will meet the learning needs of Higher Education students from building related sectors (architects, engineers, BIM managers, facility managers, and interior designers) that will be relevant to the labour market and meet societal needs.

The building and construction industry are an important part of the EU economy and society. It contributes to about 9% of the EU's GDP and provides around 18 million direct jobs. It also creates high-skill jobs and investment in other industries that leads to further social and economic benefits.

The current use of **BIM** methodology and its increasingly widespread use in the construction sector aims to digitalize the construction process.

The demand of public and private environments adapted to the needs of older adults is expected to grow in the coming years. By 2050, the number of people in the EU aged over 65 is expected to grow by 70% and the number of people over 80 by 170%. This means that EU citizens will spend more years in the environments conceived for younger and healthier people, that will increase their risk of being dependent, isolated, and experience mental health issues. Nourishing physical and social environment are essential for people to remain healthy and autonomous into their old age.

In this context, the use of BIM in the design, construction and management of multifunctional indoor environments will contribute to the requirements of EU's ageing population while promoting healthy and safe ageing.

Professionals from the construction sector acknowledge that the use of BIM is valuable and is the direction in which the architecture, engineering, and construction industry (AEC) should be headed.

A 2011 survey of construction companies revealed that companies prefer to hire graduates that have both conceptual knowledge and software skills and companies prioritized BIM knowledge and competencies for the immediate, near future, and far future. (Ku & Taibet, 2011)¹.

¹ Ku, K. and Taibet, M., (2011). *BIM experiences and expectations: The constructors' perspective. International Journal of Construction and Research*, 7(3), 175-197.



Ambient and assisted living (AAL), is a framework that aims to improve quality of life for older adults and to strengthen industry opportunities in the field of healthy ageing technology, and innovation: “Ageing well in a digital world”.

The main objectives are:

- To encourage the development of innovative ICT-based products, services, and systems for healthy ageing at home, in the community, and at work.
- To help creating the market conditions for the industrial exploitation of healthy ageing products and services by establishing European framework that supports the development of standardized solutions and facilitates their adaptation to local, regional, and national levels to account for varying social preferences and regulatory requirements.

Smart Housing or digital home technologies enable the automation and coordination of all the electronic devices at homes so they can be controlled. It aims to improve the quality of life of people living in such environments enhancing their level of independence and wellbeing. In the implementation of a Digital Home, a multitude of elements come into play, make up the different housing systems: from a central management, centralized systems, up to user interfaces, without forgetting the different types of sensors that monitor the environment or users acting on it.

The principal aim of this report is to raise awareness among the AEC industry, the educational community, and local and regional authorities about the benefits of both: BIM processes and smart assisted living environments, which will promote the training curriculum to future students and may influence local and regional policies and plans.

2. SWOT analysis: current use of BIM in the design and construction of buildings for older adults and an overview on how Smart Housing and AAL technologies are being implemented in such environments.

2.1 Introduction.

This analysis presents a study of the current use of BIM processes in the design and construction phases of new and renovated public or private environments for older adults, such as day centres, geriatrics units, co-housing, dwellings, etc., as well as an overview on how the concepts of Smart Housing and AAL are being implemented in such environments.



We identified and analysed good examples of environments supporting active, healthy, and positive ageing and the use of AAL principles. The analysis pays special attention to the feedback that is provided by the different stakeholders: enterprises and workers, students, public bodies, caretakers, relatives, etc. It provides the information needed to prepare more attractive learning content by identifying the challenges that current initiatives in the field have faced in terms of knowledge, skills, and competences at different levels: industry, pedagogy, legislation, etc.

2.2 Methodology.

We created a template (Annex 1) to gather information about current practices and identify case studies of new/renovated environments, either public (day centres, geriatrics, co-housing, residences, etc.) or private dwellings, and the use of BIM processes and AAL technologies in the design, construction, and management phases of new and renovated facilities for older adults.

The partnership has identified 30 success cases within the countries of the strategic consortium. Additionally, certain members of the SHELD-ON COST action, have contributed to provide the information on current practice of creating environments for the elderly with the BIM methodology and AAL technologies.

In Annex 2, five of the cases analysed are available, we have omitted the names of the companies interviewed to preserve their privacy.

The summary and SWOT analysis of the collected information on case studies is presented below.

2.3. SWOT ANALYSIS – CASE STUDY.

The following analysis summarizes the information collected on success cases.

The main objective is to identify the use of ambient and assisted living technologies in new/renovated environments for older adults. We will define certain characteristics of the users and tools, such as their profile and level of acceptance, as well as specific issues concerning devices (e.g., settings, security, maintenance, etc.)

Additionally, we will consider the use of BIM processes in the design, construction and management phases of the facilities for older adults.



SWOT ANALYSIS

Strengths

- **The user group profiles** that use Ambient and Assisted Living (AAL) technologies covered in the case studies: elderly people over 65, some of them “managing well” or, “mildly frail” and others with a wide range of degree of dependency. The staff, caregivers, and social welfare professionals involved in care for older adults are included as well. In some cases, people suffering from illnesses are included.
- **AAL technologies that are being implemented by case studies:**
 - Smart sensors that interact with the smart home:

Radiator control, light control, smart water clock, presence and motion detector, panic button to fall detection, remote controlled windows, height adjustable appliances, gesture recognition, affective computing, telemedical system floor with fall detection, biodynamic light, smart furniture elements, (such as, height-adjustable, and self-opening cabinet elements in kitchens), bathroom with a shower, WC with sensor technology for vital sign, automatic curtain lift, bell amplification, remote stove monitoring, energy harvesting system, inactivity detector, wireless AAL technology.
 - Assistive and social robotics.
 - Mobile apps.
 - Energy efficient buildings, (mainly building integrated renewable systems) PV, and solar thermal energy.
 - LED lighting and ground source heat pumps for energy efficiency.
 - Specialized software (for managing home care service).
 - Outdoor technologies: beacons, magnetic loops, podotactic pavements, signalling with accessibility criteria or alert systems.
 - Multispectral technology intends to create lighting adapted to the circadian rhythm.
 - Early version of media and communications platform for older adults.
- **Applications:** tele-care and tele-health, fall prevention, detection and intervention, gait analysis, support activities of daily living (ADL), mental health



and cognitive stimulation, indoor and outdoor mobility, well-being, social interaction and isolation.

- **Settings** where AAL technologies are found: residential complex, dwellings, geriatrics units, warehouses, simulated apartments, home care service (SAD), outdoor areas around care centres, hospitals.
- These technologies **perform best** when users are **familiar** with the system management.
- Users accept the use of technology when it is **usable, accessible, and inexpensive**. If the functionality is brought closer to the users it reduces uncertainty and increases acceptance.
- User groups use these solutions/technologies interacting with the system and controlling parameters of the house like temperature, light, humidity, etc. sometimes they learn from their peers.
- The privacy of the data is protected by adhering to the **GDPR**.
- The accessibility criteria are guaranteed in most cases.
- The use of BIM ensures compliance with accessibility and protection standards in buildings.

Weaknesses

- Some devices, such as fold-up beds, do not have enough space to be included.
- Individual technological solutions depend on the **needs of the residents and their individual characteristics**.
- When users are in a stage of cognitive decline, they can experience **difficulties** in using the devices.
- AAL technologies in the market are expensive.
- Sometimes firms are not responsible to maintain the technologies they created.
- Limited use of BIM method in the design and construction of new and renovated public or private environments for older adults: due to lack of knowledge, skills, and abilities in using BIM.
- Only in some cases have been used BIM method.
- Smart devices require a reliable internet connection.



Opportunities	<ul style="list-style-type: none"> • Opportunity for creating accessible technology products at more competitive prices for the elderly. • The need for a common platform to integrate existing AAL systems. • The need to train in the use of BIM. • Relaxation of the situation when caring for elderly people • Need to involve caretakers from the early stages of BIM design. • Need for training on how to integrate ALL technologies into BIM methods.
Threats	<ul style="list-style-type: none"> • In some cases, end users are responsible to maintain devices and technologies, which generates additional costs. • Device features may not adapt to the individual characteristics of the elderly end users. • A general development and quality standard for products still needs to be defined. • Lack of physical space for remodelling and improving accessibility of common spaces in existing buildings.

3. Knowledge, skills and competences needed for the use of BIM processes in smart habitats.

3.2. Introduction

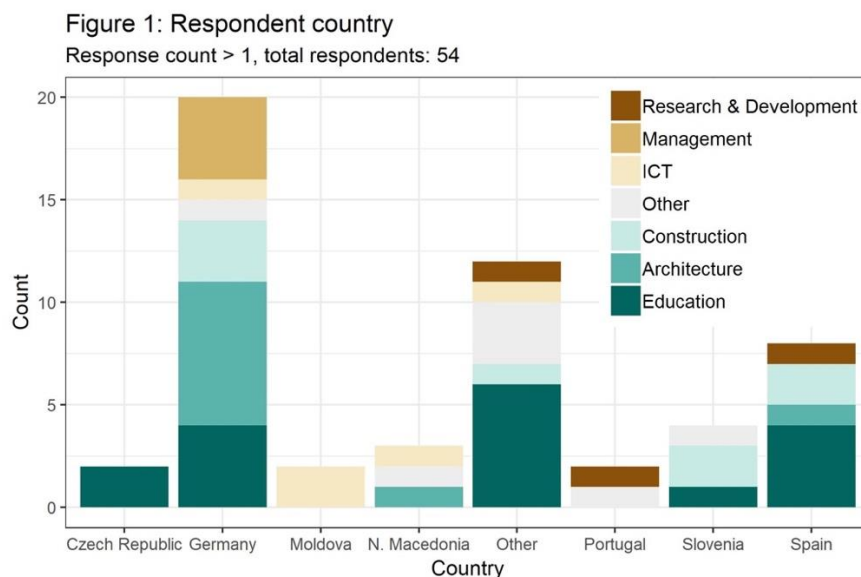
The ESSENSE Erasmus+ project aims to create a course on integrating smart solutions, ambient assisted living (AAL) elements, and building information modelling (BIM) methods into the built environment to facilitate support of active and healthy ageing. One of the first steps to achieve this goal is to identify the current practices in the field and what new knowledge, skills, and competences are needed to improve them. We started by preparing a survey asking experts from the building field about several topics related to BIM and smart buildings, including current practices related to construction, active ageing, ICT and necessary skills for (future) employees in the field (questionnaire can be found in Annex 3). In addition to the survey, we interviewed professionals from the industry regarding current practices and attitudes related to BIM (questionnaire is available in Annex 4). Finally, we prepared an overview of currently available courses on BIM and AAL in the countries of project partners (template available in Annex 5).



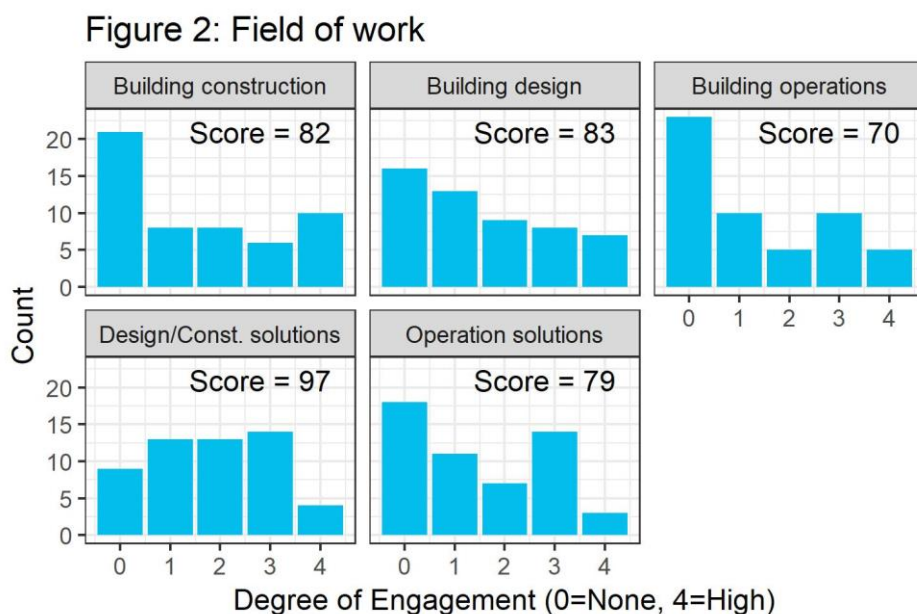
3.2. Survey

Respondents

54 respondents from 19 countries provided at least two responses in the survey (Figure 1). Most of them are from Germany, followed by Spain, Slovenia, and North Macedonia. Most respondents work in education, many of them are from the fields of architecture and construction, while others come from ICT, management, research & development, and other fields.

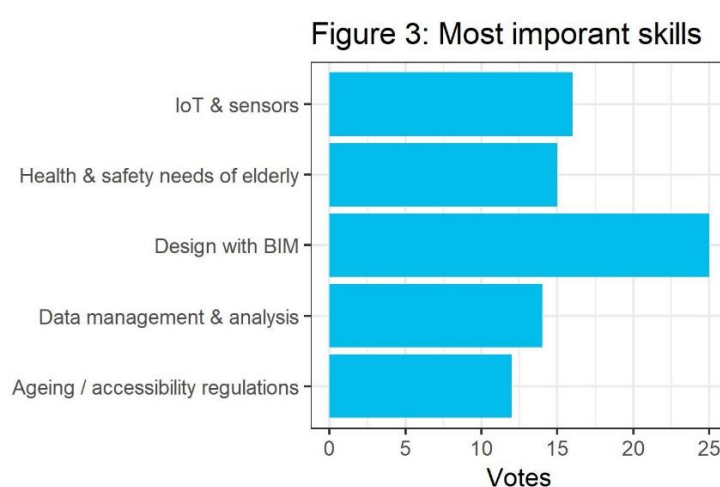


The institutions where respondents work for are somewhat engaged in the fields of design/construction solutions, less engaged in the fields of building construction, building design, and operation solutions, and not very engaged in building operations (Figure 2).

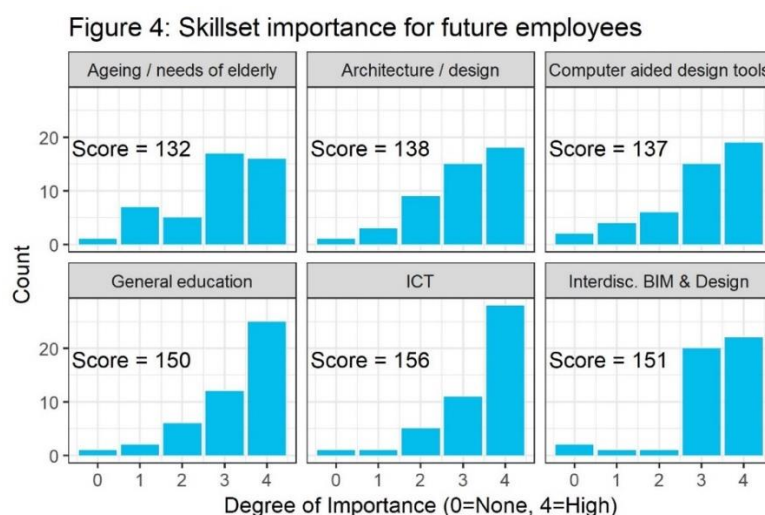


Results

Respondents selected the 3 skills they deemed most important (out of a list of 12 skills) for graduating students that are related to smart buildings, ageing, and BIM. Respondents view design with BIM as the most important skill (25 votes received). Other top-rated skills (between 12 and 16 votes) are Internet of Things (IoT), sensors, and related services; health and safety needs of older adults, data management and analysis (collection, storage, etc.), and ageing and related regulations regarding accessibility (Figure 3). Skills outside of the top 5 top rated skills include social needs of elderly (11 votes), software development (9 votes), development of BIMs, general design, computer aided design (8 votes each), meeting standards in design (7 votes), and conversion from BIM to computer aided manufacturing (6 votes).

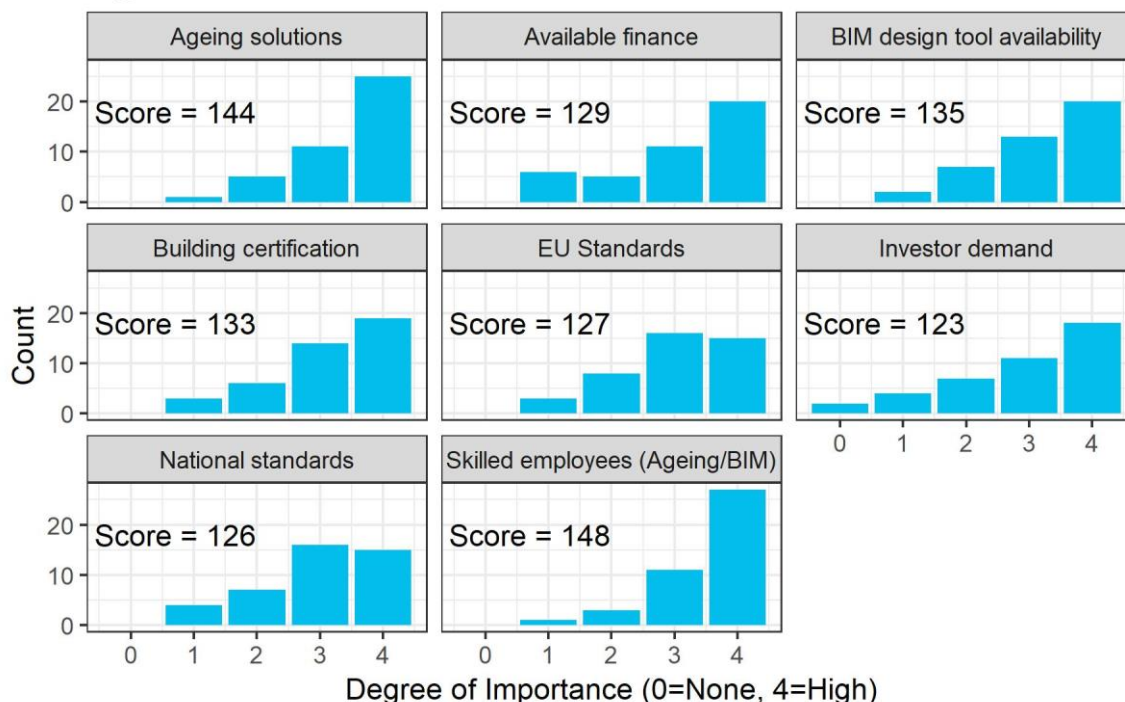


In general, participants believe that all skills presented in the Figure 4 are important for future employees. As the most important skills they considered ICT, general education, and interdisciplinary skills in BIM and design. Perceived as somewhat less important (but still important) are skills related to ageing and needs of older adults, architecture and design, and computer aided design tools.



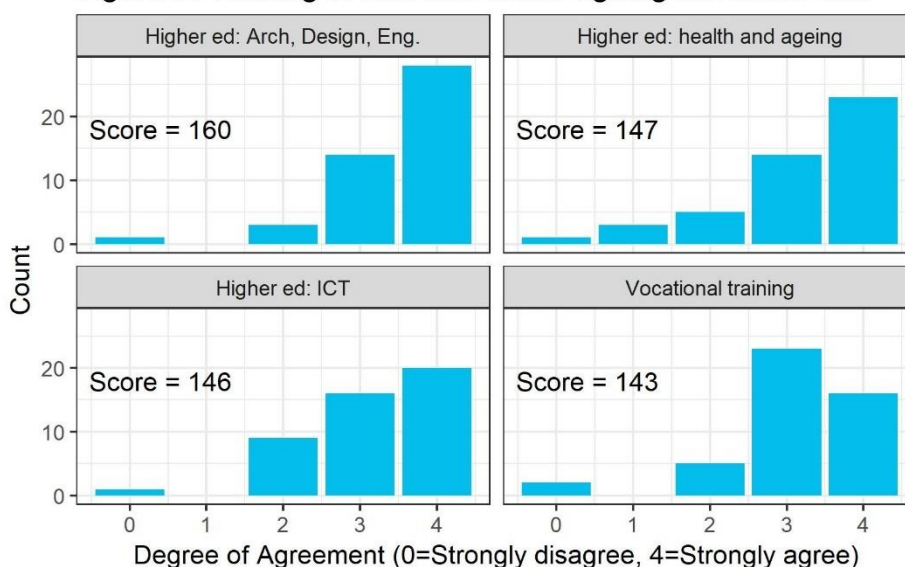
Respondents rated the importance of the following construction factors in terms of integrating BIM and active, positive ageing within the built environment (Figure 5). All presented construction aspects are generally seen as important. Slightly more important than the others are availability of a) employees with skills in BIM and/or positive, active ageing and b) availability of solutions for positive, active ageing.

Figure 5: Critical construction factors

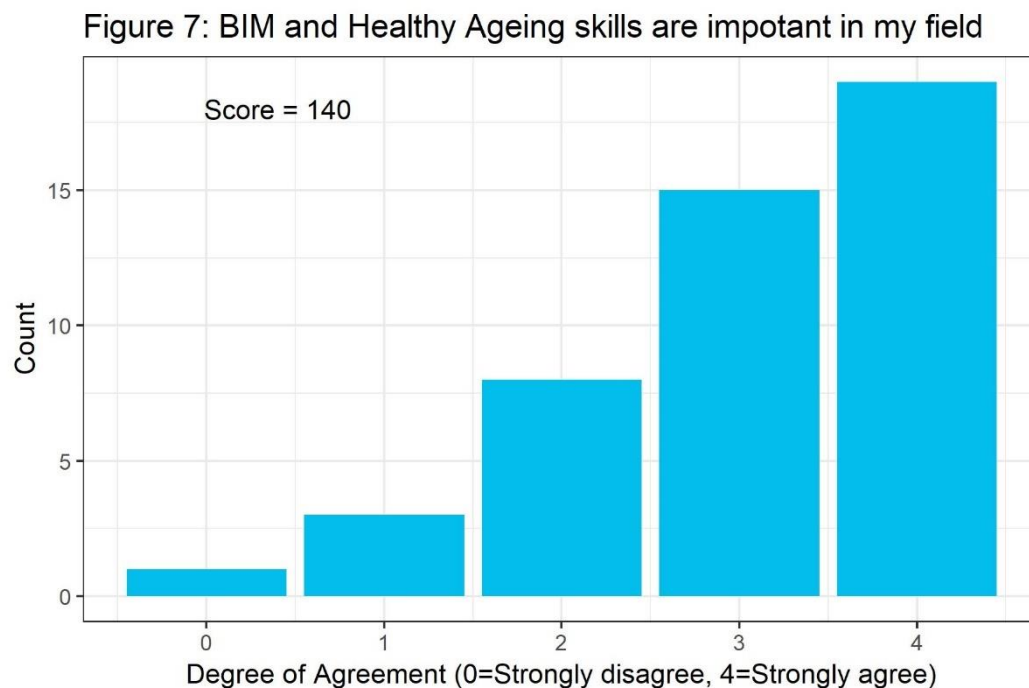


Respondents believe that training in BIM and active ageing should be provided in both vocational training and in higher education related to a) ICT, b) health and ageing, and c) architecture, design, and engineering (Figure 6).

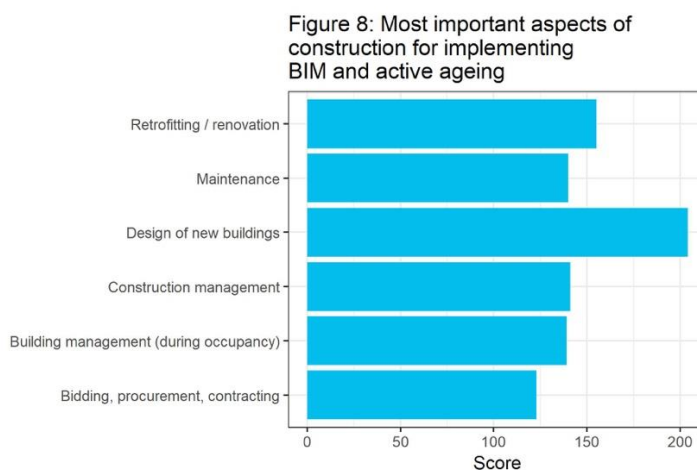
Figure 6: Training in BIM and active ageing should be in...



Most respondents either agree or strongly agree that skills related to BIM and Active Healthy Ageing are important in their field (Figure 7).



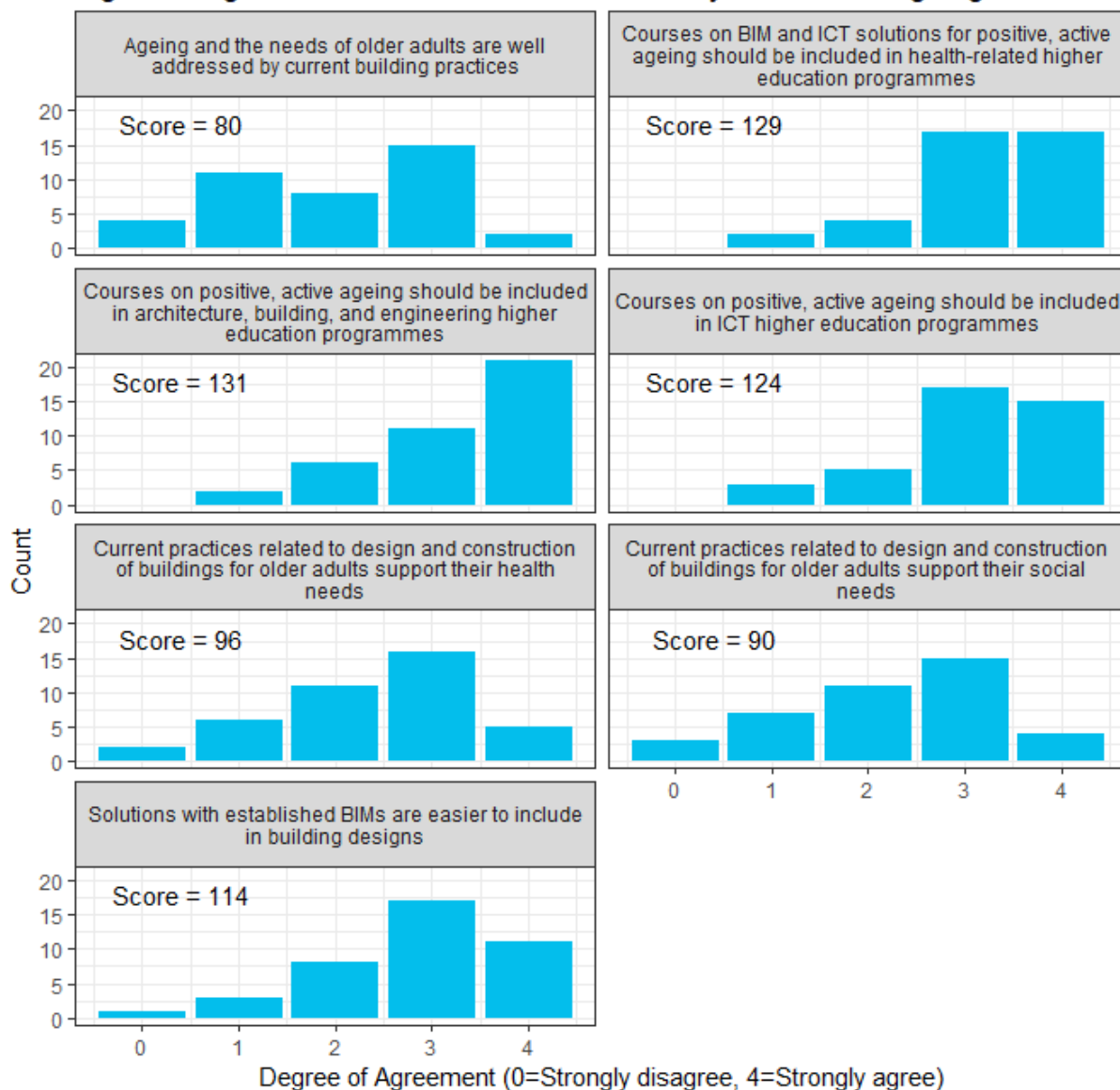
Participants were asked to prioritise (rank) the following aspects of construction in terms of implementing BIM and active, positive ageing (Figure 8). Design of new buildings is generally seen as the most important aspect. ("Score" was calculated by ascribing points to ranks and summing them up.)



In general, respondents have mixed opinions about how well current building practices address ageing and the needs of older adults, indicating there is a need to be addressed (Figure 9). Most participants hold the opinion that courses on positive, active ageing should be included in higher education programmes related to ICT and architecture, building, and engineering. This indicates that the need identified may be best filled by higher education content that is accessible to students in each field. Generally, they slightly agree that current building practices support social and health needs of the elderly. Similarly, they believe that courses

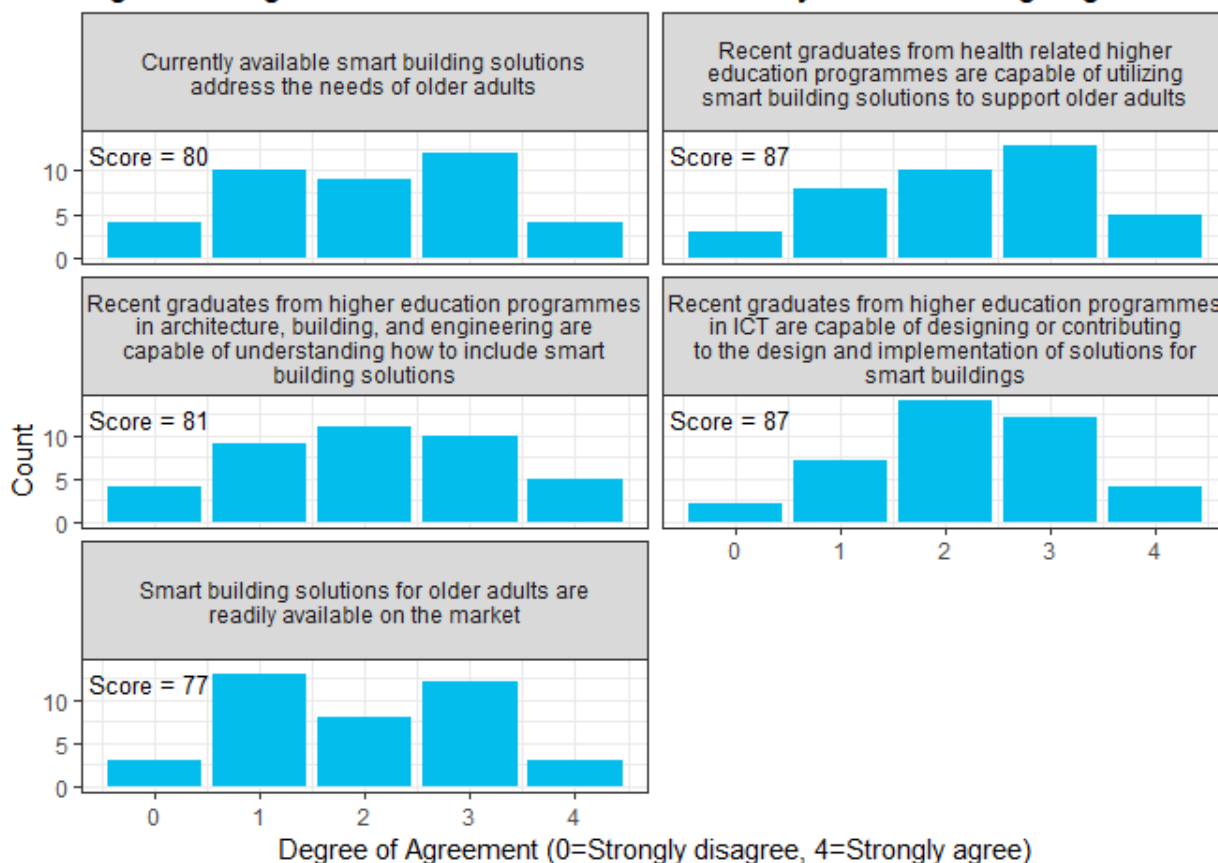
on BIM and ICT solutions for positive, active ageing should be included in health-related higher education programmes. Most respondents think that solutions with established BIMs are easier to include in building designs.

Figure 9: Agreement related to Positive, Healthy, and Active Ageing



In general, participants have mixed opinions regarding 1) how well current building practices address ageing and the needs of older adults and 2) how well smart building solutions for older adults are readily available on the market (Figure 10). Similarly, they have conflicting views on the capability of a) recent graduates from health to utilize smart building solutions, b) recent graduates from ICT to design or contribute to the design and implementation of solutions for smart buildings, and c) recent graduates from architecture, design, and building to understand how to include smart building solutions.

Figure 10: Agreement related to Positive, Healthy, and Active Ageing



3.3. Interviews.

Participants.

We interviewed 14 building professionals (each representing one institution) regarding current BIM practices in their organization and their general outlook on BIM. (Questionnaire is available in Annex 4) 7 interviewees come from Slovenia, 6 from Germany, and 1 from Spain. Most participants have a background in architecture and typically work on a variety of building types, including residential, office, and healthcare buildings.

Familiarity with BIM and its role in the company/field.

Respondents typically have long-term experience and advanced knowledge of BIM. They are thoroughly familiar with different software tools and have been using them regularly in their career. In many respondents' institutions, however, BIM is relatively new for most other employees, but they are generally eager, or at least willing, to adopt it soon. In some cases, many employees were undergoing training at the time of the interview. All interviewees shared the opinion that using BIM is necessary to remain competitive and profitable in the industry. They emphasized that BIM saves a lot of time, decreases the number of mistakes, and substantially improves collaboration. In general, BIM leads to higher quality products. Some respondents pointed out that some project proposals and clients demand the use of BIM, making the need

to use BIM even more evident. Although some believe that it is currently still possible to be successful without BIM, they all agree that transition to BIM will be a must in the near future.

Access to skilled employees.

In some cases, institutions have several employees capable of using BIM. Often, however, only one or few employees are experienced in BIM, while most employees and the company as a whole are either slowly transitioning or are planning to soon transition to BIM. Companies find it hard to meet skilled employees and emphasize the importance of providing quality training to professionals in the field. Respondents usually learn BIM with the help of online courses, tutorials related to specific software, or in-person training provided by one of the company employees. At the same time, they do not hold a favourable opinion on the existing BIM courses. Although they are familiar with the existing BIM courses and they support employee enrolment, they would usually point out that the taught topics are too theoretical, and do not focus enough on practical skills that can be directly transferred to the industry. Those who are more experienced with BIM point out that training should be provided in advanced methods, such as 6D BIM. Respondents unanimously believe that having BIM experience is a considerable advantage for candidates applying for job positions.

BIM tools.

Companies with access to BIM software point out that BIM tools are suitable for the general use and highlight many advantages of using BIM, including work effectiveness and efficiency, lower number of mistakes, and improved communication and collaboration. At the same time, many respondents emphasize that many specific functionalities are missing from BIM tools and that it is important to develop tools that can address specific needs. Some point out they need to use many add-ins with the existing BIM software (and in some cases develop their own) or use a combination of available tools. According to interviewees, issues arise when different companies use different types of software, which makes collaboration more difficult. Interoperability was generally seen as the most useful, and, at the same time, the most underdeveloped feature of BIM tools. Users of BIM software indicate that not all new software on the market is necessarily useful. In addition, existing useful tools can become quite complex and more difficult to use when many additional functionalities are added with time. Despite of that, having access to a variety of tools does not guarantee availability of methods able to solve specific challenges. The general opinion is that the user experience of BIM tools is something that should be improved. In fact, many users expect this to happen in the near future. They also expect to see BIM to become more widespread.

BIM & Sensors, AAL, Building Management.

In general, interviewed companies are not yet at the stage of using BIM in conjunction with building management, AAL, or building sensors. Most often, the reason for this is the lack of skilled staff. In some



cases, employees are not knowledgeable enough about relevant topics, such as AAL interventions that could encourage active and healthy ageing. Some companies, however, are beginning to use BIM together with building sensors, for example, to monitor the construction process.

3.4. BIM & AAL courses.

We collected information on courses related to BIM and AAL that are available in North Macedonia, Spain, Germany, and Slovenia. Most of the identified courses are available at the Bachelor and Master level within study programmes related to engineering, architecture, and computer science. An overview of the courses for each country is provided below.

North Macedonia.

In North Macedonia, we identified BIM and AAL courses on faculties of computer science, engineering, and architecture, on a Bachelor, Master, and PhD level. All identified courses are annual electives; most require no prerequisite knowledge. Most discovered courses focus on AAL and cover the area of a) ambient intelligence, including monitoring health and activity of building occupants with sensors, b) time series analysis and forecasting, including trend detection and analysis of health evaluation and diagnostics, c) assistive technologies, including assistive devices, software, and mobile applications, d) advanced interaction technologies, including voice, gaze, and gesture interfaces, e) mobile and embedded application development, including wearables, smart appliances, and home networking, f) medical informatics, including bio signal processing, computer aided medical environment, and medical user interface, and g) information technologies for architecture, with a broad focus on BIM.

Spain.

In Spain, we found BIM and AAL yearly courses on a variety of universities and programmes. Several AAL courses focus on healthy and active ageing. In fact, at least two master's programmes are entirely dedicated to active and healthy ageing. These cover a broad range of topics, including cognitive stimulation, e-health technologies, ICT & emotional intelligence, and physical, social, and leisure activities. Identified courses typically include a segment on ICT technologies that can improve the current health system. Although these courses and programmes are primarily aimed at students in the health field, student from many fields can enrol (e.g., pharmacy, biology, chemistry). We identified a master's programme on BIM with a special focus on project management with BIM, in addition to other courses that are primarily focused on BIM. Courses tend to include a broad range of BIM related topics, for example, different software tools and BIM project management. In addition to the standard university level courses and programmes, some Master programmes and courses are available online.



Germany.

In Germany, we identified several courses focusing mainly on AAL. On top of that, there are at least two Master programmes entirely focused on AAL. Programmes and courses cover a broad range of topics, focusing on both theoretical and practical aspects, hardware and software, mobile and medical technology, and other important topics. Practice oriented training emphasizes new and perspective topics, such as e-mobility and ergonomics. On Bachelor and Master level, we identified many courses with BIM as the main topic. In at least one Master programme, BIM can be chosen as a major study focus. In many cases, BIM is an important topic in civil engineering Bachelor and Master programmes. Typically, courses cover project management with BIM together with a variety of more technically oriented topics, including different software tools, design, engineering, and overall best practices. When BIM is not the main focus of the course or the study programme, it is typically covered in programmes or courses on digital construction, civil engineering, or energy efficient design.

Slovenia.

In Slovenia, we identified both required and elective courses including BIM at two universities, mostly at faculties of architecture and civil engineering. Most courses do not require any prerequisites, while some are offered on a higher level and expect basic ICT and BIM knowledge. At least two courses are entirely focused on BIM. These provide a broad coverage by teaching the use of BIM in all project phases and emphasize the entire process, from the initial idea to the finished building model. This includes a variety of topics, including BIM related data, methods, standards, and tools. Typically, however, BIM is not the main course topic, but is instead covered in courses on technology in architecture and civil engineering. Usually, students are familiarized with various BIM tools. Different courses emphasize use of BIM for different purposes. Some courses, for example, promote the collaboration that becomes possible when using BIM, while others focus more on specific goals, such as using BIM for building facades. Often, practical knowledge is emphasized, and it is expected from the students that they will be able to independently plan and implement BIM on small scale projects after completing the course.



4. Conclusions: Knowledge, Skills and Competences needed for the use of BIM processes in smart habitats for an active and positive ageing.

BIM methodology treats the construction industry in global terms: it is a collaborative work platform that uses modern digital technologies to efficiently manage planning, building and facility management phases.

How can we achieve urban and smart housing affordability? Millions of people cannot approach good/suitable housing solutions and the use of Building Information Modelling (BIM) tools can support the international community for future technological challenges. It can change the way we plan, build and manage our houses, optimizing costs throughout the whole project life cycle.

By using Building Information Modelling tools, we can foresee design clashes, prevent problems (before they present during the construction) and optimize the whole planning process, this is especially important in the area of AAL and smart housing. In public sector, it means saving public funds and in the private field it increases the housing affordability, implementation of modern approaches and taking costs under control from the design stage to the building end of life. The application of this methodology implies a change of attitude in construction industry, it encourages the training of a working group including all the stakeholders of the whole design process from the earliest design stages.¹

The BIM methodology has a decisive influence on the future training of engineers, since not only the technical skills in the application of BIM but also a new understanding of the role of those involved in construction must be learnt. For the universities, this may mean a revision of the curricula towards more interdisciplinary cooperation between different disciplines (e.g. architecture, civil engineering, building services engineering, facility management) within the framework of joint projects. (Government)²

We discovered that **building experts generally view BIM, AAL, and ICT tools as essential** for professionals in the field. They believe these skills bring considerable advantages to the work process and they will become even more important in the future. Similarly, they think that having **knowledge about ageing and needs of older adults is important** for building professionals. Accordingly, they hold the opinion that teaching and training on these topics should be provided in vocational training and in higher education programmes related to 1) ICT, 2) health and ageing, and 3) architecture, design, and engineering.

Design with BIM is generally viewed as the most important skill for graduating students in the field. Respondents also highly rate skills related to:

- Internet of Things (IoT), sensors, and related services.
- Health and safety needs of older adults.



- Data management and analysis (collection, storage, etc.).
- Ageing and related regulations regarding accessibility.

Knowledge viewed as somewhat less important for graduating students includes social needs of elderly, software development, development of BIMs, general design, computer aided design, meeting standards in design, and conversion from BIM to computer-aided manufacturing.

According to the respondents, future employees should be **first and foremost** well versed in:

- ICT.
- Interdisciplinary field of BIM & design.
- General education.

Additionally, they should be knowledgeable in architecture & design, computer aided design tools, and ageing and the needs of elderly.

In order to successfully implement BIM and active, positive ageing in design of new buildings, it is essential, according to respondents, to have access to 1) skilled employees in ageing & BIM and to 2) solutions related to positive/active ageing. Other factors are important as well, including national & EU standards, finance & investors, building certification, and access to BIM tools.

Participants point out that current practices related to building solutions and ageing could be considerably improved. Many companies struggle with obtaining employees that are skilled in BIM. Although they support employees entering existing BIM courses, they draw attention to the teaching content that is, in their opinion, too theoretical and not focused on skills that are directly applicable in the industry. Although **BIM and AAL** are a part of several university-level courses, they **are rarely the main topic and usually only covered briefly** within a broader topic or presented only for the purposes of a very specific use. In many cases, building professionals are not using BIM in conjunction with building management, AAL, or building sensors due to the lack of skilled staff. Evidently, **students and professionals could benefit immensely** from a comprehensive and systematic course that integrates BIM, AAL, and healthy and active ageing.

¹ (Utica, et al.)

² (Liebchen)

5. Annexes.

Annex 1: Template 01-Essense



Template 01-Essense

A) General Information about Institution, user groups:

- 1) What is the name of your firm?
- 2) Which user groups use your facilities or device? (Profile, degree of dependence, models of coexistence)

B) Use of technology (AAL)

- 3) Which AAL solutions/technologies do you provide and what challenges do they address?
- 4) Where and how are they used (e.g. type of building; wearable device and/or ambient-integrated sensors)?
- 5) In which settings do they perform best (and worst)?
- 6) How do user groups use your solutions/technologies? Do you differentiate physical attributes of devices, services, etc.?
- 7) What is your general approach to data privacy and security?
- 8) What is your firm responsible for in deploying your technologies? For example: are installation, set-up, and maintenance included in your sales price?
- 9) If more than one technology is provided, which ones are the most successful? And why do you think they are?
- 10) What are the advantages of your technologies/solutions over your competitors?
- 11) What feedback is provided by the different types of users? What do they complain about? What do they love about it or think is really useful?
- 12) Could you give a brief summary of your business models for the products/services offered?
- 13) Has your technology been modelled for simulation or BIM?

C) Accessibility

- 14) How do you ensure the facilities or devices accomplish of the universal accessibility criterion according to national laws where your products are sold or used?

D) Ethical Principles

- 15) Do your AAL technologies account for ethical principles stipulated in each region?



Annex 2: Examples of current success cases.

Case 1



Template 01-Essense

General Information about Institution, user groups:

- 1) What is the name of your firm?

Case 1.

- 2) Which user groups use your facilities or device? (Profile, degree of dependence, models of coexistence)

The solutions generated are applied to diverse contexts and user groups that have a big impact in multiple areas. Solutions pay special attention to the daily home activities in order to create better life conditions for elderly adults in their own homes with multiple profiles and degree of dependence.

A) Use of technology (AAL)

- 3) Which AAL solutions/technologies do you provide and what challenges do they address?

The solutions are based on Ambient Intelligence. This term refers to environments that are sensitive and responsive to the presence of people and their feelings and needs. Environments combine different ICT-related disciplines like sensing, networking, pervasive computing, human-computer interaction, artificial intelligence, etc. Moreover, it is fundamental to have other disciplines involved in order to truly revolutionize our quality of life by applying it.

- 4) Where and how are they used (e.g. type of building; wearable device and/or ambient-integrated sensors)?

It has three services:

- Smart Lab. This is a real apartment with multiple and heterogeneous sensors and actuators that are connected to a unified middleware. This environment can be used to test solutions.
- Software. A set of graphic software tools to monitor in an easy way a set of sensors of different types in your environment.
- Repository. It allocates multiple datasets from both external sources and our own resources. These datasets are available for the community.

- 5) In which settings do they perform best (and worst)?

We have a great expertise to analyse and deploy solutions in real and test environments

- 6) How do user groups use your solutions/technologies? Do you differentiate physical attributes of devices, services, etc.?

The concept is based on personalization. We apply computer algorithms to customize solutions to the needs and profiles of each user.

- 7) What is your general approach to data privacy and security?

Distributed storage and anonymous data.

- 8) What is your firm responsible for in deploying your technologies? For example: are installation, set-up, and maintenance included in your sales price?

We provide a set of services that have been support by national and international projects.

- 9) If more than one technology is provided, which ones are the most successful? And why do you think they are?

The easy way to manage our software solutions. This fact has been contracted with multiple users.



- 10) What are the advantages of your technologies/solutions over your competitors?

User Personalization

- 11) What feedback is provided by the different types of users? What do they complain about? What do they love about it or think is really useful?

Feedback is really positive. The users are really excited about automatic home monitoring, customization and ease of use of the software tools.

- 12) Could you give a brief summary of your business models for the products/services offered?

A personalized contract is made with the services offered with all terms fixed by both parties.

- 13) Has your technology been modelled for simulation or BIM?

No

B) Accessibility

- 14) How do you ensure the facilities or devices accomplish of the universal accessibility criterion according to national laws where your products are sold or used?

Through an exhaustive study and the personalization of each user.

C) Ethical Principles

- 15) Do your AAL technologies account for ethical principles stipulated in each region?

Yes, Ethical principles stipulated in the following levels regional, national and European are considering.

Case 2

essense Education
Supporting Smart
Environments for
Seniors

Template 01-Essense

A) General Information about Institution, user groups:

- 1) What is the name of your firm?

Case 2.

- 2) Which user groups use your facilities or device? (Profile, degree of dependence, models of coexistence)

Very wide range of different inhabitants, depending on the installation.

- a. AAL apartment.
- b. Position of the interviewees: Division Manager Smart Home/AAL.
- c. AAL sample apartment.
- d. different objects: nursing homes, assisted living, homes of one's own.
- e. 39 apartments over with different packages to light without extension cable etc.
- f. New project: 70 apartments.

B) Use of technology (AAL)

- 3) Which AAL solutions/technologies do you provide and what challenges do they address?



AAL sample apartment: KNI basic equipment, radio bus systems which do not need batteries. Room equipped exclusively with digital power, Paul as home automation with simple user interface, Home controls radiators, lights, etc. and offers a uniform surface for various control devices, etc.

- a. Smart water clock, presence detector and motion detector to check that residents are not injured.
 - b. Future Shape bottom with fall detection.
 - c. Remote controlled windows.
 - d. Toilet and washbasin adjustable height.
 - e. Height-adjustable stove and sink in the kitchen.
 - f. Rising bed.
 - g. Orientation lights on the strips on the floor
 - h. Stove guard, which detects whether the stove is too hot and switches itself off if necessary.
- 4) Where and how are they used (e.g. type of building; wearable device and/or ambient-integrated sensors)?
- a) Optimal technologies presented in AAL show apartment.
 - b) Cooker guard is standard in all managed objects.
 - c) Home emergency call device is standard in all serviced objects.
- 5) In which settings do they perform best (and worst)?
- a) Fall-detecting floor, especially in care facilities, useful for supporting nursing staff (especially at night). The Future Shape is particularly recommended.
 - b) The fold-up bed works very well for people who have problems getting into the upright position.
 - c) Bathrooms are a success factor in outpatient care: usually no nursing person is included in the calculation of space and radii within the bathroom → inadequate planning.
 - d) Stove guard works very well (is already mandatory in Scandinavia in all new buildings).
- 6) How do user groups use your solutions/technologies? Do you differentiate physical attributes of devices, services, etc.?
- a) Feedback from older people "Self-assessment - hostile to technology" - but in principle people are already surrounded by technology (often do not perceive it) often a fear factor.
 - b) But: if you can break down these fears by making them aware that they are surrounded by technology with washing machine, iron etc., then fear disappears.
- 7) What is your general approach to data privacy and security?
- a) Data protection and security in the sense of the residents the collected data are used only for the purpose of assistance.
 - b) Greater relevance of this topic when everything is planned, built and operated with BIM.
- 8) What is your firm responsible for in deploying your technologies? For example: are installation, set-up, and maintenance included in your sales price?
- a) Mostly no subsidies, because nothing permanent.
 - b) Special equipment such as drop-detecting floor not the standard, but usually too expensive for the standard.
- 9) If more than one technology is provided, which ones are the most successful? And why do you think they are?
- a) Stove detector works very well and does not call the fire brigade in every optical detection case of smoke.
 - b) Future Shape Sensorics floor works best under fall detection floors.
- 10) What are the advantages of your technologies/solutions over your competitors?



The stove detector functions particularly well due to the numerous measurements, because it has many advantages over conventional fire alarms above the stove. These detect either only an optical signal in case of smoke (which happens much too fast) or by burnt particles.

- 11) What feedback is provided by the different types of users? What do they complain about? What do they love about it or think is really useful?

General problem: "self-assessment as hostile to technology" - but in principle people are already surrounded by technology (often do not perceive it) if you can break up these fears (by mentioning that they use washing machines and irons), fear disappears solution lies in communication with people.

- 12) Could you give a brief summary of your business models for the products/services offered?

At the moment there are many innovative projects that have to be implemented and established on the market, which is why further training and qualifications are very important.

C) Accessibility

- 13) How do you ensure the facilities or devices accomplish of the universal accessibility criterion according to national laws where your products are sold or used?

Not yet barrier-free built throughout Germany, far too few flats are available for those who need them (approx. 3-4 % barrier-free).

D) Ethical Principles

- 14) Do your AAL technologies account for ethical principles stipulated in each region?
 a) Varies according to living solution.
 b) Social welfare provisions required in nursing facilities.

Case 3



Template 01-Essense

A) General Information about Institution, user groups:

- 1) What is the name of your firm?

Case 3

- 2) Which user groups use your facilities or device? (Profile, degree of dependence, models of coexistence).

The main users of the system are the staff and caregivers of residences of disabled people. The residences include people from all ages with disabilities (primarily cognitive or physical), either born with this condition or acquired through accidents or illnesses. Some of the residents have high level of dependence.

B) Use of technology (AAL)

- 3) Which AAL solutions/technologies do you provide and what challenges do they address?

The AAL solution monitors the resting time of residents remotely. It detects when the user is resting in the bed or in an armchair and identify possible dangerous situations, in case the resting time does not correspond to the usual behaviour of the resident.



- 4) Where and how are they used (e.g. type of building; wearable device and/or ambient-integrated sensors)?

It is an ambient integrated sensor, distributed in resident's beds and armchairs. Nowadays the system is working in a residence for disabilities but can be installed in geriatrics or private homes for monitoring elderly.

- 5) In which settings do they perform best (and worst)?

The solution performance is better when the users (residence staff and residents) are familiar with the system management.

- 6) How do user groups use your solutions/technologies? Do you differentiate physical attributes of devices, services, etc.?

The system includes a friendly web interface, very easy to understand and manage. The residence staff uses the web interface to manage and check the information on real time. The interface also includes sound alerts in case non-usual resident behaviour is detected.

- 7) What is your general approach to data privacy and security?

We have into account the GDPR directives.

- 8) What is your firm responsible for in deploying your technologies? For example, are installation, set-up, and maintenance included in your sales price?

Nowadays, our firm is responsible for installation, set-up and maintenance because the system is being validated. Sales price is under study.

- 9) If more than one technology is provided, which ones are the most successful? And why do you think they are?

The solution is only provided based on WIFI technology with textile sensors.

- 10) What are the advantages of your technologies/solutions over your competitors?

The main advantage on using textile sensors is that they can be integrated on bed surface and the user does not notice the existence of the sensors. Another advantage of the system is that WIFI networks are currently installed in most residences and personal homes, so the system does not require any additional device to be distributed (for example additional gateways or PC).

- 11) What feedback is provided by the different types of users? What do they complain about? What do they love about it or think is really useful?

We often visit our clients and obtain feedback personally. They consider the web interface very useful, not only for monitoring the residents resting time, but also for managing the bedrooms of their residents and control the distribution of them. They complain about the external power supply needed for the system.

- 12) Could you give a brief summary of your business models for the products/services offered?

We are a non-profit organization. The actual version of the system has been financed by public authorities and private sponsors. Nowadays, the business model is under study.

C) Accessibility

- 13) How do you ensure the facilities or devices accomplish the Universal accessibility criterion according to national laws where your products are sold or used?

We have almost 15 years expertise in electronic sensor networks and IoT field. Our staff and experts are updated on national and international laws and they have into account all requisites derived from these laws.

E) Ethical Principles

- 14) Do your AAL technologies account for ethical principles stipulated in each Region?

Our AAL system does not have any ethical contradiction.



Case 4



Template 01-Essense

A) General Information about Institution, user groups:

- 1) What is the name of your firm?

Case 4

- 2) Which user groups use your facilities or device? (Profile, degree of dependence, models of coexistence)

People of all ages with disabilities (primarily physical, cognitive), either born with this condition or acquired through accidents or illness. Most of the clients have a high level of dependence.

B) Use of technology (AAL)

- 3) Which AAL solutions/technologies do you provide and what challenges do they address?

Alternate keyboards, mouse devices for accessing computers (for education and work places), special education software, tablets, AAC devices (for communication), switches and toys for early intervention, smart home solutions (especially speech assistants) for environmental control.

- 4) Where and how are they used (e.g. type of building; wearable device and/or ambient-integrated sensors)?

Home, school, workplace, care homes and hospitals.

- 5) In which settings do they perform best (and worst)?

They perform best, when the environment (people/caregivers/communication partners ...) is also familiar with the system, has a positive attitude towards the solution and is committed to support its use.

- 6) How do user groups use your solutions/technologies? Do you differentiate physical attributes of devices, services, etc.?

Together with our clients we try to find the optimal solution which solves specific problems. We usually instruct clients on how to use the solution.

- 7) What is your general approach to data privacy and security?

We try to follow the directives of the GDPR.

- 8) What is your firm responsible for in deploying your technologies? For example: are installation, set-up, and maintenance included in your sales price?

We offer free consultations. If a product is purchased by Solutions, we give first level support in case of problems. Trainings (on how to use a product) are charged. We usually do not do installations or set-ups.

- 9) If more than one technology is provided, which ones are the most successful? And why do you think they are?

Tablet-based solutions seem to be most successful and best accepted.

- 10) What are the advantages of your technologies/solutions over your competitors?



Most of our recommended solutions are standard solutions which are also used by our competitors. Our self-developed solutions (software, apps, Integra Mouse) solve specific problems and satisfy specific needs, advantages are rather subjective.

- 11) What feedback is provided by the different types of users? What do they complain about? What do they love about it or think is really useful?

We do not gather feedback systematically. We often see our clients once and do not learn how they are using a solution. Generally, the clients want simple and reliable solutions. They sometimes complain about prices or when they encounter problems with a solution (required training time, loss of data, breakage, ...).

- 12) Could you give a brief summary of your business models for the products/services offered?

We are a non-profit organization; consultations are for free and financed by public authorities and private sponsors; recommended solutions can be bought. Trainings and workshops are charged. We also participate in various national and international research programs with increasing focus on AAL and high age-related challenges.

- 13) Has your technology been modelled for simulation or BIM?

No.

C) Accessibility

- 14) How do you ensure the facilities or devices accomplish of the universal accessibility criterion according to national laws where your products are sold or used?

We have 20 years of expertise in the field of AT and AAC; we are including experts in all our projects if needed and usually follow a user-centered co-design process when developing services/new products.

D) Ethical Principles

- 15) Do your AAL technologies account for ethical principles stipulated in each region?

No yet.

Case 5



Template 01-Essense

A) General Information about Institution, user groups:

- 1) What is the name of your firm?

Case 5.

- 2) Which user groups use your facilities or device? (Profile, degree of dependence, models of coexistence)

Profiles:

- a) Professional workers from the medical field, nurses, physiotherapists, general practitioners, and gerontologists.
- b) Professional workers from the field of social work, psychology, and andragogy.
- c) Users/patients: older adults (65-80 years old).



Levels of independence:

- a) Persons living independently or/and in the joint household with a partner or family members.
- b) People with limited independence, who live alone and who occasionally receive help from a caregiver.
- c) People with limited independence living in a joint household with a partner or family members.

B) Use of technology (AAL)

- 3) Which AAL solutions/technologies do you provide and what challenges do they address?

We are offering AAL technologies in the development phase:

- a) Monitoring health parameters (blood pressure, heart rate, blood oxygenation, body weight).
- b) Monitoring activity in indoor environments.
- c) SOS device connected with a call centre (in the testing phase).
- d) Monitoring rooms and the use of devices (opening of doors, cabinets, and refrigerators).
- e) Detection of water spills and smoke.
- f) Medication delivery system.

- 4) Where and how are they used (e.g. type of building; wearable device and/or ambient-integrated sensors)?

We are using simulated environments (simulated apartments) and actual living environments (apartments and houses of users). The devices are typically mobile, while some are installed in the environment (SOS device, motion sensors).

- 5) In which settings do they perform best (and worst)?

- The best: At the time, they perform the best in situations with a single user in a setting. Each device is more or less responsive (depending on the device).

- The worst: Some sensors, mostly motion sensors, are sometimes activated when not appropriate.

- 6) How do user groups use your solutions/technologies? Do you differentiate physical attributes of devices, services, etc.?

Users are using the solutions based on their life situation. In the “living lab” we are testing many options (or services) from different providers.

- 7) What is your general approach to data privacy and security?

Data security and privacy are in line with GDPR.

- 8) What is your firm responsible for in deploying your technologies? For example: are installation, set-up, and maintenance included in your sales price?

Currently, we are responsible for testing the solutions and assessing the satisfaction of the end users. Our partners are responsible for technical aspects.

- 9) If more than one technology is provided, which ones are the most successful? And why do you think they are?

We are currently testing many options – more information will be available in 10 months. We are satisfied with personalized and modular solutions and the solutions that enable renting the equipment.

- 10) What are the advantages of your technologies/solutions over your competitors?

As said, more information will be available in 10 months.

The solution from our consortium is still in development.

- 11) What feedback is provided by the different types of users? What do they complain about? What do they love about it or think is really useful?

Users are most worried about protecting their privacy and the feeling they are being monitored. Also, they can be bothered by aesthetical aspects of the visible sensors/devices. In addition, they can get overwhelmed with large devices, especially wearables.

- 12) Could you give a brief summary of your business models for the products/services offered?

The business model is still in development and I cannot share it here. After we finish the development of the solution and the business model, our service will be in the market in 1.5 years.

- 13) Has your technology been modelled for simulation or BIM?

No.

C) Accessibility

- 14) How do you ensure the facilities or devices accomplish of the universal accessibility criterion according to national laws where your products are sold or used?

We are still in the development phase. Other solutions we have in the demo centre are handled by their manufacturers or providers.

D) Ethical Principles

- 15) Do your AAL technologies account for ethical principles estipulated in each region?

We are in line with ethical principles. For this purpose, we have an ethical commission in the project.



ANNEX 3: Questionnaire for online survey.



General Questions:

Company field:

Age of company:

Position at company:

Time at company:

Country:

Please rate your firm's engagement with the following topics: [1 = not at all engaged, 5 = highly engaged]

- Design, production, or implementation of smart building solutions for positive, active ageing.
- Operation of smart building solutions for positive, active, ageing.
- Building design for older adults.
- Operation of living or shared space for older adults.
- Construction of buildings for older adults.

Topic 1: Necessary skills for smart buildings, ageing, and BIM

Which skills do you believe are most important to graduating students related to smart buildings, ageing, and BIM? (Choose 3)

- ICT – Software development (e.g., for BIM extensions).
- ICT – Data management and analysis (collection, storage, etc.).
- ICT – Internet of Things, sensors, and related services.
- Tools – Design with BIM.
- Tools – Conversion from BIM to computer aided manufacturing.
- Tools – Development of BIMs.
- Ageing – Regulations regarding accessibility.
- Ageing – Health & safety needs of older adults.
- Ageing – Social needs of older adults.
- Design – General design/architecture.
- Design – Computer aided design.
- Design – Meeting certification/standards requirements.

How would you rate the importance of the following areas of expertise on a scale of one to ten (one = lowest priority, 10 = highest priority)?

- ICT [1 – 10]
- Computer aided design tools [1 – 10]
- Ageing / needs of older adults [1 – 10]
- Architecture/Design [1 – 10]
- General education [1 – 10]
- Interdisciplinary training focused on BIM and design [1 – 10]

Please respond to the following statements [Agree, Disagree, I don't know]:



- Vocational training is a useful tool for increasing employee skills related to BIM and active, positive ageing.
- Higher education programmes in architecture, design, and engineering should provide training related to BIM and active, positive, ageing.
- Higher education programmes in ICT should provide training related to BIM and active, positive ageing.
- Higher education programmes in health or ageing should provide training related to BIM and active, positive ageing.
- Skills related to BIM and active, positive ageing are valuable for workers in my field.

Which skills do you believe are most useful for implementing BIM and active, positive ageing?

[Open ended]

Topic 2: Buildings and construction

How would you prioritize the following aspects of construction in terms of implementing BIM and active, positive ageing?

- Design of new buildings.
- Bidding, procurement, contracting.
- Construction management.
- Retrofitting / renovation
- Maintenance.
- Building management (during occupancy).

How important are the following related to implementing BIM and active, positive ageing? [1 = not important, 5 = very important]

- Investor demand.
- Available finance.
- National standards.
- European standards.
- Building certification systems.
- Availability of tools for design with BIM.
- Availability of solutions of positive, active ageing.
- Availability of employees with BIM and/or positive, active ageing.

Topic 3: Positive, active ageing

Please state the extent to which you agree with the following statements (1 = strongly disagree, 5 = strongly agree)

- Solutions with established BIMs are easier to include in building designs.
- Ageing and the needs of older adults are well addressed by current building practices.
- Current practices related to design and construction of buildings for older adults support their health needs.
- Current practices related to design and construction of buildings for older adults support their social needs.
- Courses on positive, active ageing should be included in architecture, building, and engineering higher education programmes.
- Courses on positive, active ageing should be included in ICT higher education programmes.
- Courses on BIM and ICT solutions for positive, active ageing should be included in health-related higher education programmes.



Topic 4: ICT solutions for positive, active ageing.

Please state the extent to which you agree with the following statements (1 = strongly disagree, 5 = strongly agree).

- Currently available smart building solutions address the needs of older adults.
- Smart building solutions for older adults are readily available on the market.
- Recent graduates from higher education programmes in architecture, building, and engineering are capable of understanding how to include smart building solutions.
- Recent graduates from higher education programmes in ICT are capable of designing or contributing to the design and implementation of solutions for smart buildings.
- Recent graduates from health-related higher education programmes are capable of utilizing smart building solutions to support older adults [*would like to phrase this differently*].

Closing.

May we contact you to follow up on your responses to this questionnaire? [Y / N]

If Y: Name, Email.

If N: thank you taking your valuable time to complete our questionnaire. You may learn more about the Essense project at: [URL].

ANNEX 4: Follow-up Questions for respondents to previous case studies.



Topic A: Familiarity with BIM and its role in your company/field.

QA.1: Please tell us about your familiarity with BIM.

QA.2: Please tell us about the general familiarity with BIM at your organization? (i.e., do your employees have these skills? Do you utilize a third party or partner organization with these skills?).

QA.3: Do you consider BIM as a necessary tool/skillset to be or remain competitive in your field? How does BIM contribute to competitiveness in your case?

Topic B: Access to skilled employees.

QB.1: Do your current employees have the appropriate skillset to work with BIM?

IF YES, QB.2_Y: How did your employees receive training? Was the training received effective? How has work experience with contributed to worker expertise with BIM?

IF NO, QB.2_N: Are BIM training programmes available (e.g., Higher education or Vocational Training)? Are these programmes suitable? Why or Why not? Do you or would you support your employee's enrolment in BIM training programmes?

QB.3: How should training programmes change to address the needs of BIM for your company/field? What new knowledge.

QB.4: Would you be more likely to hire a candidate for a position if they had previous experience or training with BIM?

Topic C: BIM tools.

QC.1: How do current BIM tools meet the needs of your company/field? Do you have access to these tools?

QC.2: What features are most useful in BIM tools? Which features do you consider to be missing?

QC.3: What changes do you anticipate regarding BIM tools in the near future (within 5 years)?

Topic D: Other

QD.1: Do you currently or do you plan to utilize BIM in conjunction with tools like building systems management, ambient assisted living, or building sensors?

QD.2: Please share any other thoughts you may have related to BIM and your company/field.

QD.3: What challenges or difficulties do you see in reconciling the various requirements of specialty projects related to positive, active ageing (senior-friendly, barrier-free construction, AAL and BIM)? Please name a few key challenges.

QD.3a: What does it take to solve these challenges?

[These questions may be answered from the previous exercise]

What is your specialization in this area (e.g., architect, solution provider, planner, health facility operator, etc.)?

What type of building projects do you normally work on? (Housing, public, hospital, multi-family, multi-level).



ANNEX 5: Course info template.



Course X	
Course Name	
Institution	
Country	
Link	(Link to website describing the course)
Credits offered	
Frequency	(Annually, Every other year, etc.)
Course Type	(Required / elective)
Course level	(1st Bologna / 2nd Bologna / other)
Avg. No. of students	
Prerequisites	
BIM-Related content	
Course outcomes (skills & competences after the course)	

