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ReAAL

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Evaluation, validation and evidence report

[Deliverable 5.3, Revision a]

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Version	Date	Author	Partner	Description
0.1	9-Jul-2015	Alejandro Medrano	UPM	ToC
0.2	8-Aug-2015	Marleen de Mul	EUR	Chapter conceptual model and Methodology first version
0.3	27-Sep-2015	Marleen de Mul	EUR	Appendices filled
0.4	30-Sep-2015	Alejandro Medrano / Alessio Fioravanti / Marleen de Mul	UPM /EUR	Introduction Methodology Main results filled conclusions
0.5	30-Sep-2015	Marleen de Mul	EUR	Internal review for intermediate version to be sent to commission
0.6	30-Sep-2015	Saied Tazari	Fh-IGD	Intermediate version for project review
0.7	23-Oct-2015	Alejandro Medrano	UPM	Update of results
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0.9	27-Oct-2015	Alejandro Medrano / Alessio Fioravanti	UPM	Update of results
0.95	5-Nov-2015	Alejandro Medrano / Marleen de Mul	UPM/EUR	Version ready for internal review
0.96	13-Nov-2015	Alejandro Medrano / Marleen de Mul	UPM/EUR	Version ready for release
1.0	14-Nov-2015	Helmi Ben Hmida	Fh-IGD	Official release

Statement of originality:

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

Executive Summary

This is the D5.3a report on evaluation of the make it ReAAL project. At the time of release, most pilots have started deployment. For that reason, this report focuses on the results from the adaptation phase of the project.

To structure the analysis of the results of the ReAAL project six research questions have been defined:

1. *What are the reasons for the partners to join ReAAL and what are their expectations on open platforms?*
2. *How has the universAAL platform developed through time, and what evidence is there for the quality of this platform and its potential to serve as a standard for the AAL domain?*
3. *What are the experiences of the pilots with using universAAL and which value does universAAL have for them*
    a. *when adapting their existing applications?*
    b. *when importing an application from another pilot?*
    c. *when optimizing their application and service portfolio?*
4. *What is the impact of universAAL on the application and service quality, and as a consequence on the value for the end user to support independent living?*
5. *How has the ecosystem within and around the ReAAL project evolved, and what is needed to sustain this ecosystem around universAAL for the future?*
6. *What are the socioeconomic benefits of deploying AAL applications based on the open platform universAAL?*

Chapter 2 shortly introduces the conceptual framework OPEA, and which indicators from this framework are relevant to report. **Chapter 3** deals with methodological considerations, for example how the quality of the work was assured, which data collection tools were used for which indicator, and how the showcase pre-assessment was arranged. The actual findings are presented in **chapter 4**. This chapter provides, among others, statistics about the platform quality, a description of the service providers, and a profiling of the developers. It should be noted that D5.3a is an intermediate release of the evaluation. More data will become available in the coming months. Some interesting observations so far are that there is high polarization between developers in their evaluation of universAAL's value. Most developers experienced problems with the documentation, but the support from the community (universAAL experts) was good. Most value is experienced, or to be expected, from using universAAL to integrate services. Cost of universAALization differed also to a great extent between pilots. In **chapter 5** the evaluation team gives a preliminary answer to the research questions, based on the current status of the project. Furthermore, they conclude that from evaluation perspective, the ReAAL project has just begun, because now the base has been laid on which developers can build. The next steps in the project (importing applications, showcase evaluation) are crucial to have a full evaluation of the socioeconomic benefit of open platforms.

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1. About This Document

1.1. Deliverable context

Project item	Relationship
Objectives	*O4 (development of multidimensional evaluation methodology); O6 (provide evidence of the values of open platforms); O7 (validate the effectiveness of the value chain)*
Exploitable results	*Res8: A multi-dimensional evaluation methodology and framework for open service platforms for the provision of active and independent living services*
Work plan	*This deliverable is related to task T5.3: Evaluation execution and evidence delivery*
Milestones	*MS4: Final corrective actions*
Deliverables	*This deliverable builds on D5.2 and is input for D5.3b*
Risks	*Rk12: Failure in performing field studies, esp. due to users' difficulties to carry out the tests* *Rk14: Inconsistent or too low quality of data for the evaluation*

1.2. The rationale behind the structure

Even though the evaluation framework covers many domains, for this intermediate report we only report on indicators we have data on; this is mainly indicators from the adaptation phase. The final deliverable, covering more domains and evaluation activities could have a different structure.

The pilot-level digests are added as an Appendix to this document. It contains raw data from the pilots not collected through questionnaires and interviews but by self-reporting.

1.3. Version-specific notes

D5.3a is an intermediate report, to show the evaluation progress, and some first results. As such, it can be used within the consortium to discuss about the project's progress and whether the overall aims are met. Because of the timeline of the project, D5.3a mainly reports on the adaptation phase of the evaluation, and the first phase of the showcase evaluation. It is important to note that the pilots who joined later (the associated pilots) have full responsibility in the evaluation, but have other deadlines for delivering their complete data. Therefore, these pilots will only report in D5.3b. However, we included all data that was available at this time, in the main report and the appendix.

At the end of the project deliverable D5.3b will be released. That report will also include the deployment phase and overall evaluation of the project.

2. Research questions and evaluation framework

This chapter starts with the research questions of the ReAAL evaluation. After that, the basic concepts behind the evaluation are elaborated on, when introducing the evaluation framework.

2.1. Main research questions

The ReAAL project aims to demonstrate, by large scale deployment, the value of open platforms for AAL, in this case the universAAL platform.

This large scale deployment builds on local pilots in different countries, each with their own ecosystem and application portfolio. The assessment of the value of universAAL within these ecosystems, is the key objective of the evaluation. All evaluation activities at pilot and project level contribute to an answer to the central question of the European Commission, when launching the ICT-PSP call in which ReAAL was funded:

What are the socioeconomic benefits of deploying AAL applications based on an open platform?

This can only be answered, within ReAAL, for the open platform universAAL. However, the methodology developed for this project is generic, and should be applicable to any AAL platform evaluation.

The question to socioeconomic benefit is the final question of the ReAAL project. In order to draw meaningful conclusions about this, universAAL itself has to be evaluated, as part of the different local ecosystems. The value experienced by all involved stakeholders is crucial to collect: do they experience benefit from universAAL? Therefore, the evaluation follows the trajectory of the ReAAL project as a whole, and within each pilot.[1] The following research questions are addressed:

1. *What are the reasons for the partners to join ReAAL and what are their expectations on open platforms?*

   This question is relevant because the basic assumptions of the project participants are an important factor for the success of the project, and their commitment towards the project's goals. If stakeholders have specific expectations, it is easier for them to assess the value. Most likely, different stakeholders have different reasons for being interested in open platforms, which will influence their assessment.

2. *How has the universAAL platform developed through time, and what evidence is there for the quality of this platform and its potential to serve as a standard for the AAL domain?*

   The universAAL platform is by no means a finalized technology. The platform has gone through several iterations, also during the ReAAL project. This natural development might have an impact on the experienced quality (system quality, service quality), which is an important predictor for experienced benefit. Any social economic benefit can only be achieved if

[1] More information about the set-up of the ReAAL project can be found in other deliverables of this project. In general, all pilots deploy at least one application of their own choice, and import one application from another pilot.

universAAL is a sustainable platform, accepted and supported by the developer community.

3. *What are the experiences of the pilots with using universAAL and which value does universAAL have for them*

    a. when adapting their existing applications?

    b. when importing an application from another pilot?

    c. when optimizing their application and service portfolio?

    This question follows from the previous one. The application developers, with support of the platform experts, go through the process to adapt their applications and systems to universAAL. Their experiences, again, are an important predictor for experienced benefit. They will also look into improving their applications. The value of universAAL is not only visible for a developer, but also for the vendor of an application, and for the buyer, mainly a service provider (municipality, health care organization, senior housing). Finally, the end user of the application might experience the value of the universAALized[2] application. All these stakeholders at pilot level are relevant to include in the evaluation.

4. *What is the impact of universAAL on the application and service quality, and as a consequence on the value for the end user to support independent living?*

    The adaptation phase ends with real life user tests. The quality of the applications (without and with universAAL) should be good at that point. Naturally, with new applications, also during deployment quality issues might arise. Therefore, for the adaptation phase (reported in this version D5.3a) can only provide preliminary answers to this question. It is interesting to assess the ways in which a universAALized application is different from a non-universAAlized one. Is this application considered 'better' by the ones who sell it, and valued higher by those who buy it? Ultimately, all applications deployed support independent living, and improve quality of life of the end user. Therefore we also assess the end user experience, and the impact these AAL services have for their lives.

5. *How has the ecosystem within and around the ReAAL project evolved, and what is needed to sustain this ecosystem around universAAL for the future?*

    Continuously through this project, it is relevant to assess the way the philosophy of the ReAAL project is incorporated in the ecosystem, and if indeed such an ecosystem is being established. For example, expansion of the project is an indicator for this, but also the dissemination activities, and the diffusion of universAAL to other projects. Looking at the future, the social economic benefit can only be achieved if universAAL is a sustainable platform, supported not only by the developer community, but also by service providers.

[2] The 'slang' words "universAALization" and "universAALized" are used frequently in this report. universAALization is a term used in ReAAL to refer to the integration of all functional components to be deployed in pilot sites with the universAAL software platform (http://uaal.aaloa.org/) prior to their deployment where Goal of universAALization is to resolve the dependencies between these components for the exchange of data and functionality based on an open platform in order to achieve future-proof interoperability, adaptability, and extensibility to a wider extent.

6. *What are the socioeconomic benefits of deploying AAL applications based on the open platform universAAL?*

   This is the final question of the project. Building on what we conclude from the benefit universAAL brought to the pilots (the evidence), we can provide the estimations for what it can potentially bring in any ecosystem that is interested in flexible and interoperable solutions for supporting active and assisted living.

In the report D5.3a, based on the data we currently have, it is only possible to partially answer these questions.

2.2. Assessing the socioeconomic benefits of open platforms

2.2.1. What is an open platform?

A platform is anything that can be used to work or build on top of it. In case of software platforms, they offer a set of services that ease application development when used.

Software artefacts have different perspectives on which the openness may refer to.

1. **API openness**: Application Programming Interface (API) is the definition and specification of the services offered by the software platform. Open APIs are those that are accessible to application developers, well documented and supported.

2. **Scope openness**: The scope of a platform determines the domain of the offered services. Another way to look at it is the limitations the platform imposes (where it is designed to run: mobile, web, desktop; what is used for: resource management, system management, etc..). Open Scope refers to the capability of using the platform for purposes it wasn't planed for.

3. **Source openness**: The source code is the written implementation of the service specifications (see API). Open source refers to the explicit legal right for developers to edit the source code of the platform, in order to extend its functionality or fix bugs.

4. **Usage openness**: The legal contract between the user and the provider of the software, typically referred as "the license", defines the conditions under which any piece of software is to be used by the user. These conditions may include, but not be limited to, number of users, geographical region restrictions, purpose, or number of features. An open license is one that defines procedures or conditions for users to use the software in any way imaginable, including cases such as reselling, or embedding the software as part of another product.

It is important to note that openness is not the same as cost-free. For example licenses may determine the procedure by which in exchange for better conditions, the user may reimburse the software provider. The English language fails to differentiate between "*free as in freedom*" and "*free as in free beer*". For this reason we chose to use *open* for the first case and *cost-free* for the second.

Because of the scope of ReAAL project, examined open platforms must include AAL or health as part of their scope (explicit or extended). In the explicit case of this report the open platform which is being studied is universAAL (which complies with

all openness conditions plus it is cost-free). None the less the properties of this platform are also available by other platforms, therefore in these cases results may be generalised. In other cases the methodology used (especially showcases) may always be applied using other open AAL platforms in other to compare results.

2.2.2. How to assess the socioeconomic benefit of open platforms?

Socio-economic impact of any innovation is the social value added by that innovation. The following equation applies:

Socio-economic impact = Value added – Value destroyed

Value added (or destroyed) can be measured the following way:

Value added from open platform

=

Value of AAL applications and services with an open platform – Value of AAL applications and services without an open platform

The ReAAL project focusses only on the universAAL platform as it is not possible to perform the same detailed evaluation on other potential open platforms. However, the evaluation methodology is so generic that it can also be applied to assessing the value of other open platforms.

The Δ, the difference between *with* and *without* universAAL, is the focus of the evaluation.

Showing cost effectiveness and return on investment for information technology has been problematic, and discussed extensively in the literature (Philips 2002). For example, studies in health IT predicted the cost savings and life years gained by information exchange (interoperability), but the extrapolation of results was criticised (Walker 2005, Kellermann 2013). These forecasts usually ignore the context in which IT systems are implemented. Other research has shown, however, that this context is a crucial factor in any success or failure of technology (Greenhalgh 2004). Scholars argue that more case studies are needed, to be able to extract common mechanisms which, in these different contexts, lead to the outcomes (Denyer 2008). The effectiveness of Information Technology is highly context-dependent.

The same challenges arise when assessing the socioeconomic benefit of open platforms. There as well the context has to be taken into account, in order to have any credible conclusions. The OPEA framework, described in the next paragraph is specifically meant to collect as much data as possible about the context of universAAL implementation within the ReAAL project. It will look at the open platform from different angles, both thematically and from various stakeholder perspectives.

Every pilot can be seen as a case study for assessing the value of universAAL. Because every pilot has its own dynamics, benefits in one pilot might not be valued the same way in another pilot. Therefore, the experience in ReAAL provides the evidence for socioeconomic benefit, but in specific contexts. In order to have more generalizable results, a secondary analysis is needed. This is called the “ReAAL impact validation.”

2.3. The OPEA evaluation framework

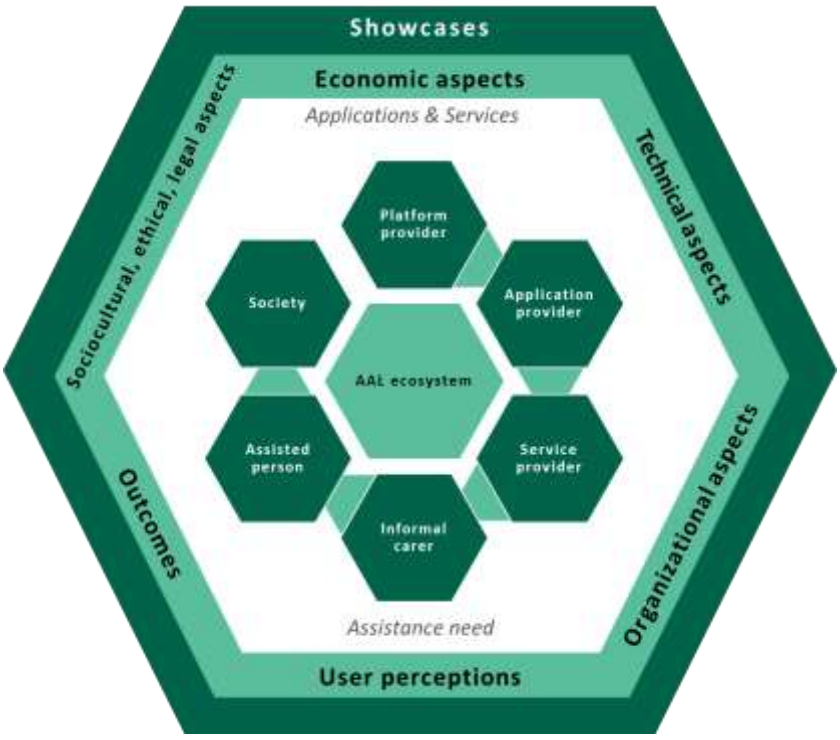
This report uses the OPEA framework for the analysis of the collected data. The framework has been explained thoroughly in D5.2.[3]

The framework consists of a conceptual model, an indicator model derived from this conceptual model, and an evaluation design to collect the data for these indicators.

2.3.1. Conceptual model

The conceptual model illustrates the multi-stakeholder perspective we choose for the evaluation. These stakeholders are part of the ecosystem like in a value network; both the universAAL platform and the applications that run on them and the services that are provided through these applications, add value. Complementing the multi-stakeholder perspective, the next level is the multi-assessment domain. Because of the different stakeholders, who each have different goals and expectations, assessing the benefit of open platforms should be studied from various angles. Aspects that seem more relevant for one stakeholder, may be values of less importance for another stakeholder. Following the principles of Health Technology Assessment, six assessment domains have been defined. For each of these domains a set of indicators has been developed, taking into account the different stakeholders and their role in either providing the data or judging the outcome. The third and final level of analysis combines these assessment domains to the features and key selling points of open platforms. This is what we call the “showcase” layer of the model.

Figure 1.OPEA conceptual Model

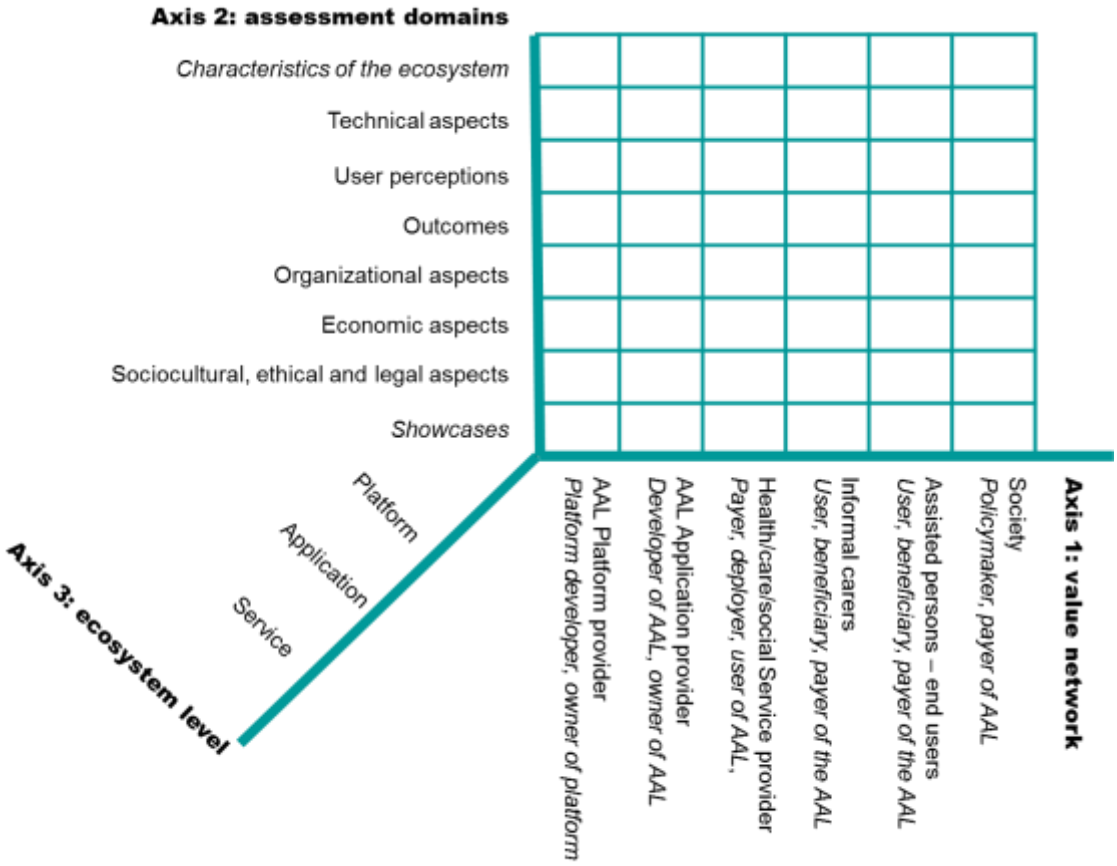


[3] D5.2 has been released in Spring 2015, before many of the evaluation activities started. We found out, while writing this report, that some minor updates to our original evaluation framework are needed. Therefore D5.2 will have a final release at the end of the project.

2.3.2. OPEA indicator model

The indicators derived from this conceptual model can be visualized in the following diagram:

Figure 2. OPEA Indicator model



This diagram illustrates the indicators that have been defined on each assessment domain, looking at the whole value network. Some indicators relate to the universAAL platform, other to the applications and services.

The table on the next pages provides an overview of all indicators measured at pilot and ReAAL level, including the indicators for the showcases. The columns at the right show in which phase of the evaluation this indicator is measured. As a consequence of this, not all indicators are reported in D5.3a. The data needed for these indicators is implemented into the data collection tools or derived from ready available reports (see the overview table in chapter 3).

Table 1. Indicator overview

Characteristics of the ecosystem			Stage I			Stage II
Indicators	Subindicators		Pilot evaluation: Adaptation phase	Pilot evaluation: Deployment phase	Showcase evaluation	ReAAL impact validation
1. Description of ecosystem	CE_1a	Description of involved stakeholders	X	X		X
	CE_1b	Current financing structure		X		
	CE_1c	Experience with AAL	X			
2. Description of user group	CE_2a	Assisted person	X	X		
	CE_2b	Informal carer		X		
	CE_1c	Formal caregiver (incl. assistance provider)		X		
	CE_1d	Application developer	X			
3. Description of application and service	CE_3a	Description of application and service	X			
Technical aspects			Stage I			Stage II
Indicators	Subindicators		Pilot evaluation: Adaptation phase	Pilot evaluation: Deployment phase	Showcase evaluation	ReAAL impact validation
1. Platform quality	TA_1a	Description of platform	X			
	TA_1b	Platform code metrics	X	X		
	TA_1c	Platform Tracker system	X	X		
	TA_1d	Platform code Commits	X	X		
2. Application and universAALization quality	TA_2a	Technical description of the application	X			
	TA_2b	Ontology evaluation	X			
	TA_2c	universAALization of the application(s)	X			
	TA_2d	Application quality assurance	X			
	TA_2e	Application universAALization test results	X			
	TA_2f	Application Tracker		X		

User perceptions			Stage I			Stage II
Indicators	Subindicators		Pilot evaluation: Adaptation phase	Pilot evaluation: Deployment phase	Showcase evaluation	ReAAL impact validation
1. User acceptance	UP_1a	Reliability of the application	X	X		
	UP_1b	Usability of universAAL	X	X	X	
	UP_1c	Usability of application	X	X		
	UP_1d	Usefulness of universAAL	X	X	X	
	UP_1e	Usefulness of application		X		
	UP_1f	Role of social environment		X		
2. Use	UP_2a	Use of universAAL features	X		X	
	UP_2b	Use of universAAL components	X		X	
	UP_2c	Use of the application		X		
3. Satisfaction	UP_3a	Satisfaction with the universAAL platform	X	X		
	UP_3b	Satisfaction with(formal/informal) care		X		
	UP_3c	Satisfaction with the application/service		X		
	UP_3d	Information quality universAAL documentation	X			
	UP_3e	Information quality application/service level		X		
	UP_3f	Service quality universAAL	X	X		
	UP_3g	Service quality application/service level		X		
4. Value	UP_4a	Experienced value of universAAL	X	X		
	UP_4b	Fit with needs of assisted person		X		
	UP_4c	Experienced value of the service		X		
	UP_4d	Experienced value of interoperability for end user		X	X	
Outcomes			Stage I			Stage II
Indicators	Subindicators		Pilot evaluation: Adaptation phase	Pilot evaluation: Deployment phase	Showcase evaluation	ReAAL impact validation
1. Health & health consumption	OC_1a	Health of the assisted person		X		
	OC_1b	Health consumption of the assisted person		X		
2. Quality of life	OC_2a	Health related quality of life of assisted person		X		
	OC_2b	Wellbeing related quality of life of assisted person		X		
	OC_2c	Quality of life of informal carer		X		

3. Independent living	OC_3a	Independent living of the assisted person		X		
4. Adverse events and side effects	OC_4a	Adverse events using the universAALized application		X		
	OC_4b	Falls		X		
Economic aspects			Stage I			Stage II
Indicators	Subindicators		Pilot evaluation: Adaptation phase	Pilot evaluation: Deployment phase	Showcase evaluation	ReAAL impact validation
1. Cost	EA_1a	Cost of universAAL platform deployment		X		X
	EA_1b	Cost of universAALization	X			
	EA_1c	Cost of deployment and operation of AAL		X	X	
	EA_1d	Cost of service		X		
	EA_1e	Cost of importing an application from another pilot		X	X	
2. Revenues	EA_2a	Revenues for platform provider		X		
	EA_2b	Revenues for application provider		X		
	EA_2c	Revenues for service provider		X		
3. Willingness to pay	EA_3a	Willingness to pay for universAAL platform		X		
	EA_3b	Willingness to pay for universAALized applications		X		
4. Market value	EA_4a	Market value of universAALized application		X		
Organizational aspects			Stage I			Stage II
Indicators	Subindicators		Pilot evaluation: Adaptation phase	Pilot evaluation: Deployment phase	Showcase evaluation	ReAAL impact validation
1. Organizational fit	OA_1a	Fit with work processes of service provider	X	X		
	OA_1b	Fit with legacy systems of application provider		X		
	OA_1c	Fit with legacy systems of service provider	X	X		
	OA_1d	Innovation climate of application provider		X		
	OA_1e	Innovation climate of service provider	X	X		
2. Implementation	OA_2a	Implementation of universAALized applications and services		X		
3. Impact on core process	OA_3a	Productivity in development process		X		
	OA_3b	Efficiency in deployment process		X		
	OA_3c	Quantity of care/service		X		

	OA_3d	Quality of care/service		X		
4. Strategic position	OA_4a	Strategic position of platform provider		X		X
	OA_4b	Strategic position of application provider		X		
	OA_4c	Strategic position of service provider	X	X		
5. sustainability of universAAL	OA_5a	Sustainability of universAAL	X	X	X	X
SocioCultural, Ethical and Legal aspects			Stage I			Stage II
Indicators	Subindicators		Pilot evaluation: Adaptation phase	Pilot evaluation: Deployment phase	Showcase evaluation	ReAAL impact validation
1. Sociocultural aspects	SCEL_1a	Accessibility	X			
	SCEL_1b	Policy for inclusion		X		
2. Legal aspects	SCEL_2a	Procurement process	X			
	SCEL_2b	Data protection	X			
3. Ethical aspects	SCEL_3a	Ethical concerns of users		X		
	SCEL_3b	Ethical approval of pilot	X			
Showcases			Stage I			Stage II
Indicators	Subindicators		Pilot evaluation: Adaptation phase	Pilot evaluation: Deployment phase	Showcase evaluation	ReAAL impact validation
1. Description of the showcase	SHOW_1a	Cross-application resource and capability sharing description			X	
	SHOW_1b	Plug and Play description			X	
	SHOW_1c	Advanced Distribution description			X	
	SHOW_1d	Scalability description			X	
	SHOW_1e	Evolution description			X	
	SHOW_1f	Integration with legacy systems description			X	
	SHOW_1g	Services Integration description			X	
	SHOW_1h	Security & Privacy description			X	
	SHOW_1i	Service Transferability description			X	
	SHOW_1j	Advanced User Interaction description			X	
	SHOW_1k	Personalized Content description			X	
	SHOW_1l	Ambient Intelligence description			X	
	SHOW_1m	Enhanced Market communication and distribution description			X	

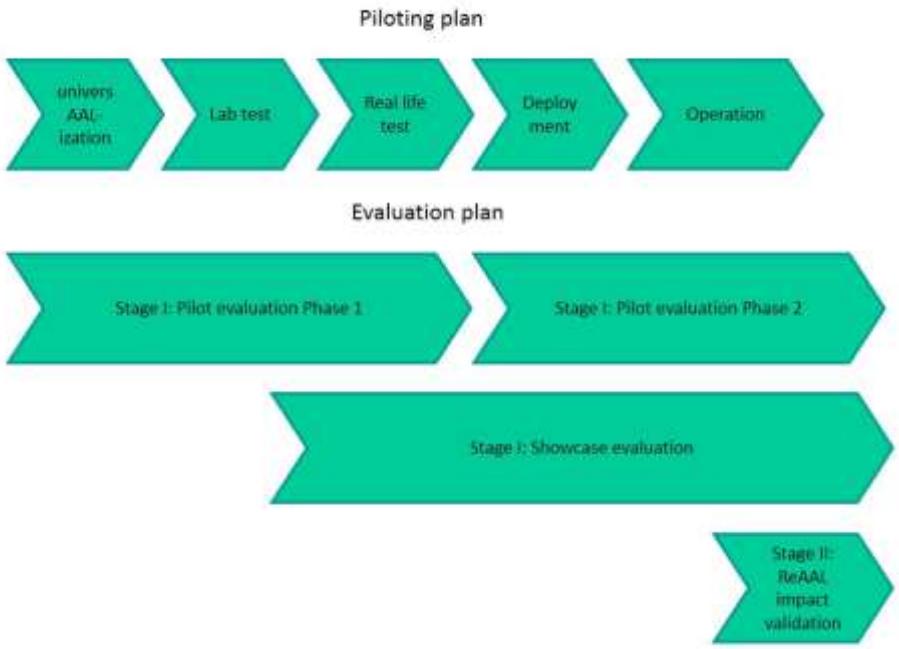
2. Demonstration of showcase	SHOW_2a	Cross-application resource and capability sharing demonstration			X	
	SHOW_2b	Plug and Play demonstration			X	
	SHOW_2c	Advanced Distribution demonstration			X	
	SHOW_2d	Scalability demonstration			X	
	SHOW_2e	Evolution demonstration			X	
	SHOW_2f	Integration with legacy systems demonstration			X	
	SHOW_2g	Services Integration demonstration			X	
	SHOW_2h	Security & Privacy demonstration			X	
	SHOW_2i	Service Transferability demonstration			X	
	SHOW_2j	Advanced User Interaction demonstration			X	
	SHOW_2k	Personalized Content demonstration			X	
	SHOW_2l	Ambient Intelligence demonstration			X	
	SHOW_2m	Enhanced Market communication and distribution demonstration			X	
3. Value of showcase	SHOW_3a	Cross-application resource and capability sharing value			X	
	SHOW_3b	Plug and Play value			X	
	SHOW_3c	Advanced Distribution value			X	
	SHOW_3d	Scalability value			X	
	SHOW_3e	Evolution value			X	
	SHOW_3f	Integration with legacy systems value			X	
	SHOW_3g	Services Integration value			X	
	SHOW_3h	Security & Privacy value			X	
	SHOW_3i	Service Transferability value			X	
	SHOW_3j	Advanced User Interaction value			X	
	SHOW_3k	Personalized Content value			X	
	SHOW_3l	Ambient Intelligence value			X	
	SHOW_3m	Enhanced Market communication and distribution value			X	

ReAAL impact indicators			Stage I			Stage II
Indicators		Subindicators	Pilot evaluation: Adaptation phase	Pilot evaluation: Deployment phase	Showcase evaluation	ReAAL impact validation
1. universAAL success	IMPACT_1a	Number of successfully demonstrated showcases			X	X
	IMPACT_1b	Number of supported operating systems				X
	IMPACT_1c	Number of supported device types				X
2. Pilot's success	IMPACT_2a	Number of pilots with successful universAALization	X			X
	IMPACT_2b	Number of pilots reaching number of users		X		X
	IMPACT_2c	Number of successfully implemented imported applications		X	X	X
3. Upscaling success	IMPACT_3a	Number of associated pilots				X
	IMPACT_3b	Number of associated vendors				X
4. Dissemination success	IMPACT_4a	Number of visits to website (measured quarterly for the whole project time)				X
	IMPACT_4b	Number of accounts in the developer depot of universAAL				X
	IMPACT_4c	Number of interested pilots				X
	IMPACT_4d	Number of visitors to ReAAL events				X
	IMPACT_4e	Number of H2020 proposals that use universAAL				X

2.3.3. Evaluation design

The evaluation follows the set-up of the pilot projects, and can be distinguished between two stages, and several phases:

Figure 3. Evaluation plan



Stage I, Phase 1: Preparation, adaptation and test phase is based on the data collected in the preparation and adaptation phase of the pilot. This phase has, mainly, a technical focus. The design in this phase is a pre-post design, using the tools listed in the methodology chapter.

Stage I, Phase 2: Deployment and operation phase is based on the data collected in the deployment and operation phase of the pilot. This evaluation phase has, mainly, a user focus. All pilots need to have an operation phase of at least six months; data is collected at start and end of use (pre-post design).

Stage I: Showcase evaluation consists of four steps: description of the showcase, pre-evaluation assessment, demonstration, value assessment. More details can be found in the next chapter.

Stage II: ReAAL impact validation. In the final months of the project, the results of ReAAL should be validated. The ReAAL impact is based on indicators at project level, that have been measured throughout the project; and a scenario analysis using the most powerful results of the pilot evaluation and showcase evaluation to calculate the socioeconomic benefit.

3. Methodology

3.1. General considerations

3.1.1. Data quality measures

Every evaluation benefits from reliable and valid data. In this paragraph the risks for suboptimal quality and the actions taken, are discussed.

The way the ReAAL project has originally been designed, is that each pilot performs its own evaluation, and writes its own report. Apart from the advantages (easy to distribute the work, pilots know best what has happened, pilots might not be biased by the project management goals) this also has drawbacks. How do we know that the pilots collect the data with enough quality and objectivity?

For this reason the evaluation team plays a more central role in the process. They designed the evaluation framework and all data collection methods and tools. The pilots have their own procedure to collect the data. Some do it themselves, others subcontract. In addition, the evaluation team has access to the raw data, also on individual level, and can perform the analyses. Moreover, part of the data is collected by the evaluation team. For example, in the past period we interviewed for each pilot at least one developer. Combined with the developer questionnaire data, the reliability of the analyses improves (data triangulation).

Likewise, there might also be bias from the universAAL founders; the project management of ReAAL has a high interest in seeing this project succeed. Also from their perspective it is important that the evaluation team has an objective approach, and always searches for additional evidence.

The practical consequence of the evaluation set-up is that it creates more dependencies for the evaluation team that the data is in time and of good quality. Also more time is needed between the deadlines of pilots (and project management) to deliver their data, and of the evaluation team to deliver their analyses and reports.

However, the project has also many strong points, methodologically speaking. The pilots are very different in nature, and given the objective of ReAAL this is an advantage because the pilots represent real life contexts and existing ecosystems for independent living and eHealth across Europe. For the external reliability this is good. Many countries can relate to these pilot's results, because they have been achieved in a similar health system and under similar conditions. Besides, extra validation work will take place towards the end of the project. However, it should be noted that the context of an EU project is always different than "real life". These projects have their own dynamics. It will be difficult to say at the end of ReAAL that similar results can be achieved without this funding mechanism.

Considering the validity of the evaluation, two points are relevant to discuss. Firstly, if the OPEA framework will be a valid instrument for assessing socioeconomic benefit. The framework is the first, and as far as we know still the only assessment framework for evaluating large scale deployment of open platforms. The project itself serves as validation for this framework. On beforehand the outcome is not known. However, both theoretically and methodologically we chose a wide array of assessments, which all contribute to answering the question about socioeconomic benefit. Specifically the recent efforts to further elaborate the showcase evaluation contribute to this socioeconomic assessment.

Secondly, since the framework is so broad, it could be questioned if everything is relevant. There are several reasons why the framework not only looks at the platform level, but also at the application and end user value. The market for AAL highly depends on service providers (care organizations, housing companies) to invest and demand standards for interoperability. Open platforms are, for them, relatively new. In addition, in the ReAAL project many service providers have little experience with AAL. This project is for them also a testcase for AAL investment in the future. It is important that also the applications themselves are evaluated and their impact on user satisfaction, independent living and the care process is assessed. For the technology providers this is crucial input to improve their application and extend functionality. In these iterations, the developers are most likely to experience the value of universAAL. Thus, all indicators have relevance for the value network. The second argument is that the ReAAL project wishes to contribute to the EIP-AHA goals. Therefore, some indicators of the MAFEIP framework[4] are included.

In the table below the risks and measures regarding data quality are summarized.

Table 2. Data quality measures

Type	Quality risk	Measure
Reliability	Bias by pilot / bias by universAAL founders	Data triangulation (interviews)
	Not enough competence	Clear data collection tools and instructions; possibility to subcontract
	Generalizability	High variety of pilots validation with stakeholders outside ReAAL
Validity	Do we really measure socioeconomic benefit?	Showcase evaluation
	Irrelevant indicators	Place the indicators back in value network

3.1.2. Privacy

In the reporting of D5.3 the privacy of the research subject, being either an older person or a developer or a pilot leader, is respected. End user data will always be analysed anonymously. To be able to link the baseline (T0) data to the follow up data during/after use (T1), each respondent has a unique identifier. The names that match these identifiers are only known to the evaluation responsible at pilot level. However, this evaluation responsible will only see raw data with the identifier removed. In that way the privacy is assured, as good as possible.

For smaller stakeholder groups, such as pilot leaders or developers, the data has not been collected anonymously due to the fact that it will be more difficult to use the data anonymised in the reports, because it is sometimes relatively easy to trace back to a specific pilot, and thus a specific person. The pilots receive the text of the evaluation reports before release, and can check these issues.

[4] More information about this evaluation framework, which has been developed for assessing the impact of EU projects in the active and Healthy Ageing domain, can be found in this report: http://publications.jrc.ec.europa.eu/repository/bitstream/JRC91162/jrc91162.pdf

3.1.3. Evaluation team

The ReAAL project has been designed in such a way that a group of technical and evaluation experts from universities and research institutes is responsible for the design of the evaluation framework, while the pilots are responsible for data collection. The evaluation team will analyse the data.

The evaluation leaders are based at Erasmus University Rotterdam (EUR) and the Polytechnic University of Madrid (UPM). The EUR team has not been involved in the universAAL project, and is also not doing any technical work in/for the project. That makes them the most independent academic partner in the consortium. UPM leads the execution of the evaluation, and is responsible for reporting. The other universities and research institutes of ReAAL (CNR, Fraunhofer, SINTEF, SmartHomes, UPV) are more actively involved in technical assistance to the pilots, and are responsible for the technical evaluation. For example they demonstrate the showcases or are asked as an expert to assess the ontologies. SmartHomes has the role of coordinating the showcase evaluation activities that take place in the lab setting in Eindhoven. It is important to note that CNR, Fraunhofer, SINTEF and UPV have been involved in the universAAL project so as such they do not have a neutral position.

One member of UPM, Alejandro Medrano, happens to be a core developer of the universAAL open platform as well as member of the evaluation team, and main editor of this document. The fact that this member is on the evaluation team makes it easier to find indicators for the platform, as well as the design of data gathering tools and analysis involving technical information. Any possible bias, or conflict of interest is removed by the review of the other members of the evaluation team, in some cases taking over the related work.

3.2. Data collection tools

The table on the next pages gives an overview of the data collection tools (to be) used for measuring the indicators. All tools are available in ReAAL's Knowledge Portal (http://reaal.aaloa.org/wiki/ReAAL_Knowledge_Portal). This wiki will become public in the coming months. A copy of the data collection tools can also be obtained via the evaluation leader (demul@bmg.eur.nl).

Table 3. Data collection tools per indicator

Characteristics of the ecosystem			
Indicators	Subindicators		Covered in data collection tools
1. Description of ecosystem	CE_1a	Description of involved stakeholders	Knowledge portal, ID5.1a
	CE_1b	Current financing structure	Project deliverable D1.1, ID5.1a
	CE_1c	Experience with AAL	Service provider T0-T1 Survey
2. Description of user group	CE_2a	Assisted person	Knowledge portal, Pilot inquiry Survey, Reallife test User Survey, Assisted Person T0, T1 Survey
	CE_2b	Informal carer	Informal caregiver T0, T1 Survey
	CE_2c	Formal caregiver (incl. assistance provider)	Formal caregiver T0, T1 Survey
	CE_2d	Application developer	Application Developer T0 Survey, application developer interview
3. Description of application and service	CE_3a	Description of application and service	Knowledge portal, Pilot inquiry Survey
Technical aspects			
Indicators	Subindicators		Covered in data collection tools
1. Platform quality	TA_1a	Description of platform	Knowledge portal, universAAL deliverables and WP2 deliverables (new releases)
	TA_1b	Platform code metrics	CI Server
	TA_1c	Platform Tracker system	Tracker system
	TA_1d	Platform code Commits	SCM database
2. Application and universAALization quality	TA_2a	Technical description of the application	Knowledge portal
	TA_2b	Ontology evaluation	Ontology evaluation internal report
	TA_2c	universAALization of the application(s)	Knowledge portal; Project deliverable D3.2b
	TA_2d	Application quality assurance	Extra questionnaire on application quality
	TA_2e	Application universAALization test results	Project deliverable D3.5, Project deliverable ID4.2
	TA_2f	Application Tracker	Issue tracker template
User perceptions			
Indicators	Subindicators		Covered in data collection tools
1. User acceptance	UP_1a	Reliability of the application	Project deliverable ID4.2, Assisted person T1, Informal caregiver T1, Formal caregiver T1, Project deliverable D3.5
	UP_1b	Usability of universAAL	Application developer T1

	UP_1c	Usability of application	Real Life Test User Experience Questionnaire, Assisted person T1, Informal caregiver T1, Formal caregiver T1
	UP_1d	Usefulness of universAAL	Application developer T1, application developer interview, Service Provider T2
	UP_1e	Usefulness of application	Assisted person T1, Informal caregiver T1, Formal caregiver T1
	UP_1f	Role of social environment	application developer interview, Assisted person T1, Informal caregiver T1, Formal caregiver T1
2. Use	UP_2a	Use of universAAL features	Application developer T1, Project deliverable D3.5
	UP_2b	Use of universAAL components	Application developer T1, Project deliverable D3.5
	UP_2c	Use of the application	Usage statistics
3. Satisfaction	UP_3a	Satisfaction with the universAAL platform	application developer interview, Application developer T1, T2, Service provider T2
	UP_3b	Satisfaction with(formal/informal) care	Assisted person T0, T1
	UP_3c	Satisfaction with the application/service	Assisted person T0, T1, Formal caregiver T1, Informal caregiver T1, Service provider T1, T2
	UP_3d	Information quality universAAL documentation	Application developer T1, application developer interview
	UP_3e	Information quality application/service level	Assisted person T0, Formal caregiver T0, Informal caregiver T0
	UP_3f	Service quality universAAL	Application developer T1, Technology provider T1, application developer interview
	UP_3g	Service quality application/service level	Assisted person T1, Formal caregiver T1, Informal caregiver T1
4. Value	UP_4a	Experienced value of universAAL	Application developer T1, Technology provider T1, Service provider T2, showcase evaluation
	UP_4b	Fit with needs of assisted person	Assisted person T1, Formal caregiver T1, Informal caregiver T1, Service provider T1, T2, focus group
	UP_4c	Experienced value of the service	Assisted person T1, Formal caregiver T1, Informal caregiver T1, focus group
	UP_4d	Experienced value of interoperability for end user	Assisted person T1, Formal caregiver T1, Informal caregiver T1, focus group
Outcomes			
Indicators	Subindicators		Covered in data collection tools
1. Health & health consumption	OC_1a	Health of the assisted person	Assisted person T0, T1, Formal caregiver T0, T1
	OC_1b	Health consumption of the assisted person	Assisted person T0, T1, Formal caregiver T0, T1

2. Quality of life	OC_2a	Health related quality of life of assisted person	Assisted person T0, T1, Formal caregiver T0, T1
	OC_2b	Wellbeing related quality of life of assisted person	Assisted person T0, T1
	OC_2c	Quality of life of informal carer	Informal caregiver T0, T1
3. Independent living	OC_3a	Independent living of the assisted person	Assisted person T0, T1, Formal caregiver T0, T1
4. Adverse events and side effects	OC_4a	Adverse events using the universAALized application	ID5.1b
	OC_4b	Falls	ID5.1b
Economic aspects			
Indicators	Subindicators		Covered in data collection tools
1. Cost	EA_1a	Cost of universAAL platform deployment	Direct contact with WP2
	EA_1b	Cost of universAALization	Cost template 1, in ID5.1a
	EA_1c	Cost of deployment and operation of AAL	Cost template 1, 2
	EA_1d	Cost of service	Cost template 2
	EA_1e	Cost of importing an application from another pilot	
	EA_1f	Platform effort	universAAL project reports and ReAAL quarterly reports
2. Revenues	EA_2a	Revenues for platform provider	Platform provider T1 Survey
	EA_2b	Revenues for application provider	Cost template 2, Application provider T1 Survey
	EA_2c	Revenues for service provider	Cost template 2,
3. Willingness to pay	EA_3a	Willingness to pay for universAAL platform	
	EA_3b	Willingness to pay for universAALized applications	Assisted person T1, Informal caregiver T1
4. Market value	EA_4a	Market value of universAALized application	Application provider T1 Survey
Organizational aspects			
Indicators	Subindicators		Covered in data collection tools
1. Organizational fit	OA_1a	Fit with work processes of service provider	Service provider questionnaire T0-T1, T2
	OA_1b	Fit with legacy systems of application provider	Application provider T1 Survey

	OA_1c	Fit with legacy systems of service provider	Service provider questionnaire T0-T1, T2
	OA_1d	Innovation climate of application provider	Application provider T1 Survey
	OA_1e	Innovation climate of service provider	Service provider questionnaire T0-T1, T2
2. Implementation	OA_2a	Implementation of universAALized applications and services	Service provider questionnaire T0-T1, T2, focus group
3. Impact on core process	OA_3a	Productivity in development process	Application provider T1 Survey, Application developer T1
	OA_3b	Efficiency in deployment process	Service provider questionnaire T2
	OA_3c	Quantity of care/service	Service provider questionnaire T0-T1, T2
	OA_3d	Quality of care/service	Service provider questionnaire T0-T1, T2
4. Strategic position	OA_4a	Strategic position of platform provider	Platform provider interview T1
	OA_4b	Strategic position of application provider	Application provider T1 Survey
	OA_4c	Strategic position of service provider	Service provider questionnaire T0-T1, T2
5. Sustainability of universAAL	OA_5a	Sustainability of universAAL	Platform developer interview, application developer interview, Service provider questionnaire T0-T1, Platform provider interview T1
SocioCultural, Ethical and Legal aspects			
Indicators	Subindicators		Covered in data collection tools
1. Sociocultural aspects	SCEL_1a	Accessibility	ID5.1a
	SCEL _1b	Policy for inclusion	ID5.1a
2. Legal aspects	SCEL _2a	Procurement process	ID5.1a, Service provider T0-T1 Survey
	SCEL _2b	Data protection	Project internal deliverable Privacy impact assessment
3. Ethical aspects	SCEL _3a	Ethical concerns of users	Assisted person T0, formal caregiver T0, Informal caregiver T0
	SCEL _3b	Ethical approval of pilot	Project internal deliverable Annex 9
Showcases			
Indicators	Subindicators		Covered in data collection tools
1. Description of the showcase	SHOW_1a	Cross-application resource and capability sharing description	Showcase evaluation pre-assessment
	SHOW_1b	Plug and Play description	Showcase evaluation pre-assessment

	SHOW_1c	Advanced Distribution description	Showcase evaluation pre-assessment
	SHOW_1d	Scalability description	Showcase evaluation pre-assessment
	SHOW_1e	Evolution description	Showcase evaluation pre-assessment
	SHOW_1f	Integration with legacy systems description	Showcase evaluation pre-assessment
	SHOW_1g	Services Integration description	Showcase evaluation pre-assessment
	SHOW_1h	Security & Privacy description	Showcase evaluation pre-assessment
	SHOW_1i	Service Transferability description	Showcase evaluation pre-assessment
	SHOW_1j	Advanced User Interaction description	Showcase evaluation pre-assessment
	SHOW_1k	Personalized Content description	Showcase evaluation pre-assessment
	SHOW_1l	Ambient Intelligence description	Showcase evaluation pre-assessment
	SHOW_1m	Enhanced Market communication and distribution description	Showcase evaluation pre-assessment
2. Demonstration of showcase	SHOW_2a	Cross-application resource and capability sharing demonstration	Showcase evaluation script
	SHOW_2b	Plug and Play demonstration	Showcase evaluation script
	SHOW_2c	Advanced Distribution demonstration	Showcase evaluation script
	SHOW_2d	Scalability demonstration	Showcase evaluation script
	SHOW_2e	Evolution demonstration	Showcase evaluation script
	SHOW_2f	Integration with legacy systems demonstration	Showcase evaluation script
	SHOW_2g	Services Integration demonstration	Showcase evaluation script
	SHOW_2h	Security & Privacy demonstration	Showcase evaluation script
	SHOW_2i	Service Transferability demonstration	Showcase evaluation script
	SHOW_2j	Advanced User Interaction demonstration	Showcase evaluation script
	SHOW_2k	Personalized Content	Showcase evaluation script

		demonstration	
	SHOW_2l	Ambient Intelligence demonstration	Showcase evaluation script
	SHOW_2m	Enhanced Market communication and distribution demonstration	Showcase evaluation script
3. Value of showcase	SHOW_3a	Cross-application resource and capability sharing value	Showcase evaluation focus group
	SHOW_3b	Plug and Play value	Showcase evaluation focus group
	SHOW_3c	Advanced Distribution value	Showcase evaluation focus group
	SHOW_3d	Scalability value	Showcase evaluation focus group
	SHOW_3e	Evolution value	Showcase evaluation focus group
	SHOW_3f	Integration with legacy systems value	Showcase evaluation focus group
	SHOW_3g	Services Integration value	Showcase evaluation focus group
	SHOW_3h	Security & Privacy value	Showcase evaluation focus group
	SHOW_3i	Service Transferability value	Showcase evaluation focus group
	SHOW_3j	Advanced User Interaction value	Showcase evaluation focus group
	SHOW_3k	Personalized Content value	Showcase evaluation focus group
	SHOW_3l	Ambient Intelligence value	Showcase evaluation focus group
	SHOW_3m	Enhanced Market communication and distribution value	Showcase evaluation focus group
ReAAL impact indicators			
Indicators		Subindicators	Covered in data collection tools
1. universAAL success	IMPACT_1a	Number of successfully demonstrated showcases	Showcase evaluation
	IMPACT_1b	Number of supported operating systems	t.b.d.
	IMPACT_1c	Number of supported device types	t.b.d.
2. Pilot's success	IMPACT_2a	Number of pilots with successful universAALization	Project deliverable D3.5

	IMPACT_2b	Number of pilots reaching number of users	Project deliverable ID4.2, bi-weekly status update
	IMPACT_2c	Number of successfully implemented imported applications	Project deliverable ID4.2
3. Upscaling success	IMPACT_3a	Number of associated pilots	Project deliverable D7.6 etc.
	IMPACT_3b	Number of associated vendors	Project deliverable D7.6 etc.
4. Dissemination success	IMPACT_4a	Number of visits to website (measured quarterly for the whole project time)	Project deliverable D7.6 etc.
	IMPACT_4b	Number of accounts in the developer depot of universAAL	Mailing list archive
	IMPACT_4c	Number of interested pilots	Project management to deliver
	IMPACT_4d	Number of visitors to ReAAL events	t.b.d.
	IMPACT_4e	Number of H2020 proposals that use universAAL	Project management to deliver

3.3. Data analysis

The data provided by the pilots and collected by the evaluation team, was stored in one database to which only the evaluation team has access.

Also the exports of the LimeSurvey tool were stored.

For making descriptive statistics and graphs Excel software was used. In this stage no advanced statistical program was needed. Special attention was given to the outliers. It was checked whether this data was valid.

Qualitative data (transcripts of interviews) has been coded first. When comparing the codes for the whole set of data, similarities and differences were found. Please note that the qualitative analysis if not finished yet. There are but few quotes in the report. We expect more qualitative data in the final release, D5.3b.

When analysing the data, the evaluation team looked at the context in which the data was collected, whether the data was complete and whether it can be used as a reliable indicator. In the Analysis chapter, the considerations of the evaluation team regarding these issues is presented next to the data, so the reader can decide how much value should be given to the data.

3.4. Evaluation activities by the evaluation team

3.4.1. Formal ontology evaluation

As a very important part of the universAAL adaptation, each pilot has to semantically describe the applications´ related domain, capabilities and relation with others through an ontological model. From the platform point of view, ontology is a basic and structured description of the features of an application. It shows the different elements in the application and the relation between them. Ontology can be described in different levels of detail, meaning from a very high level description only showing the names of the elements and the relationship between them to a very detailed description which also describes the properties and attributes of the elements.

These ontologies where shared amongst all ReAAL partners through the Knowledge portal, in an attempt of making applications interoperable through their ontologies.

We had universAAL experts look and evaluate the ontologies. Of course this is a continuous task from the experts as part of their work in WP3. For this reason and in order to collect data a formal evaluation was proposed. This evaluation was based on a form that experts will fill in for each of the ontologies evaluated. The form itself was iteratively agreed upon by experts and the evaluation team; it had to fit all ontologies, be simple to fill in yet it had to deliver some quantitative data. The evaluation of this topic was also planned carefully, since we will be asking experts about ontologies they might have helped develop themselves. Therefore, a cross validation procedure was put in place. This procedure banned experts from evaluating their own work (which would have contaminated the data); while also ensuring that each ontology was evaluated by at least 2 experts. This careful planning ensures the application quality of the data gathered.

The formal evaluation took place around January 2014, long before the finalisation of the adaptation phase. A total of three experts participated in the evaluation process. This evaluation was used to promote improvements effort of the pilots.

3.4.2. Interviews with developers

Interviews via skype or telephone took place with 10 developers, using a topic list.

Introduction

- Tell us something about your involvement in the ReAAL project and your experience with the universAAL platform.
    - Which type and which level of experience you have on AAL platform development?
    - Which type and which level of experience you have on ontologies and Web 3.0?

Performance expectancy

- What is your viewpoint on open platforms in general? Which are the advantages and the disadvantages according to your experience?
- Do you think that universAAL facilitate the integration of the system?
- What would you think needs to be improved on universAAL (community, support, documentation, ...)?
- Do you believe that a better knowledge of universAAL could facilitate the usage of universAAL platform in future projects?

Effort expectancy

- After the ReAAL experience, how much does it worth for you to show the value of UniversAAL to the world?
- What preconditions are needed for the universAAL platform to become the standard for AAL? Do you believe this could happen?
- *(you can think of the governance of it; who is supporting it; its business model)*
- You have been involved in universAALization. Can you reflect on it?
- Can you describe this process from your viewpoint? Which steps did you take?
- Were there any differences between this process and what you do at other times when you have to adapt your product to a platform or make it interoperable?
- Was it complex to universAALise? Did it take you more time than expected? Which parts where particularly cumbersome?
- Do you think you have used universAAL to its full extent? if not why?

Social influence

- Did you choose to use the universAAL platform by yourself or did you accomplish a task sked by your supervisor?
- What are your main lessons learned, and what feedback do you have for the universAAL team?

Facilitating condition

- Did you have the time and enough resources to be dedicated on this work during your job?

Other questions

- Do you have any other remark about the topics discussed in this interview, or any other topic?

3.5. Showcase Methodology

The assessment of Showcases comprises four steps:

Step1: Description of the showcase and its potential value

The technical experts of the evaluation team described fourteen showcases, and argued the value for technology provider, service provider, end user and on a societal level the stakeholders that stimulate its use and/or pay for it (governments, policy makers, insurance companies)(See D5.2 for more details)

Step 2: Pre-self-evaluation of Showcases

The next step was to map the applications deployed in ReAAL to the list of showcases. The aim of this mapping is to assure that most showcases can indeed be demonstrated in the ReAAL project and to plan the resources needed for this demonstration effort.

Pilots are provided with the description of the showcases, which include the scripts to test whether an application complies or not with each showcase. Pilots are asked to evaluate which of these tests they feel their application is capable of passing. The results are composed as a percentage of the possible tests over the total tests, grouped by showcase. The presentation of the results is done through a diagram with hexagonal configuration where each hexagon represents a showcase, the results are encoded in color scale, where the darker a showcase's hexagon is the closest to 100% the assessment is.

Step 3: Demonstration of the showcase

This demonstration can occur in several ways, depending on the showcase:

- Analytical level: requires an analysis of the system or the code by experts; Looking at the code, universAALization scheme, ontology, provided documentation, … the scripts will explain a rationale to analyse the compliance with the showcase
- Technical: Procedure will explain a process to test for the showcase in laboratory test environment, on a single deployment, typically further technical analysis is required, for example analysing logs; or changing the running environment.
- Operational: the test has to be performed at operation phase, these tests usually affect real users and multiple deployment sites;
- Programmatical: Procedure will define requirements for an executable module to be implemented, and the steps to use it to test for the showcase. The implementation will not be provided, since in some cases the module itself may have dependencies to the specific case to be tested.

Thus, the showcase evaluation does not only rely on readily available data, but also on "work" from technical experts to actually measure or demonstrate the showcase. The showcase evaluation needs a test environment. Therefore (most of) the technical work needed for the assessment takes place at the central lab test facilities of SmartHomes (Eindhoven, Netherlands), although some effort might be required form pilots and technical experts.

Step 4: Value assessment

Once the showcase has proven to be implemented, the final step is to assess the value for all stakeholders. The potential value has to be checked, while demonstrating in real life the key selling points of open platforms. This will take place in several focus groups at pilot level, at events where ReAAL has a demonstration booth, and at a seminar in the final months of the project. In addition to the technical script, the evaluation team also developed questions for the focus group at pilot level. During the focus group the attendants will get a real-life or video demonstration of the showcases, and then the questions will be asked. The questions will be discussed via a group discussion and a poll. For the focus group on pilot level, each pilot is requested to invite stakeholders from the region. For example other vendors, policymakers of the municipality/region, a representative organization for elderly, etc. These showcase focus groups are scheduled for Q4, 2015. See for example script with focus group questions ‘Appendix C. Data collection tools’.

Both the ReAAL pilots and the associated pilots contribute to the showcase evaluation.

4. Results

At this moment, most pilots have been in deployment and operation for some time. The associated pilots and Perche pilot are about to enter deployment. The Stage I, Phase 1 evaluation can be fully finalized in November for the whole project. Alongside, most pilots also started data collection for Stage 1, Phase 2, and a start has been made with the showcase evaluation. The Baerum pilot left the project in June (before the adaptation phase was ended). Available data from Baerum is included.

This report had to be released just before all data from the adaptation phase was delivered.

[will be updated for D5.3b]

In this chapter the indicators are presented and discussed. Each paragraph deals with an assessment domain. To further structure the data there are four sub paragraphs about the platform level (if the indicator relates to the platform), the application & service level (if the indicator relates to this level), the overall pilot level (to be able to compare the indicator between pilots), and the project level for those indicators that are not pilot specific. If a specific sub paragraph turns out to be not applicable to that evaluation domain, it will be removed in the final release.

This chapter starts with an overview of the type of data used for the analysis.

4.1. Available data and data quality

In D5.3a we use the following data to write the results, as summed up in Table 4. The label “T0” refers to the questionnaires at baseline, and “T1” are the follow up questionnaires.

[will be updated for D5.3b]

Table 4. Data collection overview for D5.3a

Data collection tools	D5.3a	D5.3b	
Questionnaires			Current status (related to D5.3a report)
Application developer T0	X		N= 44 (of which 4 also filled in T1)
Application developer T1	X		N=16
User Experience Questionnaire	X		N=47
Service Provider T0-T1	X		N=14
Short questionnaire on application quality	X		N=16
Assisted person T0		X	
Assisted person T1		X	
Formal caregiver T0		X	
Formal caregiver T1		X	
Informal caregiver T0		X	
Informal caregiver T1		X	
Deliverables from other WPs			
ID4.2	X		Report on lab test and real life user test
D3.2b	X		Application adaptation and

			maintenance report, released 31 Oct 2015, contains data from all pilots
D3.5	X		Report of lab test
D7.5, D7.6, D7.7	X	X	Periodic reports from project management
Focus groups			
Application developers & platform developers	X	X	Instead of a focus group, individual interviews were done at end of adaptation
Formal caregivers & assisted persons & informal caregivers		X	
Showcase validation		X	
Interviews			
Application developers / technology providers	X		N=10
Platform developers	X		N=3
Pilot leaders	X	X	Interviews done at plenary meeting in Paris, June 2015, by the Leaders of WP 4,5,6 with the ReAAL pilots
Assisted persons		X	
Knowledge portal			
Description of pilot and application	X		Knowledge portal is not always up to date, but this data can also be derived from other deliverables
Description of ontologies and universsAAlization	X		Knowledge portal is not always up to date, but this data can also be derived from other deliverables
Templates			
Cost template 1	X		All ReAAL pilots
Cost template 2		X	
Showcase evaluation template		X	
Issue tracker	X	X	Filled in, if relevant
Technical sources			
CI server	X	X	
Tracker system	X	X	
SCM database	X	X	
Mailing list	X	X	
Deliverables from universsAAL project	X	X	
Miscellaneous			
Pilot inquiry	X		All ReAAL pilots, 3 associated pilots
Ethical Annex	X		All ReAAL pilots, included in first operation report for all associated pilots
Technical workgroup; improvements of universsAALization and ontologies	X		All ReAAL pilots, based on interview between pilot leader, technical partner, WP2,3 lead
ID5.1a	X		All ReAAL pilots
Minimal data set		X	
User statistics about actual use		X	

Unfortunately, not all delivered data was complete or extensive enough for a good analysis. We are in the process of improving the data quality, and arranged that the next deliveries of pilot data will be more frequent and timely, so there is enough time for a completeness and quality check.

4.1.1. Data quality remarks

For some of the data sources used, it is important to know about the context in which the data was collected, and the data quality that can be expected.

Application developer T0 and T1

Data quality of the questionnaire is high, as long as we believe the questionnaire is designed correctly and respondents keep their attention to the questionnaire. T0 questionnaire has a mean completion time of around 20 minutes, and has been filled in by 44 participants. The T1 was very long, and filled in by only 16 participants. The mean completion time of T1 was about 4,5 hours. However, respondents could save uncompleted questionnaires and return to them later. This, and the fact that they might needed to look up some info to be able to answer a question, explains the relatively long completion time. Still, the data is quite complete, even towards the end. We experienced that the developers cared a lot about the response they gave.

Because of the low participation in T1, the data quality for T1 is not very scientifically valuable; yet it may be useful for extracting some facts. The T1 has been filled in by at least one developer per pilot, which makes cross pilot comparisons possible. As shown in Table 4, not all developers from the associated pilots filled in T1 yet. Therefore, the analysis in D5.3a based on this questionnaire, should be regarded as preliminary results.

The questionnaires contain different parts, some of which are inspired by validated questionnaires. Documentation quality of the universAAL platform was based on AIMQ (Lee 2002). The assessment of the technical support was measured using questions inspired by the RATER service quality instrument (RATER questionnaire s.f.). The questions about universAAL acceptance (satisfaction with the platform) are based on the Technology Acceptance Model (Davis 1989), and explore different aspects of the past experience, feelings and prognostic of future project of the developer with regarding universAAL.

Commits data

Commits are the mechanism used by the source code versioning system to register a new code version. Thus it is a pure indicator of actual work being done on the platform. The database of commits can be extracted directly from the source code management system and can be analysed. This indicator will be used as complement to trackers to analyse the effort performed on the platform.

Data quality of this indicator is very high, as developers have to perform a commit each time they need to upload a version of code. There are some considerations to be taken into account though:

- Commits can be of different sizes; a one character change or full code change (and anything in between). In fact each developer has different styles for committing, some like committing working code (big commits), and others take care of committing every significant change (small commits).

Efforts

In European projects, such as universAAL and ReAAL, which have been the main funding source for the universAAL platform up to now; effort is reported internally in person months (PMs). Effort is reported, as planned effort, which is agreed at consortium level; and also as invested effort (sometimes referred as actual effort),

which each partner declares. Typically the effort is reported per deliverable, and in a time period, in case of universAAL this time period is monthly in ReAAL this period is quarterly, to make it compatible the value for each quarter was divided among the component months.

Data quality for this indicator is not very accurate; there are certain contributing factors to it:

- Planned effort does not represent the dynamic planning that sometimes is required.
- Actual reported value in itself is not very accurate, sometimes the real effort is more than reported.

Since the reported invested effort directly applies to the financing of the partner involved for this activity, it should be considered as the main financing indicator for the platform.

Laboratory test report

Independent testing was performed for all applications at Smart Homes (SH) Netherlands, with in the context of T3.4 of ReAAL project. All equipment was shipped to SH, and they performed laboratory testing on each application (see deliverable D3.4 for the Test and Validation plan). Since this testing was performed by an independent observer with the proper facilities and equipment, and since the same methodology was applied to all applications, it is safe to assume the reliability of the results are high.

The methodology for issue reporting consists on filling standard forms for each issue encountered, this is the means to quantify data from issues. These forms were developed for the deployment and operation phases, therefore after the laboratory tests were performed. We asked the responsible of the laboratory tests to go through their results transforming them into the required form, so it is possible that a part of the data is lost in this transcription process.

Pilot cost template

The pilot cost template was part of ID5.1a. The data has been delivered by the pilot leader, although some had to consult their subcontracted partners. In general, accounts of money spent are not always reliable, because they do not always reflect actual status. In ReAAL many technology providers were subcontracted. The budget for universAALization was negotiated up front, and usually the partners agreed on a fixed price. This price is the only data we have from subcontracted partners. The technology providers who are, themselves, ReAAL partners, were able to specify the hours spent on development and universAALization. Multiplied by the staff costs per hour, we have more reliable cost data. However, there is still a risk that not all efforts are reported or, vice versa, that developers spent much more time on universAALization than they charged. In a focus group meeting with these stakeholders we need to look into this further. In some pilots the distinction between development and universAALization made little sense, because the application was completely rewritten in universAAL. Costs have been collected without VAT. However also staff costs per hour differ hugely within the consortium (between 25 and 100 euro). That makes it more difficult to compare between pilots.

Platform Code Metrics

The universAAL development team has adopted a methodology for code assessment called continuous integration. This means that as part of the infrastructure for code development there is a server that nightly automatically builds the code, calculating code metrics along with it. The results of the nightly build are public, for universAAL these can be accessed at http://depot.universaal.org/hudson/.

The fact that these metrics are calculated automatically means they are completely reliable, and objective; no human factor involved in the generation or gathering of the results. The only possible problem is that different versions of the algorithms used throw different results for the same input, in which case the results would not be comparable. For this report this has been taken into account and most metrics were recalculated using the same version of the tools for all the releases.

The publicity of this information forces developers to improve the quality of the code, as the metrics are indicators of such quality. Among these indicators we can find:

- Automatic tests; more successful tests, over larger section of the code indicate better code. Tests have to be developed and included in the code repository.
- There are also tools that analyse the effectiveness of the tests, called code coverage.
- Automatic documentation analysis (number of Javadocs, and comments).
- Lines of Code (LoC) count , indication of the size of the project,
- Automatic bug detection, using programs that find the most common bugs and code repetition (which indicates either not good design or a source for potential bugs),
- Code conventions, indication of the understandability of the code. Conventions are used to help different developers to create similar code, thus making it easier for code readers to understand the code.

Service provider T0-T1

This questionnaire has been sent to the pilots in summer 2015. Some pilots were already in deployment at that time, others were still in test phase. Those in deployment were asked already some questions about their experiences. For the others this questionnaire focused on expectations. The data is delivered by one organization, the service provider of the pilot. The data quality is high, because the questionnaire is filled in by people who know the project very well, but who are also neutral towards universAAL. They are not the technical people.

Tracker data

For platform development a tracker system has been used. This tracker system allows application developers using the platform to report and track issues regarding the platform. For evaluation purposes, we have taken these reports as data points to be analysed.

Data quality of this information is very high, as this is one of the main interaction points between the application developers who demand certain characteristics from the platform and platform developers who provide these characteristics. Most of the time platform developers use trackers to report the work, or to propose tasks to other

platform developers. There are some noteworthy statements about the trackers, which may affect the data quality, or at least should be considered throughout the analysis:

- Not all platform development tasks have been reported through the system. This means that this indicator should not be trusted very reliably as platform development indicator
- Not all tracker items imply the same development load. Even though they are divided by priority and by type, two trackers with the same type and same priority may not require the same effort to be closed. This is due to the open nature of each tracker (only summary and description are provided).
- Not all trackers are closed when the issue is solved, but later when it is tested, or when a tracker review is performed and forgotten solved issues are closed. This means that sometimes the time taken to close an item is not accurate.

User experience questionnaire

Before starting the Deployment phase, usability engineering methods have been used to determine how well a ReAAL product or service may be user-friendly. During the Real Life Control Test sub-phase, within the Adaptation phase, the assisted persons have been asked to transmit their feelings on interaction with the products.

In order to retrieve a suitable assessment of the user experience of interactive applications and service, participants have been asked to fill in a questionnaire with a set of 30 questions that should be answered in a scale from 1 to 7. A user experience questionnaire (UEQ) has been used for this purpose. The UEQ questionnaire supports users to express the impressions and attitudes that arise when using a product, basing on a Likert scale.

The analysis coming from these outcomes has been significant to understand and to identify the feelings of the end users when interacting with a ReAAL product or service during few days.

It should however be considered that the UEQ is a general questionnaire applicable to any product. If a statement is not applicable to a product, the respondent has to choose anyway.

4.2. Characteristics of the ecosystem

4.2.1. Description of ecosystem

Involved stakeholders

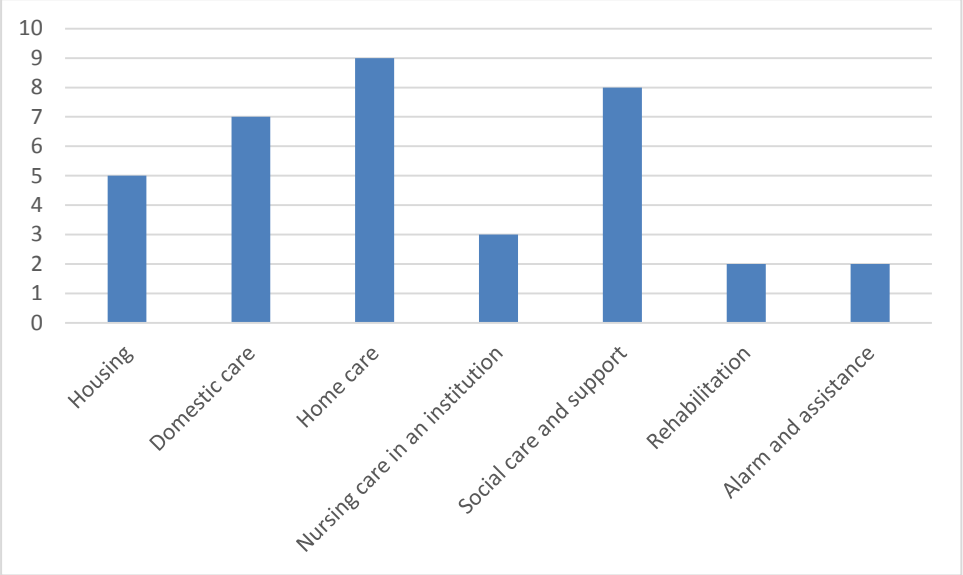
The ReAAL pilots each have their unique stakeholder map, which serves as their local ecosystem. The Appendix provides these local maps. Overall the pilots can be profiled in this table.

Table 5. Stakeholders per pilot

Pilot	Pilot leader	Technology providers involved	Service providers involved	Other relevant stakeholders
BSA	Badalona Serveis Assistencials (service provider)	TSB (SME, UPVLC spin-off, subcontracted)	Badalona Serveis Assistencials (integrated care system including hospitals, home care and social care), Amics de la gent gran (third sector care provider)	CatSalut (regional government) Ajuntament de Badalona (local government)
IBR	Ibermática (technology provider)	Ibermática	Servicios Sociales Integrados (social care service provider)	Acede (supports implementation and evaluation)
ODE	City of Odense (service provider, payer)	Medware, Sekoia (SME, subcontracted),	City of Odense (nursing homes and rehabilitation center are involved)	Medcom, Bandcizer, University of Southern Denmark
PERCHE	Trialog (technology provider)	Trialog, TSB (SME, UPVLC spin-off, subcontracted)	Municipalities, Senior associations, and other public entities.	Regional government, conseil departmental Eure et Loire, Lycée Nermont, Pays Perche Organisation.
PUG	Region of Puglia (government)	Virtech, INGEL, Steel Minds, eResult, Bioresult, Cupersafety (SME, associated partners)	n.a.	CNR (technical support), Network of Resource Centres for Assistive Technologies (supports implementation and evaluation)
RNT	Stichting RijnmondNet (Health ICT service provider)	MedicineMen, Curavista, MindDistrict, Netmedical, MiBida, almende (SMEs, subcontracted)	Lelie Zorggroep, MOB, Stichting Humanitas, IZAH thuiszorg (all longterm care), diëtistenpraktijk HRC (dietician private practice), SFG, Havenziekenhuis (hospitals)	City of Rotterdam
SL	Smart Living (technology provider)	Smart Living (SME)	Faco immobilien (senior housing)	German Red Cross (volunteers)
TEA	Tercera Edad Activa (service provider)	Virtual desk s.l (SME, subcontracted)	Tercera Edad Activa (private service provider)	Regional government; Local governments of Guadalajara, Mostelos, Alcoron;
WQZ	WoQuaz	Fraunhofer	WoQuaz (senior housing)	Diakonie Darmstadt-Dieburg, German Red Cross (volunteers)

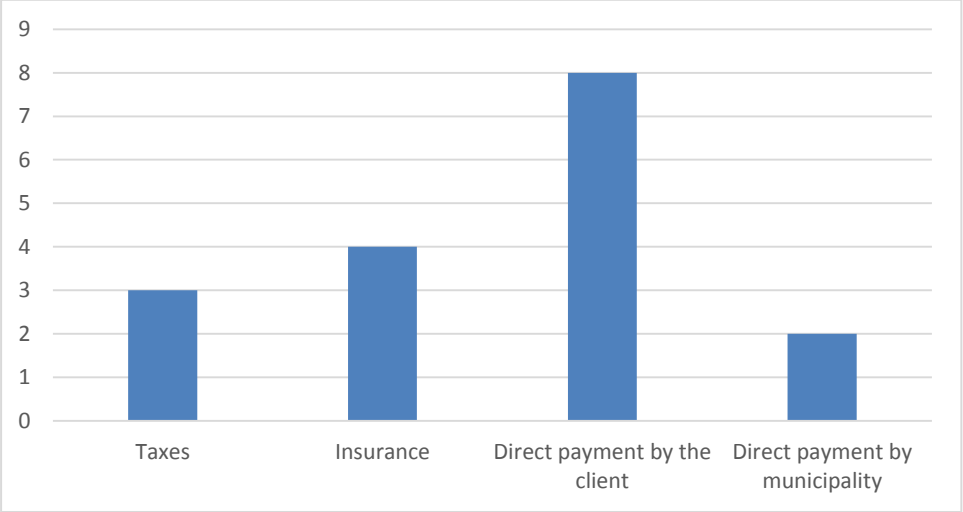
The service providers offer a variety of services (it is possible that a service provider has more than one service domain in its portfolio).

Figure 4. Services provided by the Service Provider organizations (N=14)



Current financing structure

Figure 5. Financing of current services (N=14)



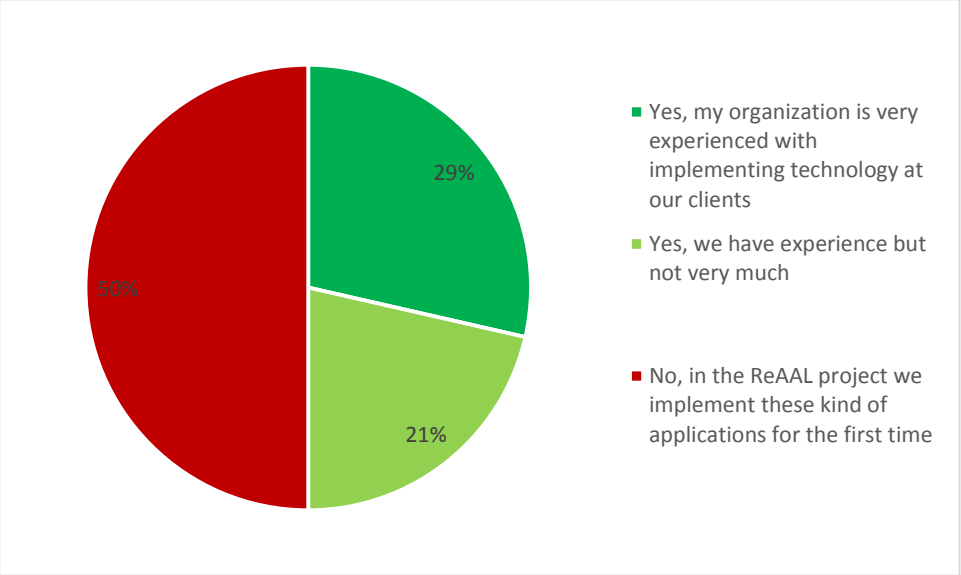
In the project most end users use the applications free of charge, because they are part of a pilot. In the 'tax paid' pilots this will also be the case for the future, if they continue with deployment: citizens are not accustomed to direct payment for care services. In Puglia, the end users 'pay' with the vouchers they have been given by the Puglia region. In Germany, the applications are built in houses or are already offered to the current users. They pay for it as part of their rent or as an additional 'service package'. For the other pilots, the business model for the future will depend on somebody paying for it, either a municipality, a health insurance company or through direct payment of the user.

Experience with AAL

A set of questions about the organization, the innovation climate and the experiences with open platforms and the universAAL platforms have been prepared.

Among these questions, organizations have been asked about their experience with implementing eHealth or AAL applications before working on the ReAAL project. The results show that a small majority of them are already experienced with such products.

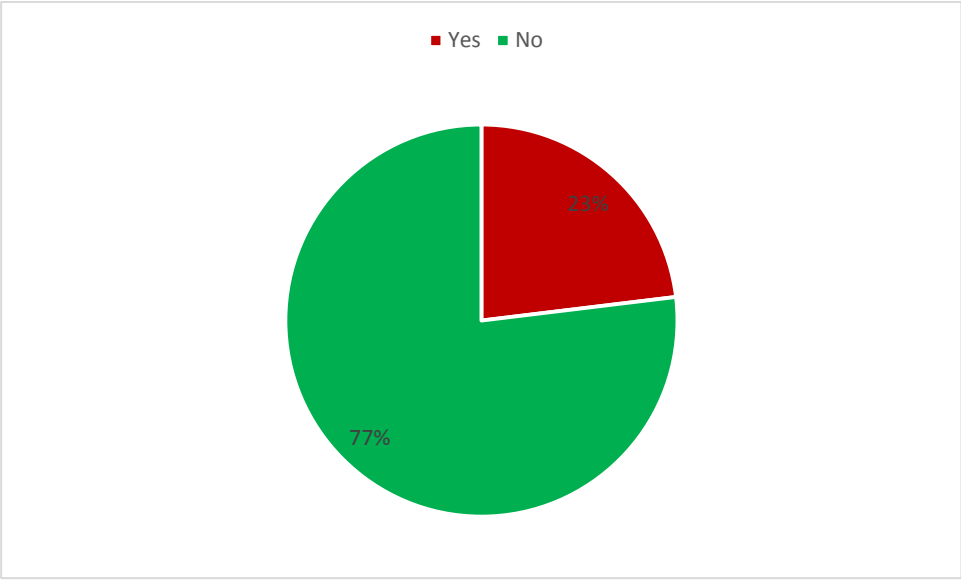
Figure 6. Experience with implementing eHealth or AAL applications, before the ReAAL project (N=14)



One of the pilot leaders comments: *"AAL technology helps us to provide patient-centred care. In an integrated care organisation such as ours it's a key factor. Even though we know that patient-centred models and integrated common care pathways require more coordination than technology."*

Some service provider organizations currently experience a vendor lock-in situation.

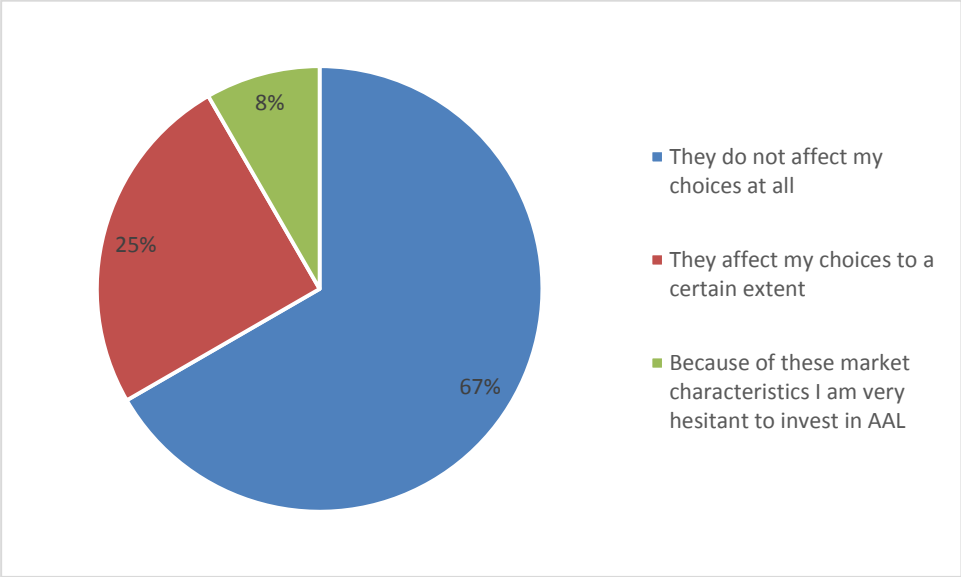
Figure 7. Vendor lock-in of service provider (N=13)



One service provider comments: *"After thorough procurement a vendor is selected, but sometimes there is a limit in the selected solution from the vendor, which makes it hard to combine with other technology or solutions. The main problems are*

customizing and integrating with other solutions, which can be expensive and difficult."

Figure 8. Influence of current market characteristics (vendor lock-in) on investment choices in AAL (N=12)



One provider, currently not in a lock-in situation, is because of these market characteristics very hesitant to invest in AAL. For the providers who are in a vendor lock-in situation, they state their investment choices are affected by it.

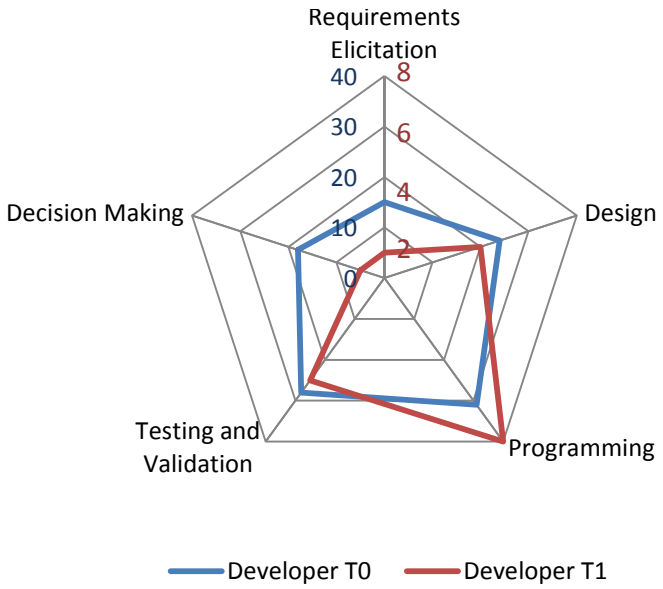
4.2.2. Description of user group

Developers

The main user group, because they have closest interaction with universAAL are the developers.

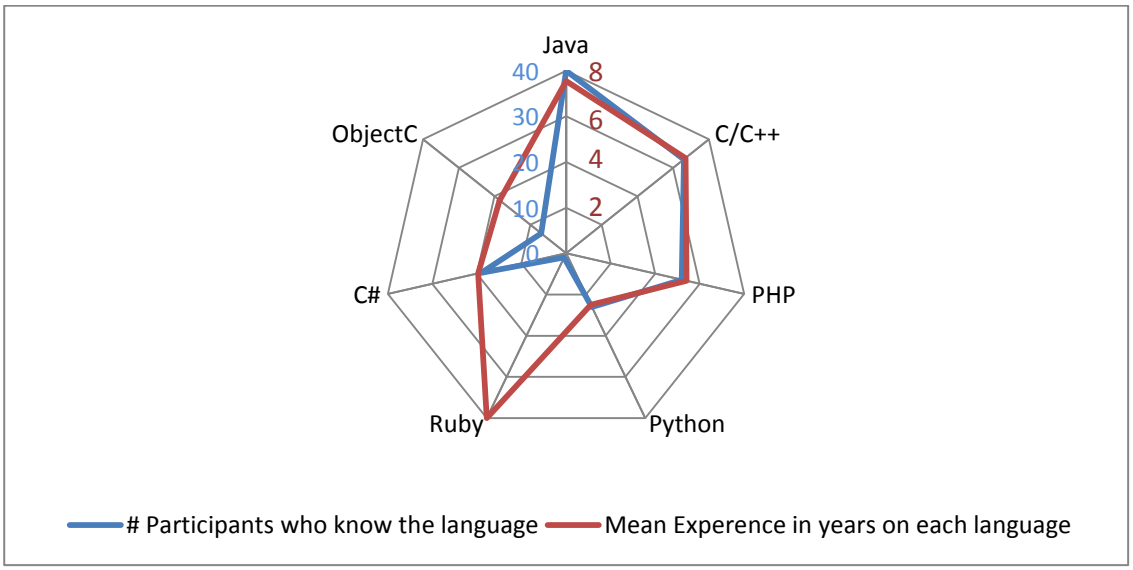
Most of the participants in the T0 questionnaire where programmers, but a substantial part of them had other roles in the development process, suggesting this questionnaire were taken by decision makers and chief engineers in contrast with T1 which was a more technical profile.

Figure 9. Role in Development Process



In T1 the same analysis shows even heavier programmer profile.

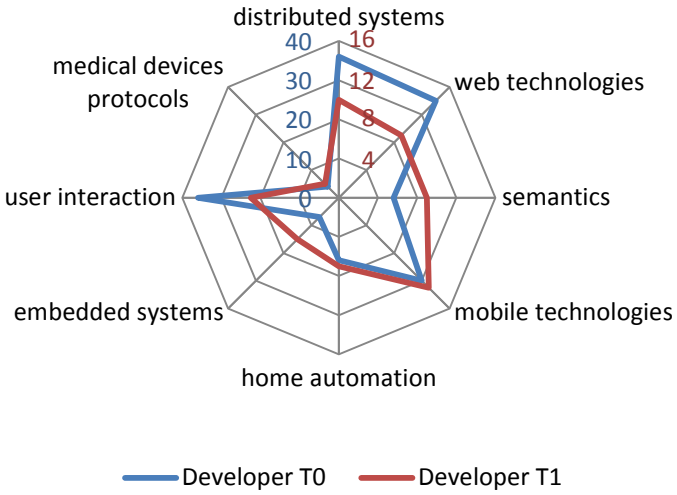
Figure 10. Relation of Programming Language use and experience (T0)



As shown in *Figure 10*, most of the developers (at T0 and T1) had a lot of use and experience with Java, which is the language used for the platform. This means their language barrier to learn the platform is expected to be lower. Other Common languages in the AAL domain are C/C++ and PHP (probably indicating there is high development of web applications).

The most common Integrated Development Environment (IDE) at T0 and T1 was Eclipse. This coincides with the Java expertise, and it is expected to help them introduce to the platform, as it has tools specifically designed for Eclipse.

Figure 11. Knowledge areas of the developers



As shown in *Figure 11* Developers in the ReAAL project, at the beginning, feel confident in the areas of distributed systems, web technologies, mobile technologies, and finally user interaction. The use of ontologies (Semantics) is not very prominent before the development, but in T1 the knowledge of this area is increased substantially (not shown in the graph but shown in the data); this is due to the semantical nature of the platform, so it is expected for developers to promote in this area of expertise.

The developers who were also interviewed had, except for 1, no previous universAAL experience, but 60% already had experience in AAL. They were involved in the project in different type of work such as: platform developer, backend and frontend in desktop or mobile platforms, service interoperability, testing and debugs, server side, ontologies definition and development, etc. Half of the developers had good experience with Web 3.0.

End users

The other user group is the assisted person, sometimes the informal carer or formal carer is also a user of the application. Formal carer is used broadly in ReAAL, it could also mean a person working for a municipality, providing information to the citizens; put differently, we have in this project assistance receivers and assistance providers. This can be the back-end use (inserting user settings) or front end use (monitoring the data). The deployment data will provide the most accurate statistics of these users. In the appendices, more qualitative specifics per pilot are given. The overall picture is as follows:

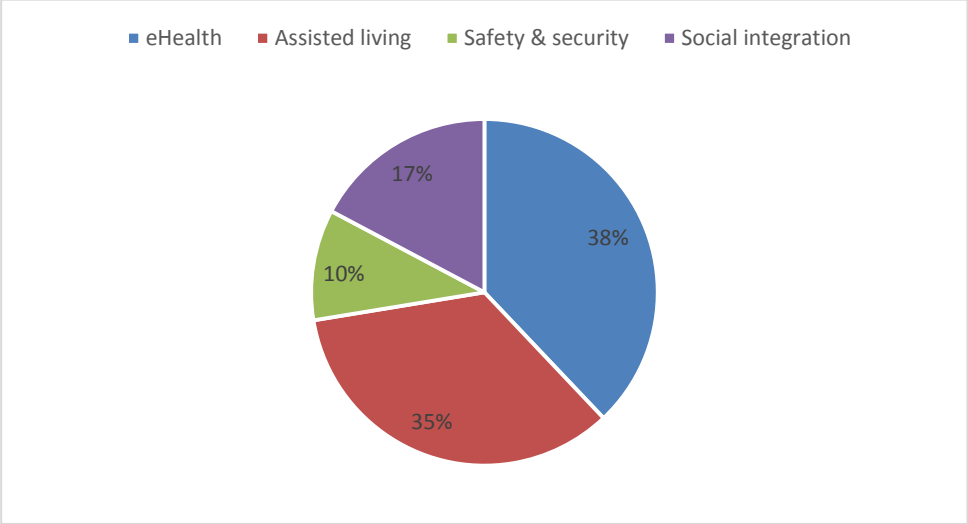
Table 6. Users

Pilot	Assisted person	Informal caregiver	Formal caregiver
BSA	Mixed, because also chronic disease, but mainly aged > 65	Involved	Many, and highly involved, physicians and nurses
IBR	Aged > 65	Involved	Nurses
ODE	For the Rehabilitation Portal it is mixed. For the Task Scheduling the citizens are mainly aged > 55	Not involved as users	Many, nurses/caregivers at nursing homes and physiotherapists
PERCHE	Aged > 65	Involved	Few, because the nature of the Applications or the nature of Formal carers organisation makes it difficult to involve them.
PUG	Aged > 65	Involved	Few private formal caregivers
RNT	Mixed, because also dietician and mental care	Not involved, but few volunteers	Many, mainly therapists, and some social workers, nurses, dieticians and physiotherapists
SL	Aged > 65	Not involved, but volunteers are	Not applicable
TEA	Aged > 65	Involved	Few, mainly social workers and nurses
WQZ	Aged > 65 Ambient system	Not involved, but volunteers are	Not applicable

4.2.3. Description of application and service

There are so many applications deployed and even more services. The details can be found in the Appendix to this deliverable, but also in dissemination materials such as the application portfolio brochure. The applications can be divided in four groups: eHealth, assisted living, Safety & security, and social integration (Figure 12). Sometimes, in this report also the more broad distinction between eHealth and AAL will be made, for practical reasons, for example when comparing cost data.

Figure 12. Applications in ReAAL by type



Looking more closely at the application portfolio of ReAAL, these applications have many aims, ranging from active ageing to health related aimed and safety. In Table 7 these aims are displayed per pilot. Some pilots checked many aims, others only a few. This can be explained by different interpretations: some focus on the core aims of their applications, others on all potential use cases for the application.

Table 7. Aims of the applications per pilot

Aims	BSA	EIC-IL	IBR	IMA	NCSR	ODE	PERCHE	PGL	RNT	SCUPS	SL	TEA	WQZ
Active ageing and independency													
being more active	X		X	X		X	X	X	X			X	
being less dependent of other people	X		X	X	X		X	X	X	X	X	X	X
sustaining my independence	X		X	X	X		X	X	X	X	X	X	X
Social status													
having more social activities	X		X	X			X		X		X	X	
having more social contacts	X			X			X		X			X	
Health status													
sleeping better	X							X	X			X	X
have better nutrition	X				X		X	X	X			X	
lose weight or sustain current weight	X				X				X			X	
reduce my blood pressure	X				X			X	X			X	
taking my medication on time					X			X	X			X	
improve my physical status after surgery			X		X	X			X	X		X	
manage my chronic disease better	X	X			X		X	X	X			X	
manage my contacts with care providers better	X	X		X	X	X		X	X	X		X	
Mental status													
being less anxious or depressed	X			X	X		X	X	X			X	
have a better self-image	X			X			X		X	X		X	
improve or sustain my memory and/or cognitive function	X			X	X			X	X			X	
Safety & comfort													
feeling more safe in my home			X	X	X		X	X	X	X		X	X
feeling more safe when I go outside	X		X	X	X		X		X	X		X	X
have more comfort in my home			X	X	X			X			X	X	X

4.3. Technical Aspects

The technical domain and the user perceptions domain are highly related to each other. The technical aspects indicators rely more on 'facts', and independently produced data; the user perceptions reflect the opinions of developers, expressed in questionnaires and interviews.

4.3.1. Platform quality

Description of platform

The universAAL project started with the mission of studying all previous AAL projects and integrate them in a single, consolidated platform that represents what any AAL platform should be. Not only the definition of the architecture is provided but also the implementation of what is today known as the universAAL open platform.

universAAL is a semantic and distributed software platform. It was designed to ease the development of integrated Ambient Assisted Living (AAL, hence the name) applications. Although universAAL is not limited to AAL, it's power make it suitable for IoT (Internet of Things), wearables, Big Data, and many more domains.

The semantic nature of universAAL makes it ideal for highly heterogeneous environments. An important property of semantical modelling, is that if for whatever reason two applications do not use the same ontology, the basis for their understanding, a third ontology mapping both of them will make them compatible, no need to redevelop or redeploy. This fact alone makes universAAL the champion of interoperability.

The core of universAAL is composed of the middleware which enables transparent communication between modules through 3 buses: the context, service and user interaction buses. Each has its own properties and purpose but all take advantage of semantic interoperability.

The universAAL platform is mainly composed of the middleware and managers. The middleware is the core part enabling transparent communication between nodes and modules; as well as offering low level services like configuration or space, node and module management. Different managers are provided to handle recurring tasks such as storage, profiling, security or remote connectivity.

The platform released its last version (3.4.0) in September 2015. The history of features since the first release (1.0.0 January 2012) can be viewed at:

https://github.com/universAAL/platform/wiki/RD-Release-History

Platform code metrics

Figure 13. Total Lines of Code per release

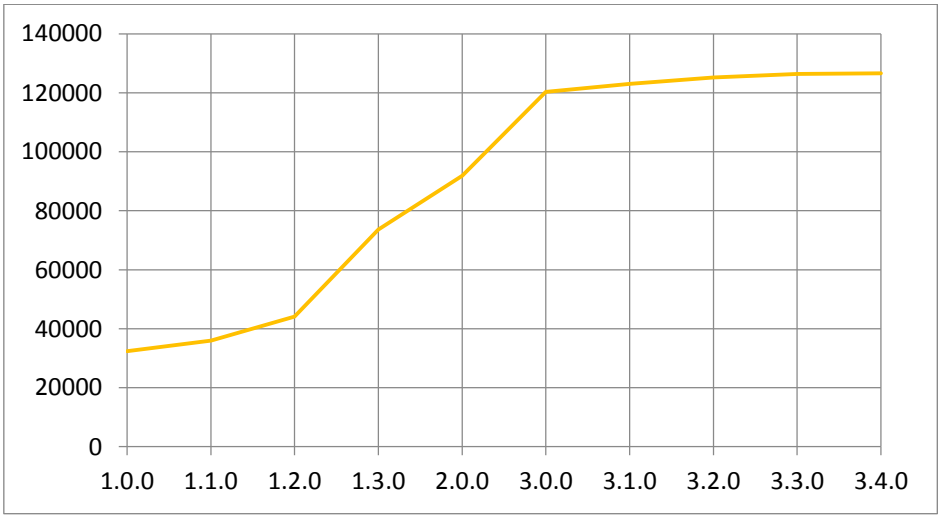


Figure 14. Evolution of surefire (automatic unit tests) report

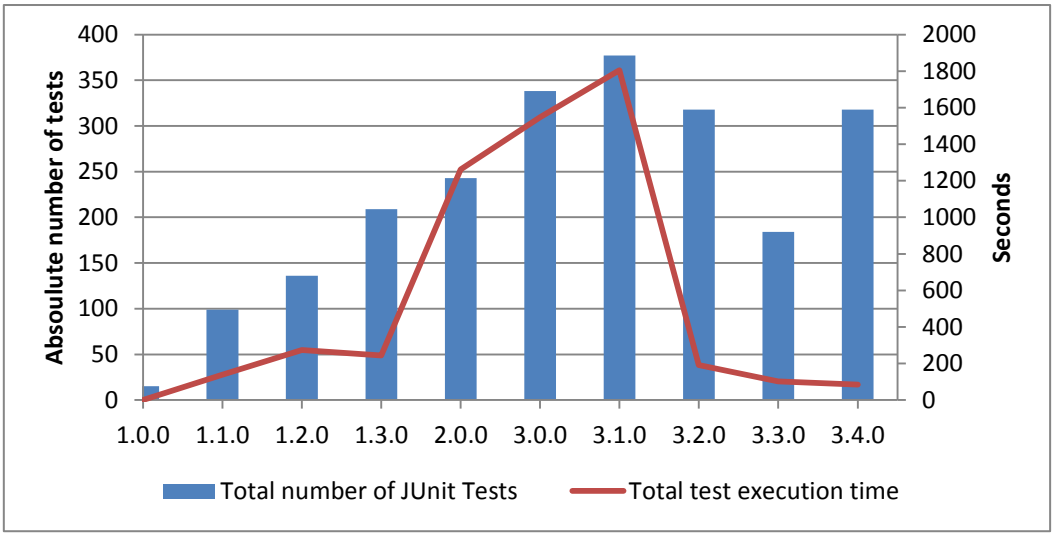


Figure 15. PMD (unofficially: Programming Mistake Detector) and CPD (Copy Paste Detector) warnings

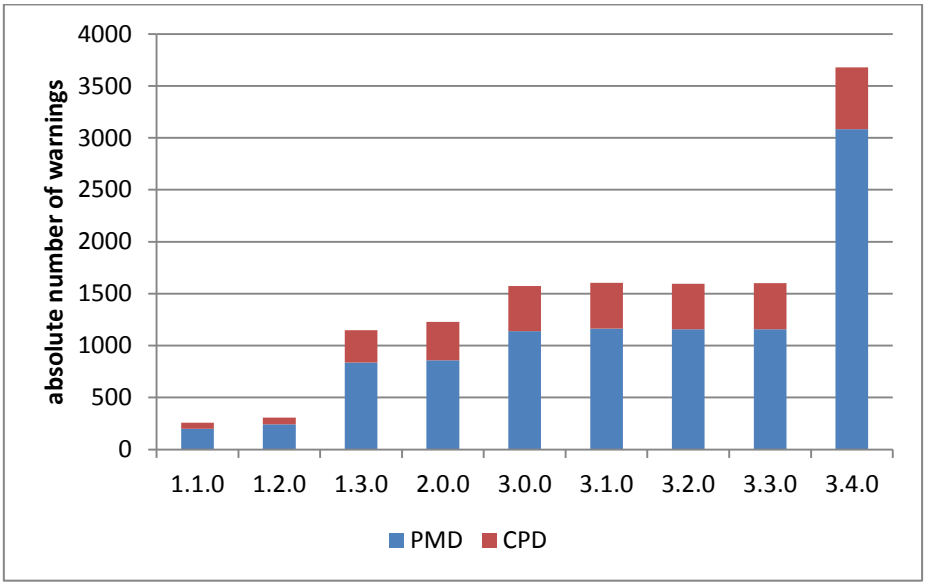
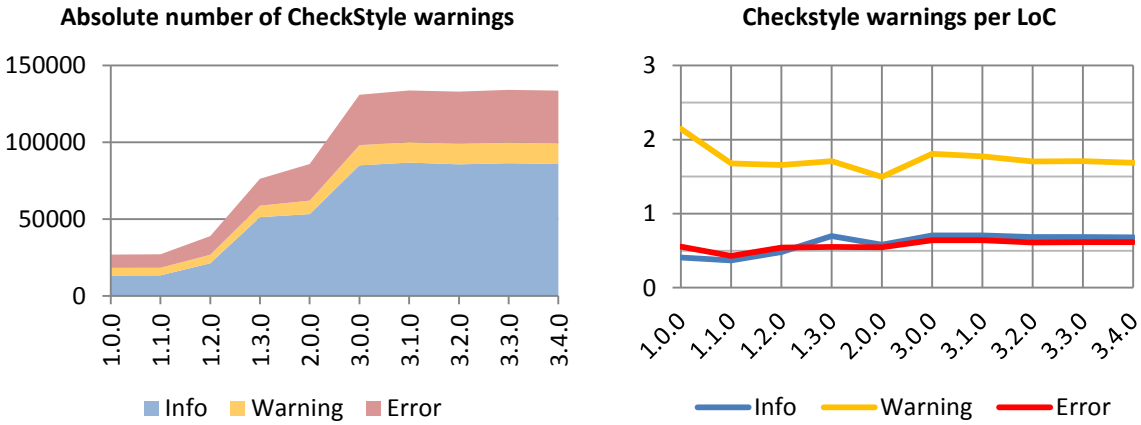


Figure 16. Code Convention (Java Checkstyle) analysis.



Some facts from the code metrics presented in *Figure 13*, *Figure 14, Figure 15*, and *Figure 16*:

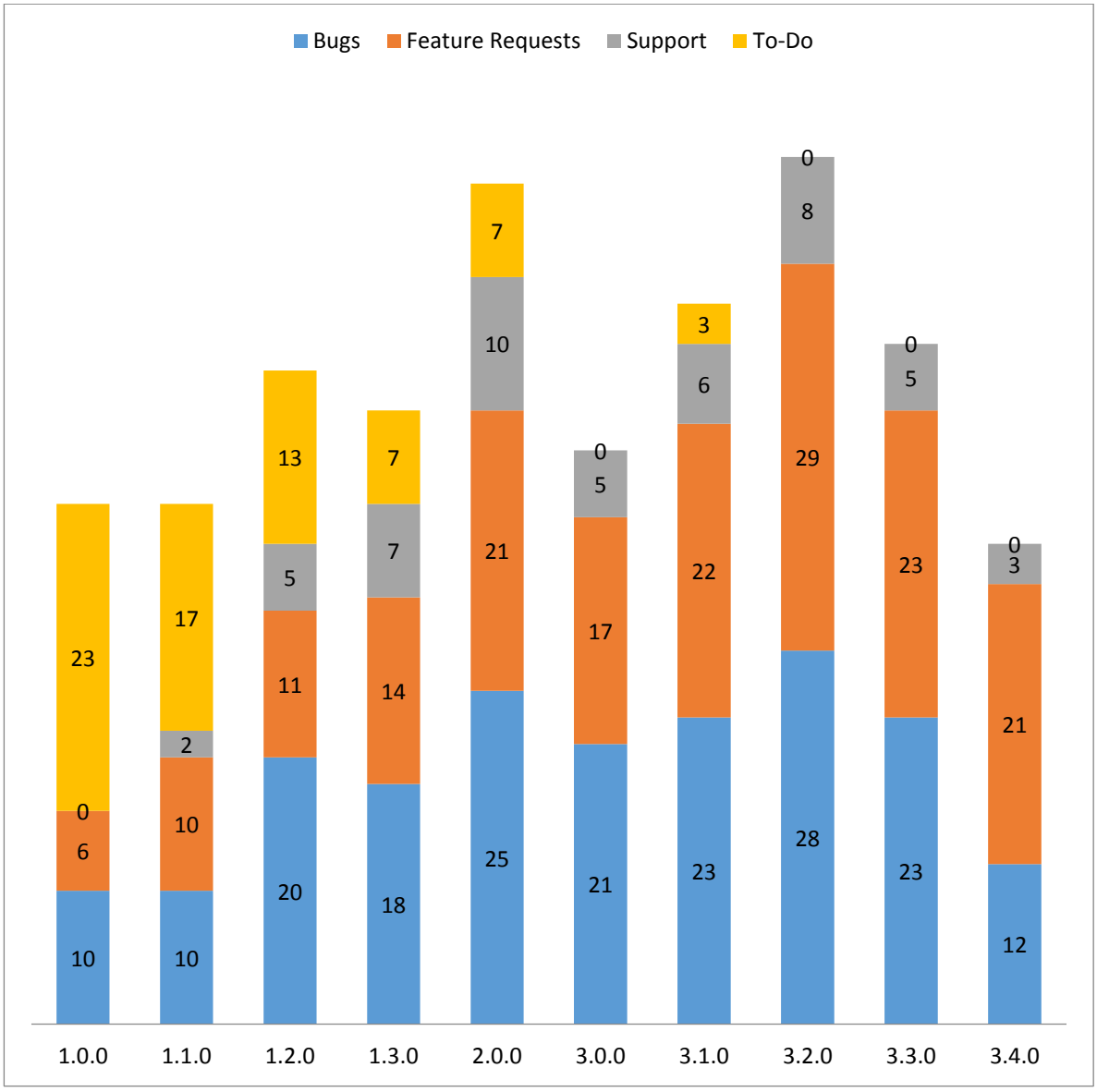
- Most of the code was developed between releases 1.2.0 and 3.0.0
- Code Testing quality dropped since release 3.1.0
    - Time might be due to optimizations done on third party libraries.
    - Decreasing number of tests might be indication of deprecation of some component (along with its tests) or new development displacing old tests, which were not substituted.
    - A bug was fixed. A bug that might have caused high times, but not failure, during testing.
- Automatic bug detector was actively used, keeping its warnings constant even when the size of the project grew. The last release did not have these warnings in consideration, so bugs might have been introduced.

- Code conventions are kept more or less constant, when total code size is considered.
    - For release 2.0.0 some effort on being more compliant with code conventions.
    - Release 3.0.0 was rushed convention wise, this was the last release of universAAL project, and more emphasis was given to functionality than form.
    - Code convention violations have been timidly descending since 3.0.0

Platform Tracker system

The trackers in the tracker system, used by the platform developers, has been analysed statistically by grouping them by type, priority, or release period (the time span leading up to a certain release), depending on the dates when they were issued, and when they were closed.

Figure 17. Total Trackers per release period divided by tracker type



Looking at *Figure 17*, there are some facts that can be extracted:

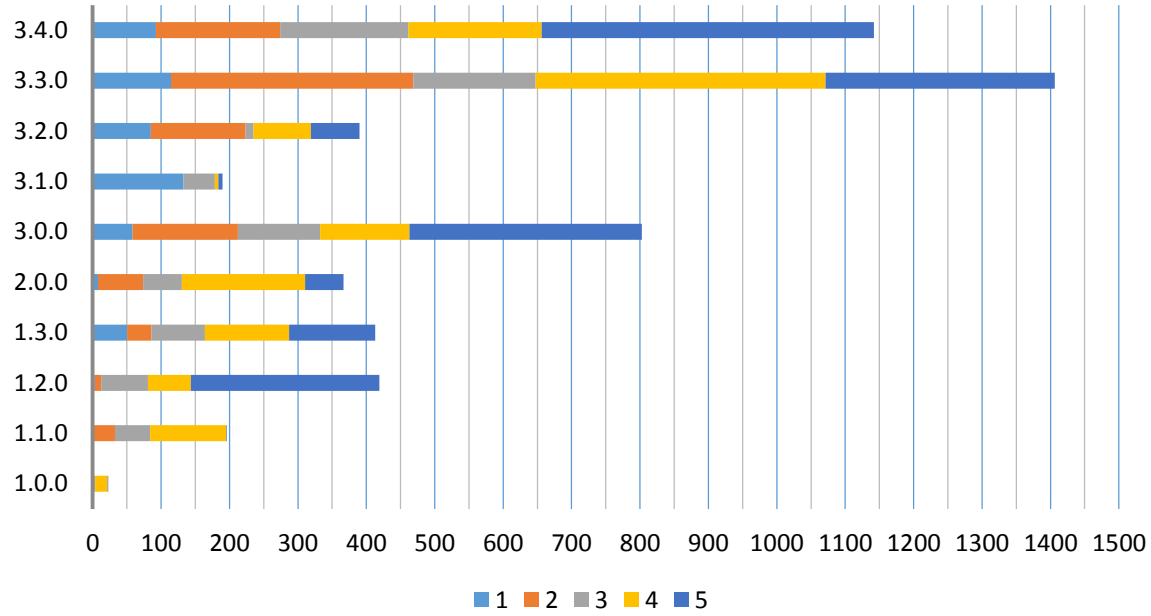
- Most of the trackers are bug type.
- Second most popular tracker is about the request new features.
- Before release 2.0.0 There are many To-Do trackers, which almost disappear afterwards
- Total number of feature requests increases up until 2.0.0 then it steps back on 3.0.0 and continues growing until 3.2.0 then it starts falling.

Other analysis can be done by looking at the difference between the opening and closing dates. This analysis gives some understanding about the support effort being delivered by platform developers. For this analysis we have grouped by priority. The terminology used is priority 1 means it is the most urgent matter, where priority 5 has the least priority.

Table 8. Mean solving time (days) per period per priority

Release Version	1	2	3	4	5	TOTAL
1.0.0	0,00	1,00	2,43	18,25	1,00	9,71
1.1.0	1,00	31,40	51,50	111,00	1,00	59,68
1.2.0	3,33	9,00	68,69	62,25	276,00	62,87
1.3.0	50,17	35,56	78,19	123,22	125,63	81,10
2.0.0	8,00	66,00	56,41	180,33	56,00	75,40
3.0.0	58,55	153,57	120,52	130,40	339,69	159,38
3.1.0	132,75	0,00	45,67	5,33	6,00	62,73
3.2.0	85,00	138,40	11,63	84,00	71,00	64,06
3.3.0	114,67	354,00	178,72	423,83	335,00	230,18
3.4.0	92,50	181,33	187,83	194,70	485,43	257,18
TOTAL	68,36	101,31	88,87	146,45	263,47	118,57

Figure 18. Mean solving time (days) per period per priority



Facts derived from *Table 8* and *Figure 18*:

- Typical distribution for each priority. As expected in general more priority items are solved quicker than less priority issues.
- In general the closing time per issue follows the total tracker load, as seen in *Figure 18*.
- Mean time for any issue is around 4 months, and almost all releases have a mean solving time of 6 months. When time between the later releases is 6 months, it means that trackers will typically be solved for the next release; except for the last 2 releases.
- The mean solving time for the last 2 releases is about 8 months, which means that work on those releases was focused on long term issues. Maybe issue reviews where less common, leaving trackers opened for long periods.

Platform code commits

The platform efforts from the analysis of trackers, can be complemented with data on commits[5]. This is reported in the Economic Aspects paragraph, as part of the actual effort of the platform developers during universAAL and ReAAL (see *Figure 31*.

4.3.2. Application and universAALization quality

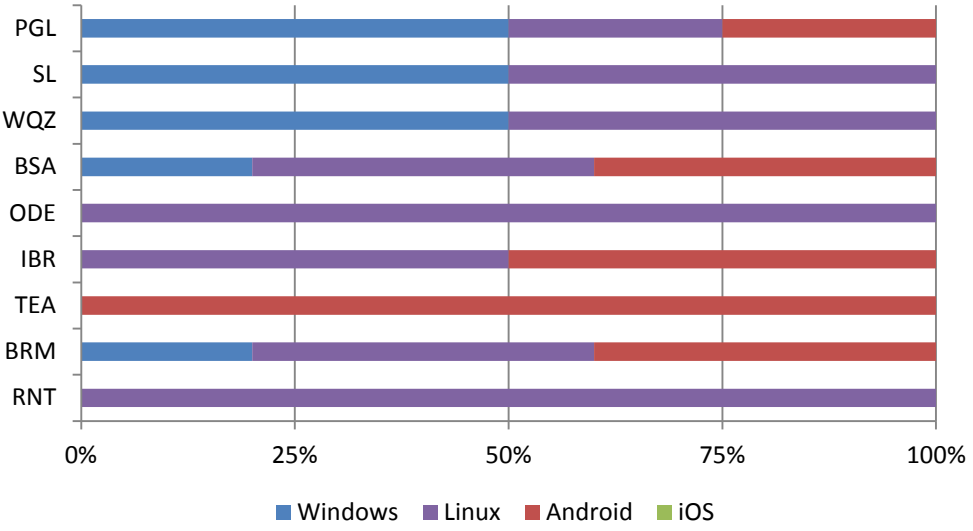
The quality of the application has been, and will be assessed several times: by checking the quality of universAALization, by the lab tests, performed centrally in Eindhoven, by the real life tests at the pilot sites, and during deployment.

[5] Commits are the mechanism used by the source code versioning system to register a new code version. Thus it is a pure indicator of actual work being done on the platform.

Technical description of the application

The applications deployed in ReAAL are very different in nature. Technical descriptions of the applications (hardware and software components, etc.) can be found in the Project Deliverable D3.1, which will be updated several times. Solutions are deployed in a variety of platforms (as shown in *Figure 19*), including a substantial part of mobile operating systems.

Figure 19. Distribution of Operating System over which universAAlized applications have been deployed per pilot (according to Developers T1)



Almost all applications (90%) involve some type of backend, as shown in Table 9. This indicates that the probability of remote operation is very high and valuable for developers.

Table 9. Application Type (according to Developers T1)

	BRM	BSA	IBR	ODE	RNT	SL	TEA	WQZ
Backend	X	X	X	X	X	X		X
Frontend	X	X	X		X		X	X

Ontology evaluation

As part of the universAAlization process, ontologies for every application had to be developed. These ontologies were shared amongst all ReAAL partners through the Knowledge portal, in an attempt of making applications interoperable through their ontologies. The formal evaluation of the ontologies, by experts, took place around January 2014, long before the finalisation of the adaptation phase. Results of this evaluation were used to promote internal improvement efforts. In *Table 10* the aggregated results are presented. Pink cells indicate below average values; the last two columns are colour coded where red is the worst negative evaluation and green is the best positive evaluation.

Table 10. Aggregated results of the formal evaluation of the ontologies undertaken by experts

Pilot	Ontology	Is it dependant on other universAAL ontologies ?	Can it interact with other ReAAL ontologies?	Evident use of an ontology development methodology?	Is it generic enough to be used in other application/domain?	Is it just mapping the data model of the application?	Does it overlap any existing universAAL ontology?	Complexity of the ontology rating	General quality of the ontology
BSA	Help when Outdoor	1	1	1	1	0	0	3	3
BSA	Agenda	0	1	0	1	0	0	1	3
IBR	IBR pilot	1	1	1	1	0	0	1	3
ODE	Rehabilitation Portal	0,33	0,33	0	0,33	1	0,33	2	0,67
ODE	Task Scheduling	0	0	0	0	0,67	0	0	0,33
PGL	Easy Home Control	1	0,5	0	1	0	0	1,5	2
PGL	Home Activity Monitoring	0,5	0,5	0	0,5	0,5	1	2,5	0
PGL	Safety at Home	1	0,33	0	1	0	0	1,67	1
RNT	Curavista	0	0	0,5	0	0,5	1	2	0,5
RNT	MedicineMen	0	0	0,5	0	0,5	1	2	0,5
RNT	MiBida	0	0	0,5	0	0,5	1	2	0,5
RNT	Minddistrict	0	0	0	0	0,5	1	2	0,5
RNT	Netmedical	0	0	0	0	0,5	1	3	0
RNT	Vitaal	0	0	0	0	1	1	1,5	0
SL	SmartLiving	0	0,5	1	1	0	0	1,5	3
TEA	Cognibox	1	0	1	1	0	0	2	2
TEA	Ehealth	1	0	1	1	0	0	3	3
TEA	SocialByElder	1	0	0	1	0	0	1	2
TEA	OptiSAD	0	0	0	1	1	0	1	2
WQZ	WQZ Devices	1	0,5	0,5	1	0	0,5	1	1,5
	Average	0,38	0,19	0,31	0,50	0,35	0,58	1,85	1,08

Analysis of *Table 10* can be summarized as follows:

BSA (+BRM): Both applications are evolutions of legacy universAAL applications therefore Ontology quality is expected to be good, and experts concur (both evaluated top marks for general quality). Even when the ontology is complex (case of Help when outdoors), experts agree the ontology needed to be that complex to achieve the purpose. In case of the Agenda ontology, experts see that there is no use of existing ontologies, nor the use of a methodology, but the domain of this ontology is not covered by any existing ontologies.

IBR: Experts agree the quality of the ontology development is impeccable. In fact there was no ontology developed; IBR used the existing ontologies to fit their service in. This is the textbook best case scenario of application adaptation with regard to ontologies. This will make applications compatible. universAAL market vision aims for this case in all domains, where applications do not require new ontologies, there should be a big enough catalogue to choose from. An additional advantage is the effort saved by not developing new ontologies.

ODE: General quality of the ontologies is not very good. This is due to 3 main factors: the ontologies are too specific to the application (they map the data model and cannot interact with other applications); they don't import concepts form existing ontologies; and their complexity does not match the problem (trivial for Task Scheduling). This is one specific case where special effort was delivered between the application developers and experts in order to improve application quality. The main actions were on creating a more generic model, and importing existing applications that will ease the ontology, and eventually application, development.

PGL: The general quality is highly dependent on the application; this is probably due to the applications (and thus the ontologies) being developed by different vendors. For Easy Home Control experts agree the quality of the ontology is acceptable. For Safety at home, experts think improvements could be made, but it should work. As for Home activity monitoring, experts agree there is much room for improvement, this derives from the fact that all agree there is overlapping between the ontology and existing ontologies, experts could not agree whether the ontology is based on existing ontologies nor if it could interact with other applications (being too specific to one evaluator). Experts also point out that the general quality of the documentation provided could be improved; thus the ratings of these ontologies could have been affected by this fact.

RNT: These ontologies cause great concern to experts (all evaluations are below 0.5 over possible 3). In general all concur on the same mistakes: they are not generic enough (at times just mapping the application internal data model), and do not use existing ontologies which in fact they completely overlap. These shortcomings might have been avoided if a methodology was used. A special task force was created in order to improve both the quality of the adaptation in general and the ontology quality in particular.

SL: The ontology was deemed as perfect by all experts. The general complexity is also evaluated very positively. Experts discussed if this could be potential for other applications being able of taking advantage of it.

TEA: General quality of ontologies is rated very well (above 2 out of 3 in all cases). Although certain concerns where risen, as the documentation was not clear about certain aspects where experts had to assume the correct procedure was undertaken. For this purpose clarifications and further corrections where needed were discussed with the TEA application developer.

WQZ: There was general concern from experts about the quality of the documentation provided, this was critical as the diagrams (main source for the evaluation) were not readable (too little resolution images). Experts had other concerns about the choices for modelling, as they were not formal enough for experts, or modelling in excess services (concepts that could be merged into one, translating the intricacies to service profile implementations).

In general ontologies are good, except for those pilots where the technical coachers are "second generation" (coachers not directly involved in the development of universAAL open platform). This shows how important it is to have experience with ontologies. Each case is different, because each pilot had their own domain, and each had their own coacher who had slightly different views. It is also important to note that the ontologies have been improved since this evaluation, so the general quality, especially of those pilots with worse scores, has improved. The final set-up is reported in Project deliverable D3.2b.

universAALization of the application

Each pilot made a visual, technical description about the set up of the pilot, and how universAAL is placed in this set-up. These descriptions can be found in Project deliverable D3.2b. In general there are four adaptation strategies. Table 11 provides an overview of the strategies used by the pilots.

Table 11. UniversAALization strategy per pilot

	universAALization strategy			
Pilot	**Decouple link between sensors/actuators and the application**	**Allow applications to interoperate with one another**	**Decouple link between applications and external servers**	**Linking remote native applications to their own virtual universAAL node**
BSA	X	X	X	
IBR	X	X		
ODE	X		X	
PERCHE		X	X	
PUG	X	Extension	X	
RNT				X
SL		Extension		X
TEA	X	X	Extension	
WQZ	X	X	Phase2	

Application quality assurance

Application providers were asked about their quality assurance methodology. The intention is to find if they cared about application quality; as well as to observe the testing procedures used in the different domains. Here we summarize our findings.

All pilots used simulated user testing; applications are tested by the developer team as part of the application development. Most of them also used real users as part of the application refinement process; in all cases these tests followed the development methodology of the application provider. Those applications that did not use real users as part of their development methodology were applications that are most cumbersome to do quick tests (like SL apartments, or WQZ concierge services).

BSA: Manual unit and integration testing was performed on site. Regarding impact of universAALization, Service integration does seem to make a difference, which also shows in service quality.

IBR: Unit and integration testing was used; developers also performed their own tests during development phase. No impact is predicted on the perceived application quality after universAALization.

ODE: Primary source of tests are the developers testing the application. Since the universAALization part took place in the backend, no application quality effect is expected.

PERCHE: Unit and integration tests were implemented, but not automatized. These tests were performed on site even similar tests were already performed on the application, as they mainly import applications. Very positive evaluation was provided about the impact of universAALization in the application and service. This is mainly due to the openness, and extensibility of the platform.

PGL: Since there are up to eight technology providers for this pilot, each of them follows a different quality assurance strategy. All of them have unit and integration tests, where most of unit testing is performed automatically, in some cases also integration testing is automatic. User testing is also part of the methodology for all vendors. Application quality is considered to be improved through universAALization because two main factors: administration of services, and the fact that a critical bug was solved thanks to it. Service quality improves mostly due to the new market opportunities; although there is some reservation involving the fact that universAALization changes the product itself (which will require further testing).

RNT: Some applications where developed using automatic unit testing. Developers generally do not use the applications to test it (due to the web nature of them). An independent party was involved in the testing procedures of the applications. Since their applications are served through a web portal, the remark is that users will not be able to find any difference in the application or service quality, but standardization of applications will be positive.

SL: Testing is restricted to the minimum, with developer manual tests and some simulated user tests. Application quality is not expected to be impacted by universAALization.

TEA: Manual integration testing was performed, as well as tests with users. universAALization is considered to have a positive effect on both the application and service quality, mostly due to service integration and transferability of universAALized applications.

WQZ: Some integration tests where developed, along with simulated user testing. Impact of universAALization is very positively regarded (but no additional comment was provided as to why).

As a general rule, all partners consider the universAALization process has positively affected application quality. Also the effect over quality of the offered service is considered positive.

Application universAALization field test results

Laboratory tests are not conclusive indicator for Application quality. There are many unknowns, most of them deriving from the fact that issues detected are not all issues present. Also every issue is unique and it is hard to make comparisons (within and between applications).

Observing the results, on *Table 12*, *Table 13*, *Table 14*, and *Table 15* one conclusion is clear: Laboratory tests worked, in the sense that they fulfil their purpose in detecting high impact issues.

Table 12. Installation type issues detected during Field Testing

			Severity of the issue			main problem related to installation		
Pilot	**Application**	**Issue**	**Estimated impact on the application**	**Estimated solving time**	**Estimated resources to solve issue**	**Hardware issue**	**Configuration issue**	**Could the problem be fixed remotely?**
PGL	iHelp	The unlock pin of the RJ45 connector from the provided UTP cable was broken off. After setting up the prototype, I came to the conclusion it did not work and the reason for this was 'no internet'. I finally came to the conclusion that... but took me extra time to figure out.	1	1	1	Y		N
ODE	Rehabilitation Portal	The tablet screen used during the rehabilitation session, after few minutes goes to black since the tablet enter in energy efficient mode.	5	1	2		Y	N
RNT	VitAAL-app	Forgot to unable the data the pilot got to put on the universAAL bus.	4	1	1		Y	Y

Table 13. Networking Type Issues detected during Laboratory Testing

			Severity of the issue			Where seems the problem have been originated				
Pilot	**Application**	**Issue**	**Estimated impact on the application**	**Estimated solving time**	**Estimated resources to solve issue**	**Home**	**Backend Net**	**[Other]**	**What was the downtime of the issue?**	**Has this issue happened before?**
PGL	iHelp	The server from Virtech was hardcoded into their bundle but was annotated as “ihelp.virtech.it” the DNS server of the computer they provided was configured wrong (non existing?). We (I) replaced this with google's DNS server and then it worked	5	2	3	Y			<12h	Never
PGL	iHelp	The phone provider used for the iHelp system was down	5	3	3		Y		<24h	Never
PGL	iCam	Camera was not visable on the smartphone app.	5	2	2	Y			<12h	Never
PGL	iCam	When an alarm is triggered, there should be a push message on the phone from the caregiver	5	4	4		Y		>48h	Never
SL	Smart Living System	IP address of the server changes repeatedly.	4	2	2		Y		<48h	Never
ODE	Task Scheduling	Pairing of the Bluetooth is very hard to do. The medical Bluetooth devices were not showed by the iOS Tablet.	5	3	3			Pairing Bluetooth connection problem	>48h	Never
PGL	Omnia	Communication port was set on 80, but documentation stated another port (3553)	5	2	3	Y			<1h	Never

PGL	Omnia	The windows machine they use for karaf was blocking all incoming data there was no communication possible	5	2	2	Y			<1h	Never
PGL	Omnia	The configuration of the android application was pointing to the WAN address of the universAAL server located in the same LAN subnet. The app could therefore not connect to the server. This must have been the LAN IP of the universAAL server	5	2	2	Y			<1h	Never

Table 14. Software Type Issues detected during Laboratory Testing

			Severity of the issue				
Pilot	**Application**	**Issue**	**Estimated impact on the application**	**Estimated solving time**	**Estimated resources to solve issue**	**Preliminary Root Analysis**	**Root Analysis type**
BSA	Agenda	When created a new agenda category on the webserver, the android application did not receive the category. (normally should automatically receive it)	2	2	1	from Gema; the server was ok, it was a minor error at the administration webpage it doesn't create the category with the right state, then the agenda server is not able to find it	Platform
BSA	Agenda	No messages are being pushed from webserver to android application	5	2	2	webserver is unstable and keeps crashing	Platform
PGL	iHelp	After a panic button was pressed, there was no received phone call to the assisted person	2	2	2	The Identification number for the VOIP service behind it was wrong. The account was therefor not recognised and blocked	Application
PGL	all applications	Instability of the applications	5	4	4	There was a major software bug in the Zigbee coordinator (made by NEWDOM). All applications used this and was therefore exposed to this bug. The bug would re-sent every package it would receive, creating a chaos on the network	Hardware
PGL	iHelp	iHelp call gives the caller the option to decline or accept the help request from the assisted person, using voice recognition. This does not work, it always accepts the help from the caller	5	4	3	Apparently, the software was in 'demo' mode and thus it gives always a YES back to the server of iHelp	Platform
PGL	iHelp	All zigbee modules fail	5	1	3	If the zigbee coordinator runs for several days, it stops working	Other

IBR	Lynx ReAAL Service	The application is very unstable. In particular, the module responsible to the connection with the sensors generated several system crashes.	4	3	3	Internal code problems.	Application
BSA	HWO	When setting the point of interest in the map the selection does not update the selection.	5	3	2	0	Application
RNT	NetMedical	The serial number of the device was not recognized by the NetMedical server due to mix up errors so the measuring done was not according to the used account.	5	3	3	0	Application
RNT	MedicineMan	Difference when creating new password using the Android app or from the Website. No synchronization between the passwords creation.	3	4	3	0	Application

Table 15. Other Issues detected during Laboratory Testing

			Severity of the issue		
Pilot	**Application**	**Briefly explain the issue.**	**Estimated impact on the application**	**Estimated solving time**	**Estimated resources to solve issue**
ODE	Task Scheduling	Due to bad quality of battery (lipo), the batteries start to be overheat and dangerous.	5	2	2
BSA	Nomhad Chronic	Logistics: We received the wrong user account so the login credential were wrong.	5	2	2
RNT	MindDistrict	Logistics: Lots of problems with getting the right user IDs so the login credentials were wrong. Try with one credential for all but failed.	5	2	2

4.4. User Perception

In D5.3a the main users are the developers of the applications. Also some data from the test users is included. But mainly, the end user data will be part of D5.3b.

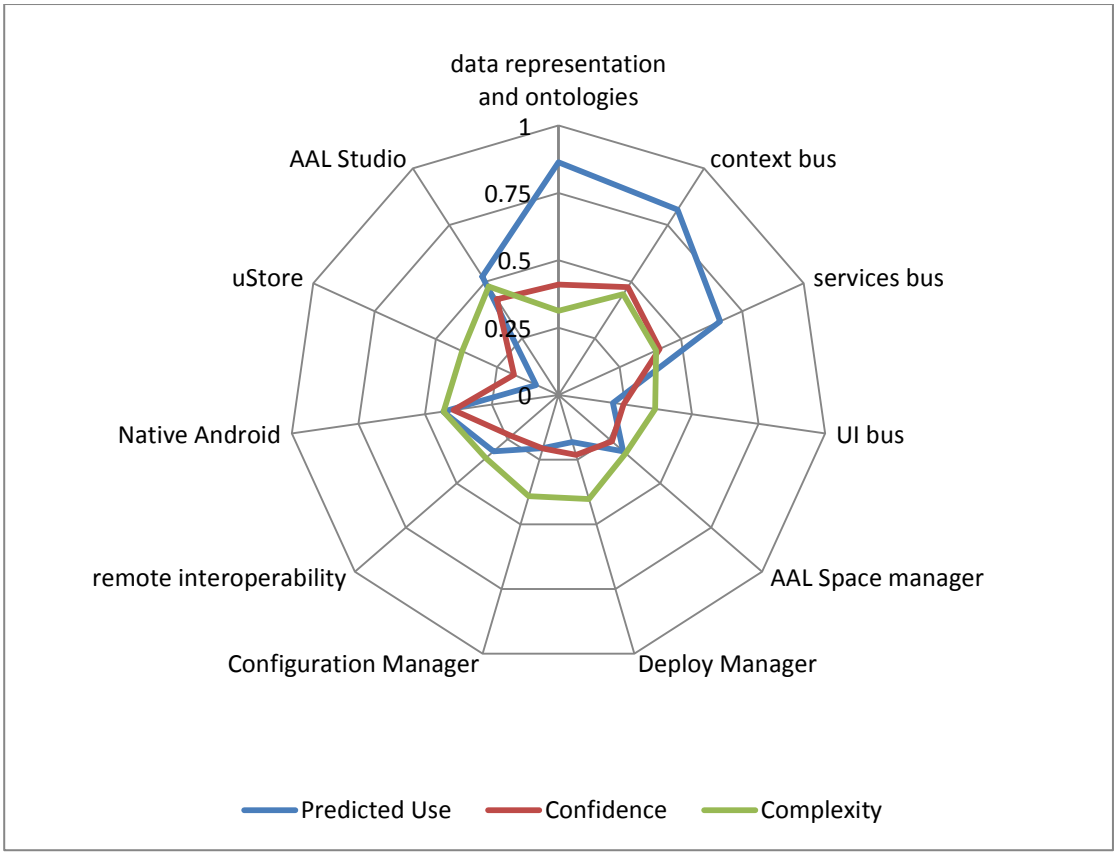
The user perceptions reflect the opinions of developers, expressed in questionnaires and interviews. This complements the data presented in the Technical Aspects section. To get a good overview of how universAAL was used and evaluated, both these sections should be considered.

4.4.1. User acceptance

User acceptance of the universAAL platform

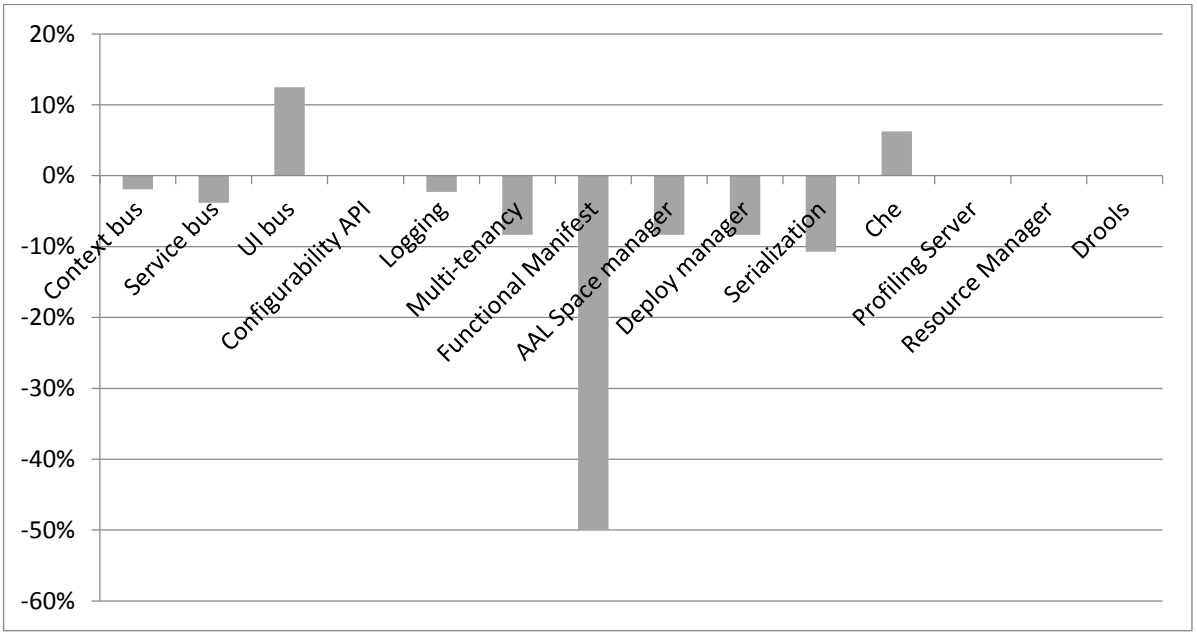
User acceptance of the universAAL platform by application developers can be assessed by looking at their expectations and experiences towards its ease of use, usefulness and fit their needs.

Figure 20. Prognostic of developing using universAAL (T0)
Legend: normalized to 0-1 scale, where 1 means all participants either predicted the use, or rated top marks.



Developers at T0 predicted high usage of ontologies, the context bus and the service bus; which in fact are the most prominent components of the platform. This indicates a very early understanding of the basics of universAAL. Complexity averages under the middle scale across all components, indicating that a-priory the platform seems very complex. Confidence seems to be lower than average, explaining how developers feel right before they get deeper into the platform.

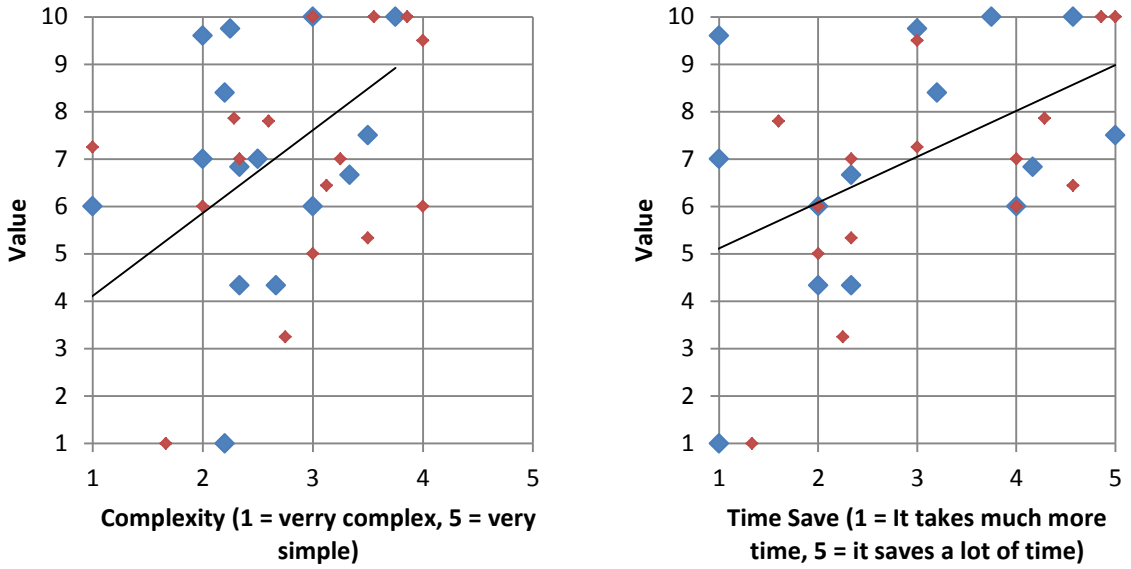
Figure 21. Difference in percentage between actual and expected fitness means per component, Filtered by usage, after the adaptation phase.



According to *Figure 21*, developers found all components to be more or less (within 10%) as expected. The only notable exception is the Functional Manifests, which are deemed as very disappointing. On the other side, UI bus turned out to be more interesting for developers than they expected, although the low usage of this component in ReAAL makes this statement not very conclusive.

Figure 22 shows two scatter graphs where each dot represents the answers of each participant in Developer's questionnaire T1. In each axis the value represents the mean value of the participant's answers to all features, in blue, and components in red.

Figure 22. Mean values of all Features (blue) and all Components(red) for Value, complexity and Time save for each developer (represented as a dot) in T1, filtered by use.



Examining the regression when complexity of both features and components are measured against value, a pattern emerges. When complexity falls, the value does rises. Developers tend to see more value on simpler artefacts. When comparing value against time save, the statistical variable dependence is not so clear. This indicates that developers realise simpler components to have greater value, but time saved is not the only component of the added value.

The experiences of the pilots with universAALization are reported in D3.2b; Table 16 provides a summary.

Table 16. Summary of experiences encountered during universAALization

Pilot	Advantages	Disadvantages
BSA	Exchanging information amongst services Avoiding vendor lock-in	Testing and Debugging (due to distributed nature of the system) Careful planning is needed to avoid delays. Encoding problems Update between versions of universAAL was hard
IBR	Great expert support Ontologies are the best tool to share information Fast deployment, Installation reduced 80% after first deployments Simple debugging Easier integration with universAALized applications Update between versions of universAAL was easy	Data exchanges have to be carefully designed Application segmentation is a critical factor Poor documentation
ODE	Great expert support	No support for Bluetooth 4.0 Low Energy Poor documentation Not easy to get existing suppliers to adapt their application to universAAL
PERCHE	Great expert support Easy App importing	Poor documentation Security and configurability of it too complex
PGL	Integration between different vendors Multi-platform Time saving using semantical models	Different programming languages in platform and existing products Bugs in the middleware Bundle deployment in karaf required order and had problems
RNT	Great expert support Slow evolution in IoT domain gives universAAL advantage	Log too verbose universAAL is complex and not mature enough
SL	Great expert support Easier integration with universAALized applications and hardware	Poor documentation Technical overhead
TEA	Easier integration with universAALized applications and hardware	
WQZ	Semantic model makes it easier to extend application More benefit when more universAAL applications Flexibility to fit many different deployments Lower investment costs	Application segmentation, smaller modules fits universAAL better. Steep learning curve (which pays off) Benefit is not as clear with less applications / components

Additionally there where some remarks, or requests, from certain pilots to further improve the universAALization experience.

PERCHE:

They would like a product packaging for improving business model

RNT:

- To involve more people in universAAL,a wider circle of stakeholders who are involved in training of the platform is suggested.

WQZ:

- In order to increase the user acceptance of the AAL technology, the provided services must be always revised and updated based on the end user experience
- A successful adaptation phase relies on a good design of the application and a complete and correct modelling of the domain.
- Although the system deployment was not too complex, automatic tools for deployment (like deploy manager and uCC) would be very helpful

In general, the following conclusions can be drawn:

- Documentation needs to be improved, even if the expert support is there. Improvements to the documentation need to be addressed at different levels, for example including design problems (not only implementation issues) and addressing other stakeholders (like end users, policy makers, etc.).
- The best experience comes when interoperating with existing universAAL applications, and / or hardware. Of course as the community grows and the availability of both increases true value of platform will be best appreciated by newcomers. Until then the learning curve is too steep to appreciate the benefit, leading to great dissatisfaction.
- Important unattended concepts of universAAL have to be revived, or better documented. The deploy manager and universAAL Control Centre (uCC) for example will help service providers deploy their services faster and easier. While the uStore will mark the difference, as it will be the main hub for the different stakeholders to request, provide, and buy universAAL-based solutions, helping the community grow.

User acceptance of the application

Before starting the Deployment phase, usability engineering methods have been used to determine how well a ReAAL product or service may be user-friendly. During the Real Life Control Test sub-phase, within the Adaptation phase, the assisted persons have been asked to transmit their feelings on interaction with the products in the User Experience Questionnaire. *Figure 23* shows the outcomes coming from the questionnaire, based on 47 surveys from nine pilots.

Figure 23. Outcomes from User Experience Questionnaire
Legend: a 7 means a high score

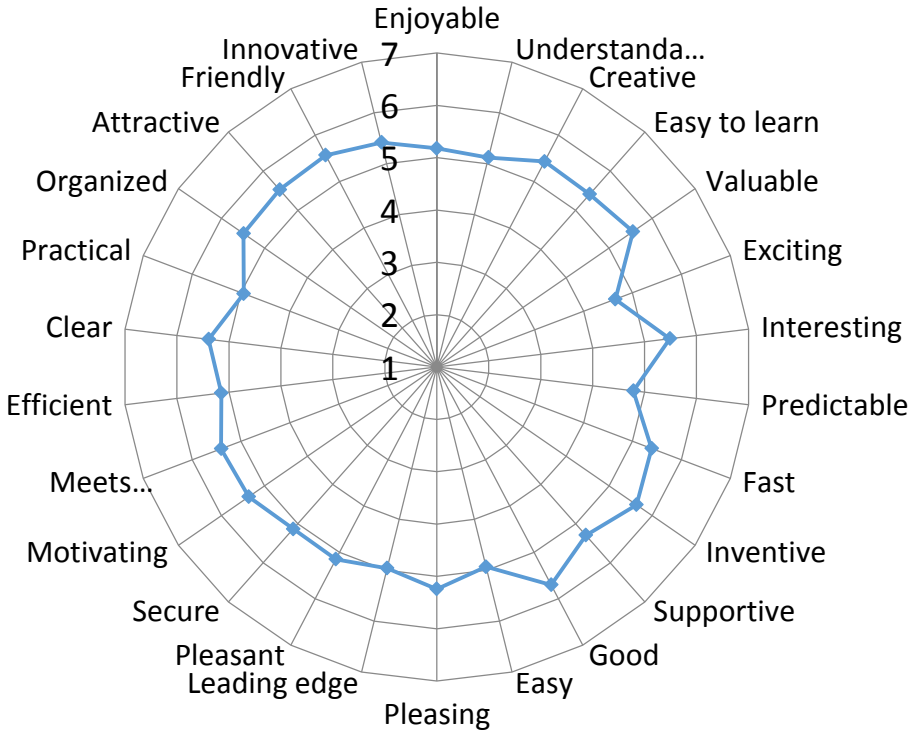


Table 17. UEQ Mean responses, inverted question compensated and sorted by mean highest to lowest

Weighted average of UEQ mean response on 26 dimensions			
Good	5,70	Motivating	5,36
Inventive	5,64	Supportive	5,30
Friendly	5,57	Pleasing	5,24
Valuable	5,55	Enjoyable	5,18
Attractive	5,53	Pleasant	5,15
Interesting	5,49	Efficient	5,15
Organized	5,49	Secure	5,14
Creative	5,43	Understandable	5,12
Innovative	5,42	Leading edge	4,96
Easy to learn	5,41	Practical	4,95
Meets expectations	5,41	Easy	4,93
Fast	5,39	Predictable	4.78
Clear	5,39	Exciting	4,65

Some comments derived from the graph and table:

- In general products are highly evaluated by users; almost all answers are well above average (all of them are over 4.5 out of 7).
- The most prominent aspects are Good, Inventive, Friendly and Valuable (all over 5.5 over 7)

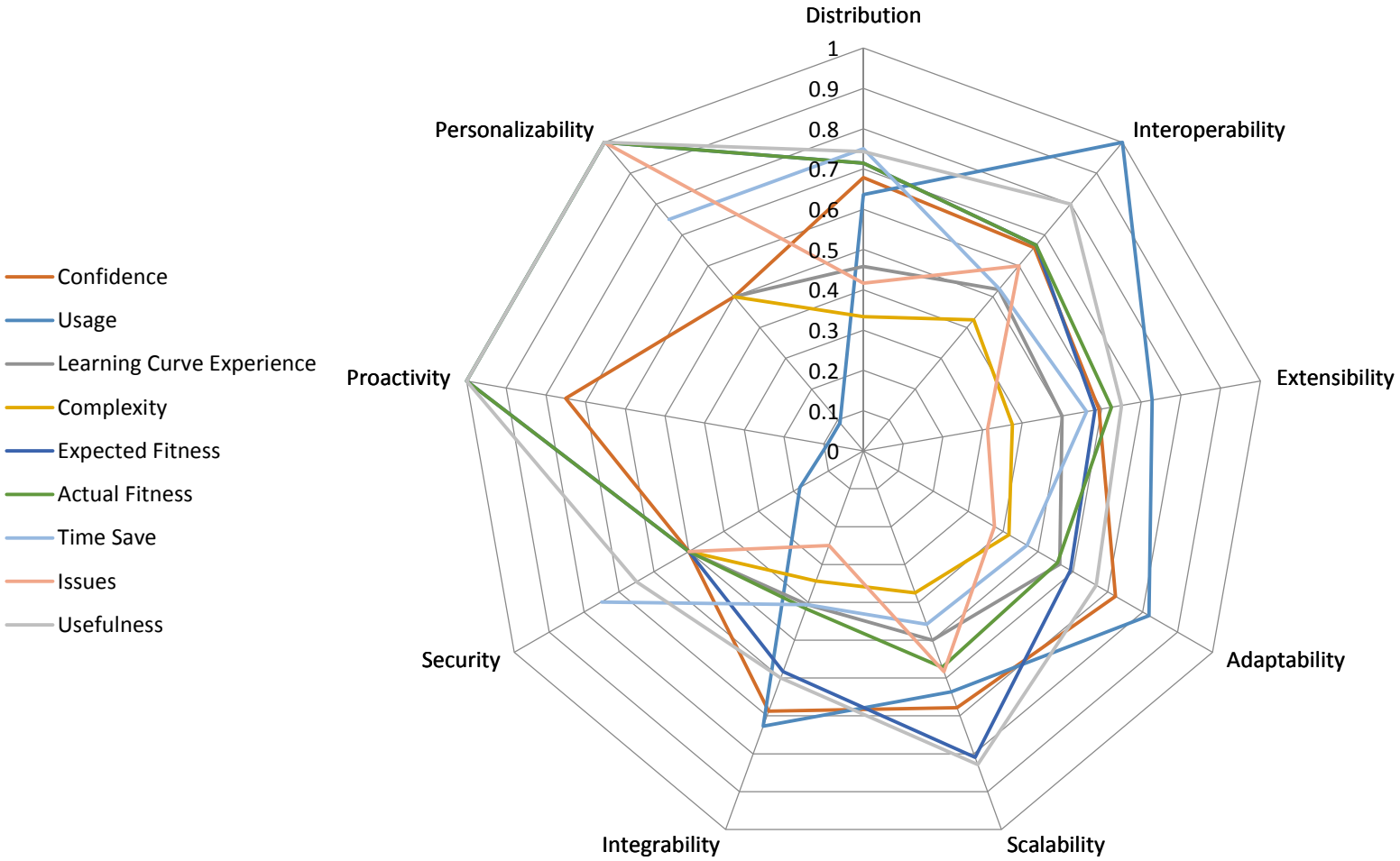
4.4.2. Use

This group of indicators report on actual usage of the platform, the platform's components, and (later) on the use of the applications.

Use of universAAL features

When analysing the features of the platform, when not filtered by usage, application developers rate them all very average. Small interests are detected on Interoperability and Scalability features; but the platform seems not to have a strong point. While if we filter by usage, in general all features rate above average (see *Figure 24*); Complexity is still deemed as the main draw back (together with some issues), but fitness and usefulness score very high. This strongly indicates that the value of the platform is only appreciated by actually using its features, while when affronting the platform fears of complexity seem to overwhelm application developers. The difference between expected and actual fitness is marginal, so we can conclude that developers find the features to be as advertised.

Figure 24. Questions in Developer's questionnaire T1, regarding Features, filtered by usage.
Legend: all statements have been normalized to a 0 to 1 scale; 1 means all participants that have used the feature have scored it with top marks



Use of universAAL components

Most of the applications have used the OSGi container, the other strong contender is the android container; again corroborating the strong influence of mobile technologies in the AAL domain.

Figure 25. Container usage (T1)

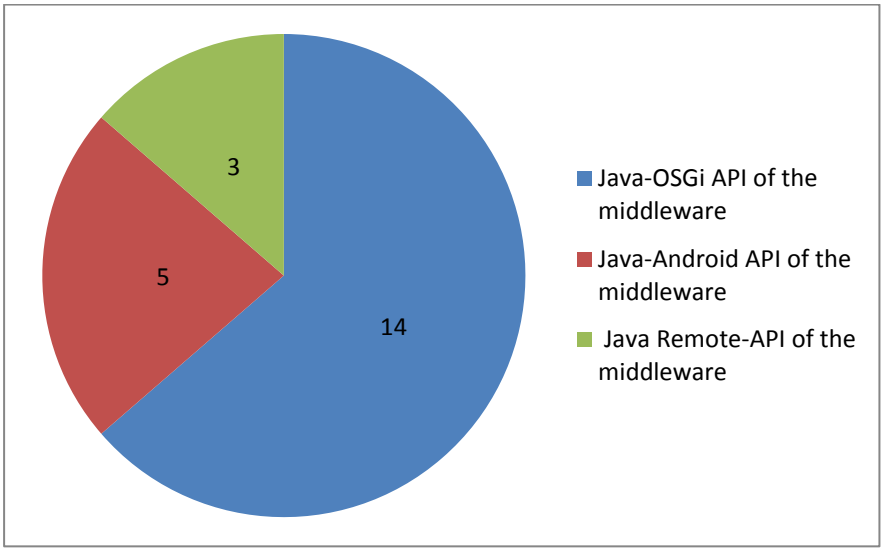
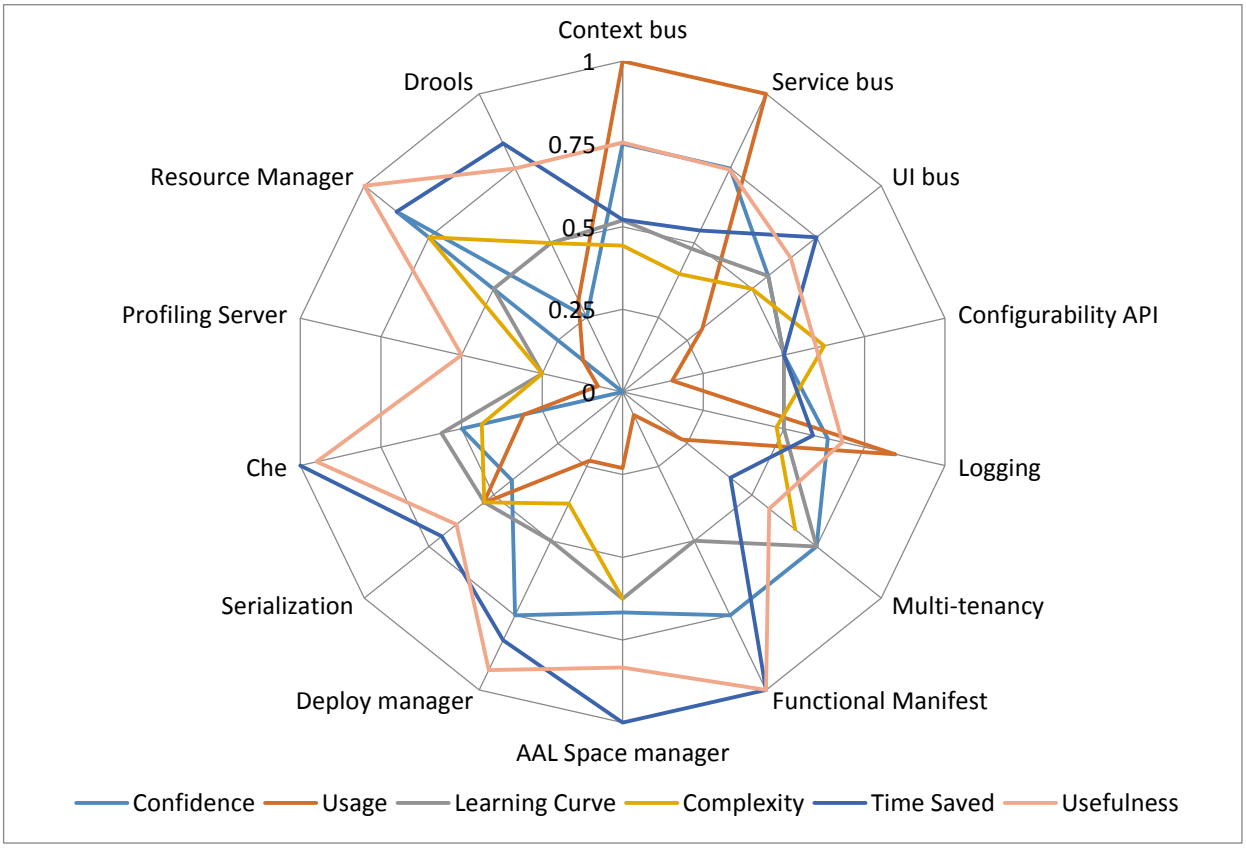


Figure 26. Questions regarding universAAL components (T1), Filtered by usage
Legend: only the evaluation of users that have actually used each component is considered, and normalized to a 0-1 scale, 1 means all participants rated the statement with maximum score.



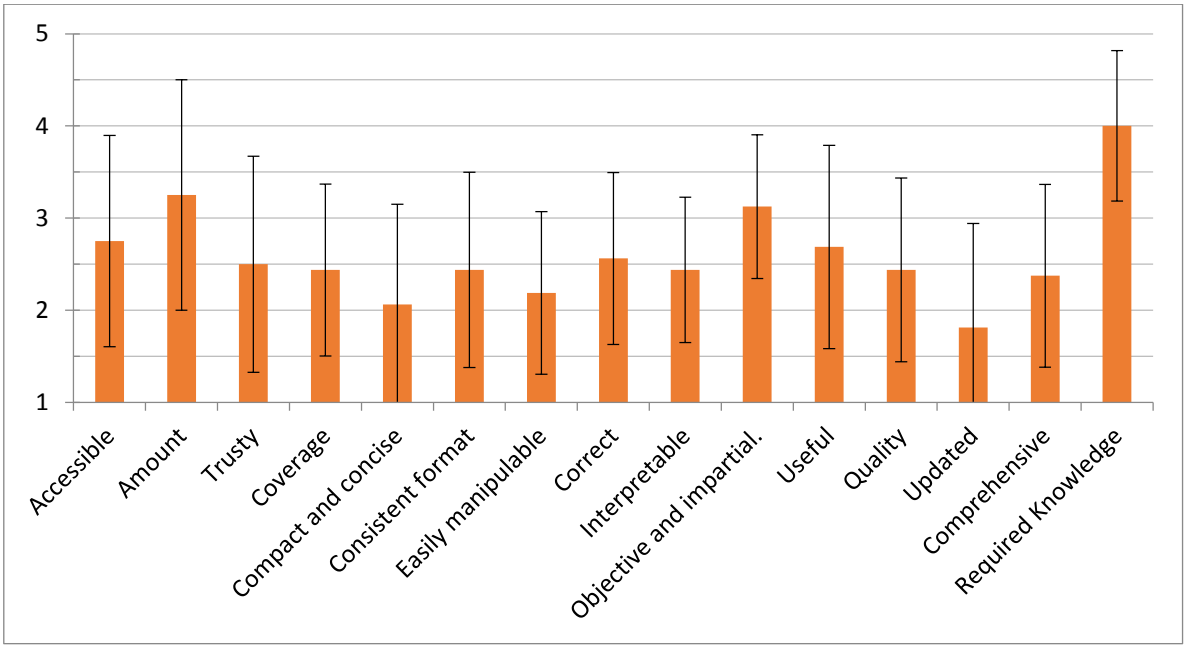
Developers after adaptation concur that the most used, and useful components are the context and service bus. All aspects are rated above average, or acceptable, for most components. Yet the complexity and learning curve are the most negative rated values.

4.4.3. Satisfaction

Information quality universAAL: Satisfaction with documentation

Application developers where asked a set of standard questions about the documentation quality of universAAL on a 5-point scale.

Figure 27. Quality assessment of the documentation (T1, N=16)
Legend: 5 = totally agree, which means totally satisfied



In general, the documentation for the platform is considered not good. Only the amount and the objectivity of documentation provided, is above the acceptance threshold (neutral agreement, equivalent to value 3 in *Figure 27*)

Participants feel the documentation is specially outdated. This is later confirmed in the open question about the documentation (2 participants explicitly mention it) during the interviews. They advise that the project to give this high priority.

The documentation fails to be concise, that explains the general feeling that there is too much information. Actually 3 respondents noted this issue, going as far as saying “it is soporific”; they also point to having more concise clearer examples, and usage of more multimedia material.

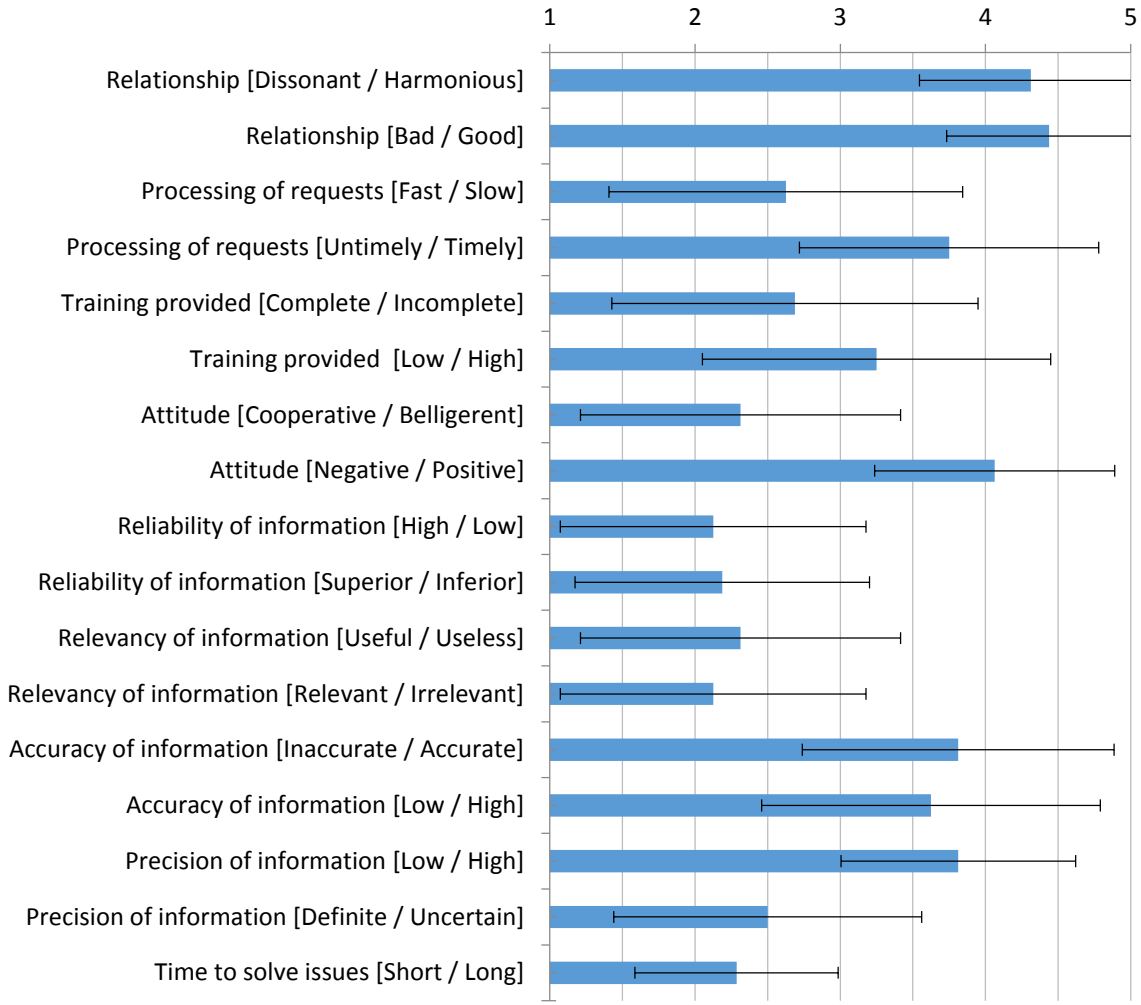
Another important failure of the documentation is trying to explain required knowledge, for example Maven, The most demanding of these prerequisites is the OSGi platform over which universAAL runs, 2 participants felt the configuration and usage of the running environment is not explained correctly and they lost much time on it because of it.

Service quality universAAL: Satisfaction with technical support

Complementary to documentation, application developers have access to technical support of universAAL. They have been asked to rate the technical support. They

could answer on a 5-point scale, ranging between two extreme qualifications of service quality. For example, how they experienced the relationship with the technical support team, on a scale from dissonant to harmonious.

Figure 28. Technical support question group in Developer T1 (averaged)
Legend: 1 = the left extreme; and 5 = the right extreme of the presented dimension



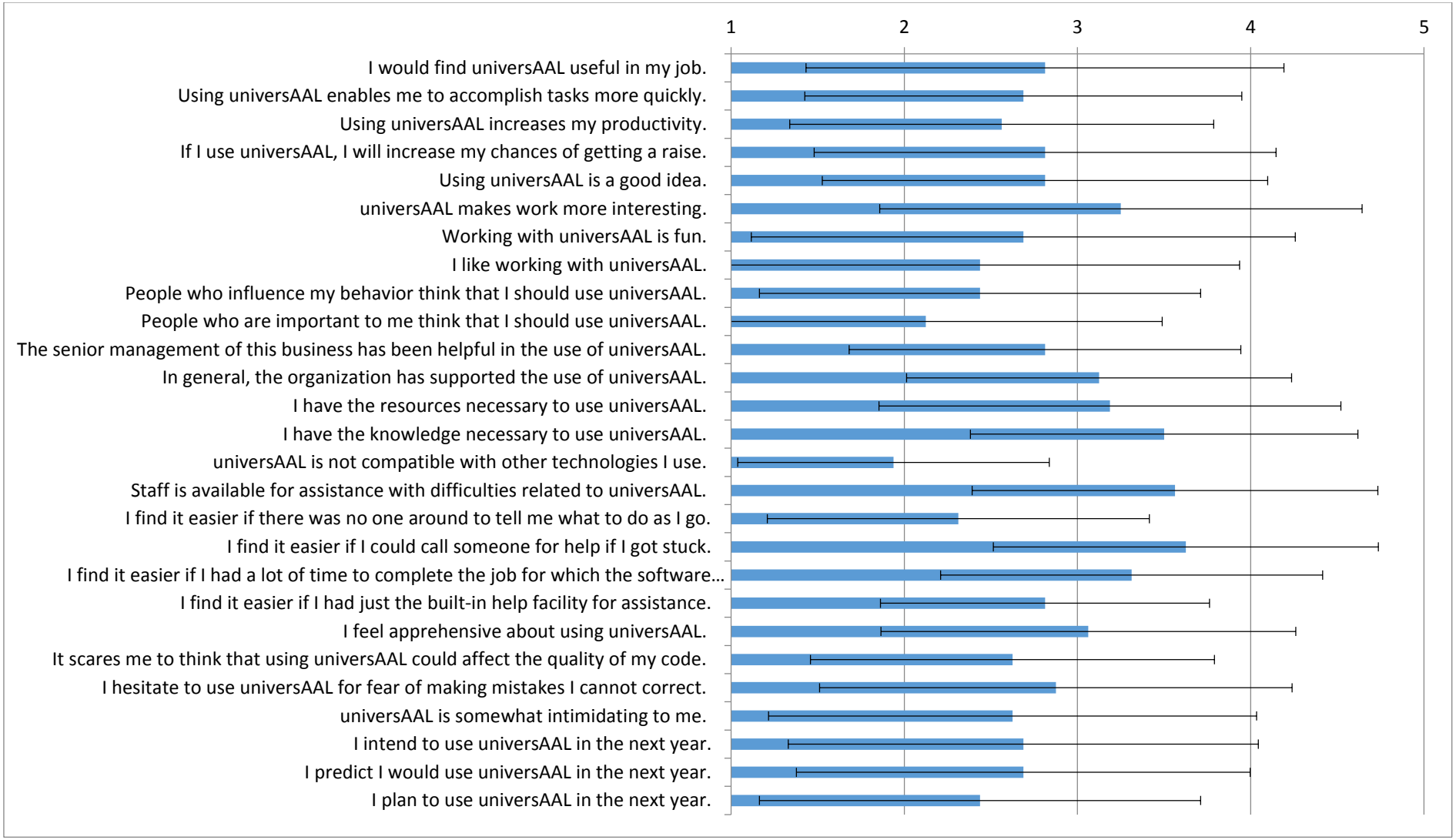
Comparison of the perceived quality of the technical support is diametrically different to the overall documentation perceived quality. When documentation failed, technical support passed with flying colours, all averages are well within the acceptable range. In some cases developers were personally thankful to the work of the technical support staff, this is specially mentioned in the interviews.

Acceptance

The developers have responded to many statements about universAAL, that indicate user acceptance. They were answered on a 5-point scale, ranging from completely disagree tot completely agree The Most interesting fact about the results, that standout at first glance is the high standard deviation. This signifies the developers were highly polarized, on one side there were those whose experience and prognostics about universAAL are very positive, and those that are not. Although

there are neutral feeling participants, overall there is a tendency towards the negative side of acceptance. This might be due to the size of the data set.

Figure 29. Acceptance related questions for Developers at T1.
Legend: 5 = totally agree; 1 = totally disagree.



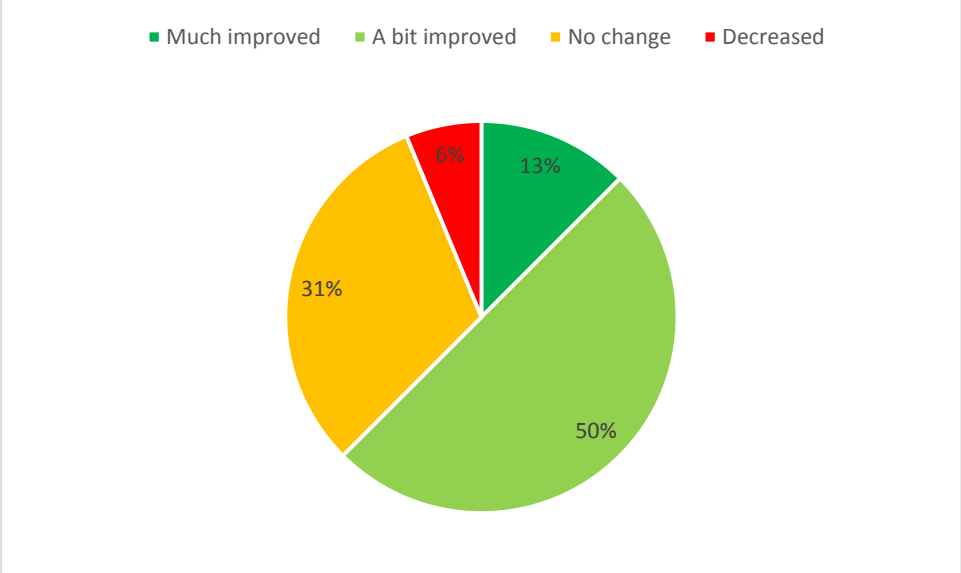
4.4.4. Value

Experienced value of universAAL

In interviews with application developers and platform developers the value of universAAL has been discussed. An important value is the support of system integration. Most of the experts (70%) agree the universAAL facilitate the integration of the system. Some developers, however do not agree universAAL facilitate the system integration due to different reasons such as many bugs (in universAAL) with long time to be solved, or much different devices to integrate.

Developers were also asked to give their opinion on application quality: has it been improved through universAALization? Most developers argue this is the case, although this improvement is small.

Figure 30. Developer opinion: impact of universAALization on application quality (N=16)



In the interviews the developers admit that they only used part of universAAL, and therefore may not have seen all the benefits. If they know more about everything that platform can be used for, they might also consider using it in other projects.

4.5. Economical Aspects

4.5.1. Cost

Platform effort during universAAL and ReAAL

Since the reported invested effort directly applies to the financing of the partner involved for this activity, it should be considered as the main financing indicator for the platform.

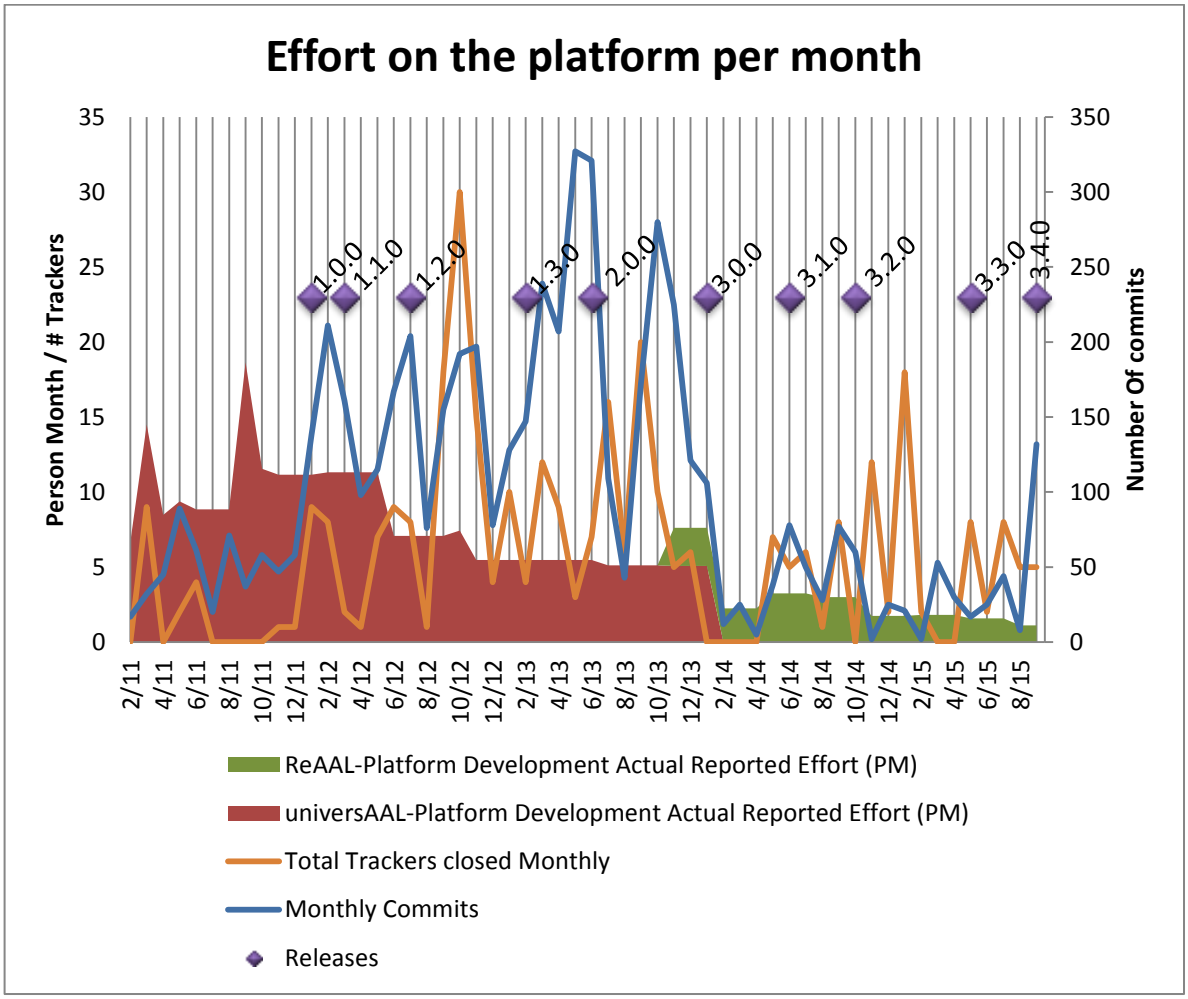
Figure 31 shows different data to show the investment versus effort on the platform. It is analysed on a monthly basis. Facts that can be drawn from this data:

- universAAL investment and effort is 8.5 times that of the ReAAL era.

- Vacation periods (August and December of every year) show as low effort being done on the platform but the investment is constant.
- Effort leading up to a release is greater than that after the release, and this is not represented in the financing.
- Period February 2011 to May 2012 consist of the most investment on the platform development, and it seems to correspond to the design phase.
- Implementation phase starts on February 2012.
- There are 4 months of tracker inactivity (from January to April 2014), that are being financed. Commits data[6] show there is not complete inactivity. While researching deeper into this fact we found:
    - During this period most of the effort was devoted to documentation tasks
    - This period also coincides with the constitution of the support framework for universAAL for the ReAAL application development.
    - The work load of the main platform developers was shifted towards other tasks.
- There is another 2 month of low activity (from March to April 2015). Checking the mailing list for the platform development, the main issue was the migration to GitHub.

[6] Commits are the mechanism used by the source code versioning system to register a new code version. Thus it is a pure indicator of actual work being done on the platform.

Figure 31. Effort on the platform per month



Cost of development and universAALization of applications

Table 18. universAALization costs

universAALization costs in Euros excl. VAT			
	TOTAL	AAL	eHealth
Average	23.600	28.820	18.485
Minimum	2.500	8.750	2.500
Maximum	49.180	49.180	27.260
As part of total development costs			
	TOTAL	AAL	eHealth
Average	36%	47%	29%
Minimum	17%	17%	18%
Maximum	60%	60%	33%

The figures in *Table 18* are based on the reported data from 23 applications. The most expensive universAALization applications are in essence a combination of products, or an integrated system. The safety at home (Puglia) and home management system (WQZ) are most expensive to universAALize. Simple eHealth applications on smartphones seem to be the cheapest to universAALize. These applications were also least expensive to develop (an outlier here is the VitAAL app of RNT pilot).

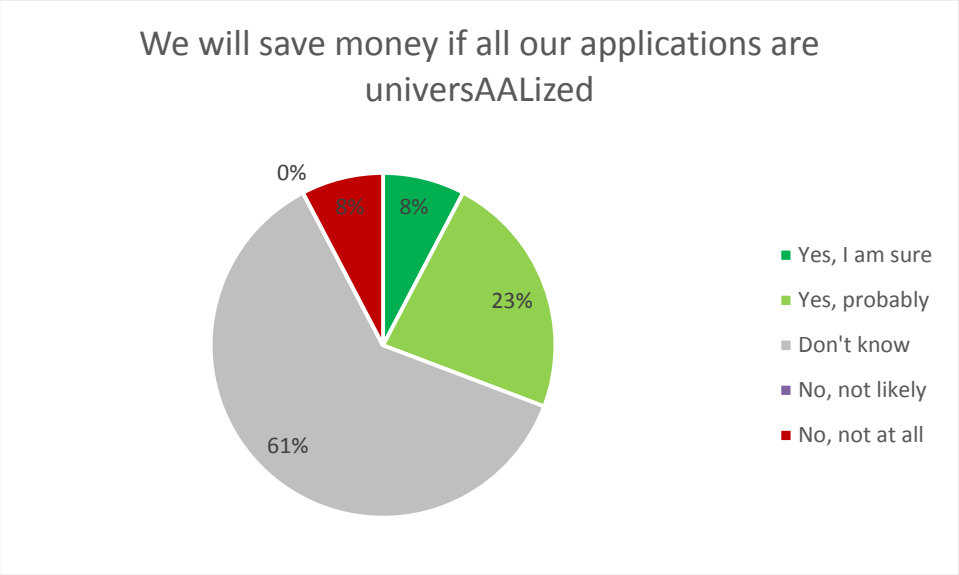
Some differences can be explained because of differences in staff costs per hour. This needs to be investigated further because not all pilots reported their costs in the same way.

Table 19. Development cost per user

Total development cost per targeted user (excl. VAT)			
	Total costs incl. universAALization (Euro)	Number of users	Average per user (Euro)
All pilots	1.667.500	5.163	325
Lowest average cost per user (BSA)	102.800	1.430	72
Highest average cost per user (WQZ)	194.000	60	3.233

The showcase evaluation has to shed more light on the potential cost savings for service providers if they use universAALized applications, or even have their whole ecosystem running on universAAL. Up front, some expected savings, but most did not know what to expect.

Figure 32. Expectations of service providers (N=13)



4.6. Organizational aspects

4.6.1. Organizational fit

Fit with legacy systems of service provider

In the Service provider T0-T1 questionnaire, the service providers were asked questions about their legacy systems. The results show that ideally their AAL solutions should fit the legacy systems. In a pilot situation this is not always the case, and applications could work stand alone. For example, a healthcare organization might wish the data from a blood pressure monitor to be stored directly in the EMR system, but this integration might not have been realized in ReAAL. For the pilots with home based solutions, this integration with the original system (if there was any) is essential for the solution to work. The results also show that some service providers expect that extra work is needed to create this fit between

universAAL and their own infrastructure. On a 1-10 scale they currently rate the fit with legacy systems as a 6.

Table 20. Fit with legacy systems (N=13)

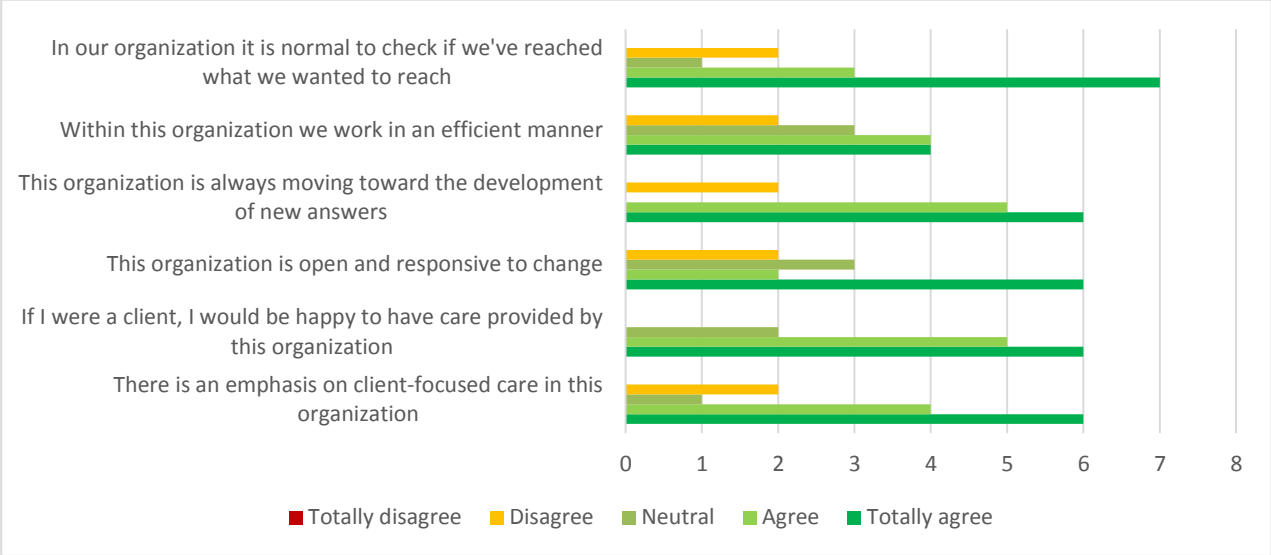
	Totally agree	Agree	Neutral	Disagree	Totally disagree
Fit with legacy systems is a prerequisite for any AAL investment of my organization	15,38%	46,15%	38,46%	0,00%	0,00%
I expect the universAALized applications to fit directly with my legacy systems and infrastructure	15,38%	38,46%	30,77%	15,38%	0,00%
I expect much work is needed to align the universAALized applications with my legacy systems	7,69%	30,77%	30,77%	30,77%	0,00%
A fit with legacy systems is, at this point, not very important for my organization	7,69%	15,38%	38,46%	23,08%	15,38%

When asked what is needed for an optimal fit with the legacy system, some point at improvements needed from universAAL, such as more stability, or better documentation. Others argue that the legacy system has to adapt. Either because it was a bad system, and universAAL “made it work”, or because the service provider wished the legacy system to be more open and easier to integrate.

Innovation climate

Service providers have shown a very positive attitude with respect to the innovation climate in their organization. This is to be expected, since they are managers of those organizations. Because it is an n=1 answer, this is not reliable. These questions about innovation climate are also be submitted to a sample of formal caregivers, which will lead to more reliable data.

Figure 33. Innovation Climate (N=13)



4.6.2. Impact on core process

The universAAL platform, and the applications deployed, both have impact on the core processes of the technology providers and service providers.

Quality of care & service

For a service provider, the core process is delivering high quality care and services. The service providers were asked about their expectations of the impact of universAALized application on the quality of care.

Table 21. Quality of care & service (N=13)

	Yes, I'm sure	Yes, probably	Don't know	No, not likely	No, not at all
I expect with universAALized applications we can provide better quality of care or services to our clients than with NON-universAALized applications	30,77%	23,08%	46,15%	0,00%	0,00%
If all the AAL applications we deploy were universAALized, our organization would be able to provide better quality of care / service	15,38%	38,46%	38,46%	7,69%	0,00%
If all the AAL applications we deploy were universAALized, our clients could stay independent for longer	7,69%	38,46%	46,15%	7,69%	0,00%
If other organizations in this region, we cooperate with, would deploy universAALized applications, we could provide better quality of care or services to all our clients	7,69%	38,46%	53,85%	0,00%	0,00%

It is interesting to see that these service providers do not see universAAL as something to compete about, but as something to cooperate on. They believe that it has value for their clients if universAAL is implemented regionally. Maybe they expect that service integration can then improve even further.

4.6.3. Strategic position

Strategic position of service provider

Service providers wish to cooperate on universAAL, not to compete. They do not see universAAL as a unique selling point that advances their strategic position. However, most pilots do feel the ReAAL has made a difference. For example, because of ReAAL they can more easily 'sell' their services to municipalities, because they can claim to be involved in an innovative European project.

Table 22. Strategic position of service provider (N=13)

	Yes, I'm sure	Yes, probably	Don't know	No, not likely	No, not at all
If other organizations in this region would deploy universAALized applications, it would be negative for our strategic position	0,00%	0,00%	61,54%	15,38%	23,08%
I expect that the ReAAL project will improve our strategic position in the pilot region	30,77%	38,46%	15,38%	15,38%	0,00%

4.6.4. Sustainability of universAAL

Evidence about the value of universAAL is not enough to guarantee its adoption by the AAL market. Although there are many changes occurring within and around ReAAL, it is important to take into account how the stakeholders estimate universAAL's potential for the future. What is needed to continue using it, or to make it even a standard? Do they trust universAAL is ready for it?

In the developer questionnaire, some developers (40%) agree that, after the ReAAL project experience, it should be important for its company, to continue show the potential of the platform to potential stakeholders in both research and market fields. Even though a high percentage of developers (40%) have some doubt on its real possibilities, mostly because of the fastness of the technology and the difficulty to compete with giant companies (i.e. Google or Microsoft). Anyway in theory it is a good idea, not only in the research but in the market as well. Some other (20%) think the platform is still not ready for such an important step because of its low robustness (too much problems in debugging, too much complexity).

The service providers had not experiences the value of universAAL, because their applications were not in deployment yet. For them it is not very easy to estimate the value of universAAL from a technical perspective. Is the market really waiting for universAAL as a standard, and will it be an advantage for an application provider to have a fully universAALized portfolio?

Table 23. Expectations of service providers (N=13)

	Yes, I'm sure	Yes, probably	Don't know	No, not likely	No, not at all
In the future, whether or not an application provider has universAALized applications in his portfolio will influence the procurement process	7,69%	38,46%	46,15%	0,00%	7,69%
In five years' time universAAL will be the standard	7,69%	23,08%	53,85%	15,38%	0,00%

Both application and platform developers state that an active community is needed, for the platform to sustain. At the moment, constant support is provided, and highly appreciated, but will this be enough if the networks expand, and if this funded project ends? Community support from universAAL is essential to extend the current ecosystem.

A high percentage of developers that were interviewed (70%) think universAAL could have the instruments to be a standard on AAL but for them it is fundamental to improve the dissemination and the community support. Other developers (30%) were not motivated to continue working on it in the future. They do not have a positive experience so far.

These conclusions are based on first experiences and on expectations for some pilots. They are likely to be more reliable towards the end of deployment, after the showcase evaluation.

4.7. Sociocultural, Ethical and Legal Aspects

4.7.1. Sociocultural aspects

Accessibility and policy for inclusion

There are differences between the pilots, that potentially have effect on the accessibility of AAL solutions in their region. The WQZ and Smart Living pilot are examples of deployment in apartment buildings. The installations are part of the package, and included (as an extra fee) in the monthly rent. Apartments with smart home technology are usually more expensive than regular apartments. The financial barrier might result in unequal access for these integrated AAL solutions.

The Puglia and Ibermatica pilots are examples of installation in individual homes; the technologies are installed in the houses of those individuals who are recruited for the project. The service provider plays a crucial role in deciding who received the technology and who does not. In the recruitment process, each pilot had his or her own criteria. The recruitment process in Puglia is unique, since the Puglia region gives vouchers to citizens, and has them decide which technologies they would like to purchase.

Successful implementation in a user group that is interested in technology and has computer skills is relatively easy. However, by definition, the users of AAL solutions are a complex target group. Usually they do not have these skills, and do not see how technology can be of benefit (only a minority of pilots requested the end user to have these skills already, and also the technical infrastructure of a smartphone and

WiFi). Especially the large pilots could not only rely on their technology-minded clients, but also had to invest in the more vulnerable groups that require a lot of support. The informal network will also play a role in this. The pilots with ambient solutions have the advantage here; their users do not have to interact with the front end of the system.

For some pilots, most of the work was in selling the applications to potential users, and supporting them to use it. All pilots had training sessions, for example, and continue to have them weekly of biweekly if needed. At these trainings, not only the use of the application needed to be demonstrated but also the devices such as the tablets and smartphones. Because of this project, however, pilot leaders believe that the elderly included in the pilot will be more positive about technology, and will gain general IT skills as well. This will be of benefit for other parts of their lives.

In the RijnmondNet pilot some service providers wished to target special, vulnerable groups, with the applications, such as Turkish elderly migrants and migrant women who are not allowed to leave their house. This is the only pilot who had a strategy for equal access, although only for a small subset of their targeted users and some applications.

At this point, the pilots do not know if their recruitment strategy will be different after the project. This also depends on their continuation plans.

Will open platforms improve the accessibility of AAL? The assumption behind this question is that open platforms might reduce the cost of developing AAL solutions. If these solutions are sold for lower prices, the financial barrier for service providers or end users is also lower, and more people will be able to benefit. However, first the technology provider has to invest in universAAL, and the application will be more expensive to develop. This can be seen very well in the economic section.

A master student of EUR is writing a thesis on open platforms and equal access to care, for which also some partners of ReAAL participated. The results of this research will be incorporated in D5.3b.

4.7.2. Ethical aspects

Ethical approval

Ethical and Legal analysis have been retrieved from each pilot through different documentation. There are three basic requirements that all pilots must fulfil:

1. Filing in a Privacy Impact Assessment (PIA), to be approved by the ReAAL Ethical board. This document consisted in a series of 11 screening questions. The answers to the questions needed to be considered as a whole, in order to decide whether the overall impact, and the related risk, warrant investment in a full-scale PIA. The answers were based on the following questions:
    a. Does the project apply new or additional information technologies that have substantial potential for privacy intrusion?
    b. Does the project involve new identifiers, re-use of existing identifiers, or intrusive identification, identity authentication or identity management processes?

c. Might the project have the effect of denying anonymity and pseudonymity, or converting transactions that could previously be conducted anonymously or pseudonymously into identified transactions?

d. Does the project involve multiple organisations, whether they are government agencies (eg in 'joined-up government' initiatives) or private sector organisations (eg as outsourced service providers or as 'business partners')?

e. Does the project involve new or significantly changed handling of personal data that is of particular concern to individuals?

f. Does the project involve new or significantly changed handling of a considerable amount of personal data about each individual in the database?

g. Does the project involve new or significantly changed handling of personal data about a large number of individuals?

h. Does the project involve new or significantly changed consolidation, inter-linking, cross-referencing or matching of personal data from multiple sources?

i. Does the project relate to data processing which is in anyway exempt from legislative privacy protections?

j. Does the project's justification include significant contributions to public security measures?

k. Does the project involve systematic disclosure of personal data to, or access by, third parties that are not subject to comparable privacy regulation?

2. Ask for the authorization for a full clinical trial in case the applications used within the pilot are considered having medical purposes.

   As a reference for the qualification and classification criteria for point 2, European medical devices directive MDD/93/42 and the “GUIDELINES ON THE QUALIFICATION AND CLASSIFICATION OF STAND ALONE SOFTWARE USED IN HEALTHCARE WITHIN THE REGULATORY FRAMEWORK OF MEDICAL DEVICES” have been used as criteria to determine if the software was considered to have a medical purpose.

   With respect to point 2, Committee Ethical Approvals have been asked by the responsible of the following pilots:

   BSA: The ethical approval has been asked and obtained from the clinical center of Fundación del Hospital Germans Trias i Pujol.

   TEA: According to the "Agencia Española de Medicamentos y Productos Sanitarios (AEMPS)" and the "Medical device certification algorithm", it was established that the pilot did not need to pass through an ethical approval committee.

   ODE: The Health Research Ethics Committee for Region of Southern Denmark approved the applications and decided that was not necessary to apply to the National Board of Health.

RNT: A signed document was provided from the Medisch Ethische Toetsings Commissie Erasmus MC in which it is declared that the pilot did not need to pass through an ethical committee.

BRM: Approval from the ethical committee for Trygghetspakken of Baerum kommune was obtained.

The pilots PGL, WQZ, SL, PERCHE and IBR did not require an ethical approval since the corresponding applications are not considered to be medical applications.

With respect to the Associated Pilots, contributions of ethical and legal issues have been collected through the Periodic Operation Reports (WP4). Apart from this, three Ethical Committee Approval have been asked to the corresponding authority from the pilots: SCUPS, EIC-IL and NCSR. The pilot IMA did not require an ethical committee approval since the corresponding applications are not considered to be medical applications.

As an internal check, fill the template Annex 9 provided in Deliverable 7.9 and send it to the Ethical Board for the final approval. The template included, for each application used during the pilot, information from:

a. Description, type and objective of the study
b. Medical implications of the study
c. System under study
d. Expected benefits
e. Related experiences
f. Pilot flow and phases
g. Funding and sponsors
h. Institutional affiliations
i. Conflicts of interest
j. Incentives for subjects
k. Identified risks through a risk analysis table
l. Adverse events reporting
m. Means to compensate subjects if harmed during the study
n. Security aspects
o. Data protection aspects
p. Ethical aspects
q. Template of the informed consent
r. Appendixes, including information brochures for users if available

Ethical concerns

Most pilots did not express any ethical concerns about their applications. This was to be expected, since they believe their applications to fulfil a need of the end user.

Two service providers had concerns about user privacy. From a series of interviews with elderly in the RijnmondNet pilot we learned that an important concern of the elderly is that their data falls into the wrong hands, for example their health insurance company. That is why they are hesitant to use online technologies with health related data.

But the most prominent concern of the elderly is that these technologies, and the policy rhetoric of self-management and independent living is in fact a way to cut costs. Although they understand this is the situation, they experience it as unfair, because they built the social security network, but cannot benefit from it.

Whether or not the end users in other pilots have ethical concerns, for example about changes in the relationship between caregivers and care receivers, will be reported in D5.3b because the data is collected in the deployment phase.

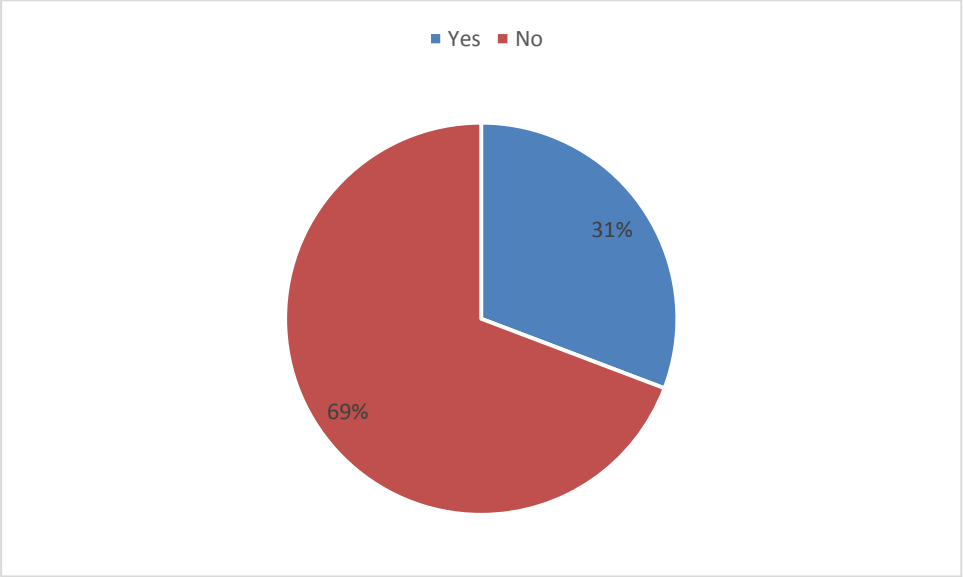
Another interesting question in this regard is the ethical aspects of interoperability. Is this only a 'good' thing for an assisted person, or is there also a downside. The integration of AAL and eHealth solutions can bring many benefits, but also increases the dependency on technology to work. In addition, people might wish to keep the medical part of their lives separate from the rest. These integrated solutions that keep track of everything, all the time, might feel more intrusive than stand alone devices that require manual input., This raises also legal questions into data protection, liability and the role of the platform in this. We did not have these discussions within ReAAL yet about these ethical concerns, but they are relevant to include as a contextual factor in the socioeconomic analysis.

4.7.3. Legal aspects

Procurement process

Will an open platform influence the procurement process? It is expected that it will, if the open platform is a new standard. During ReAAL this was not the case. universAAL was relatively unknown, and actually only one subcontracted SME had universAAL experience. Some pilots had to go through a public procurement process to select their technology providers.

Figure 34. Did service provider go through public procurement?



This took a lot of time. In general, the pilots experienced that it is not easy to find technology providers who are interested in universAAL. The fact that universAAL is the outcome of a research project, is considered a risk by SMEs. In this project they were financially compensated for their extra work, but in 'real life' this is not the case. It could be a 'breaker' in negotiations. In addition, the quality of marketing materials was in the first year not sufficient. For the pilot leaders, for example municipalities, this was difficult because they did also not know a lot about the open platform. Because of problems with engaging their local technology providers, Baerum municipality decided to contract a Spanish SME, which had universAAL experience. This SME was also contracted by BSA pilot. These differences in procurement had an effect on the set-up of the local ecosystem, and its potential to expand. To take the Baerum example again, if they want to extend their services, and not be bound to a Spanish provider anymore, they should convince their local partners to invest in universAAL. But also the other pilots face challenges in this regard. For universAAL to become the standard, service providers should put the use of this platform as a requirement in their tender.

4.8. Showcases

4.8.1. Description of showcase

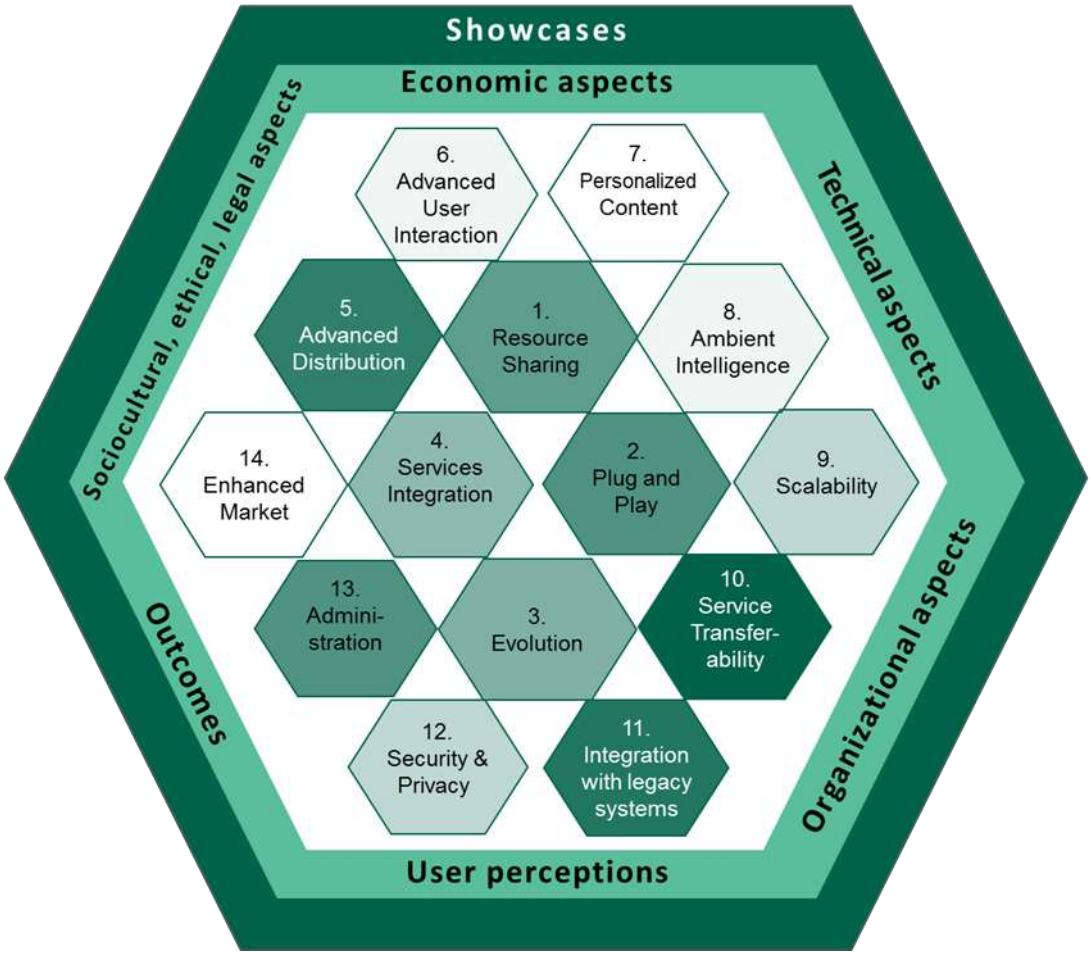
[see the Annex of D5.2]

4.8.2. Demonstration of showcase

Showcase pre-evaluation

Each Pilot has its own showcase pre-self-evaluation (see Appendices for further details). We present in *Figure 35* the Showcase coverage of the whole ReAAL project.

Figure 35. Showcase global Pre-evaluation results



Darker shades of green means that more pilots are involved and more evaluation scripts are tested. Pilots selected those showcases because they are able to demonstrate them, or because they already experience this feature of universAAL has value for them. Table 24 depicts which pilots are involed in which showcase.

Table 24. Involvement of pilots in showcases

Showcase	BSA	EIC-IL	IBR	IMA	NCSR	ODE	PERCHE	PGL	RNT	SCUPS	SL	TEA	WQZ
Resource sharing	X	X		X	X		X		X			X	X
Plug and play	X	X	X	X	X		X	X		X	X	X	X
Evolution	X	X	X	X	X	X	X	X	X	X		X	X
Service integration	X	X	X	X	X		X			X	X	X	X
Advanced distribution	X				X		X		X				
Advanced user interaction			X										
Personalized content						X							
Ambient intelligence			X					X					X
Scalability	X	X		X		X	X	X	X			X	X
Service transferability	X	X	X			X	X	X	X		X	X	
Integration with legacy systems	X	X					X	X	X	X	X	X	X
Security & privacy		X											X
Administration		X		X						X			X
Enhanced market communication and distribution value		X											

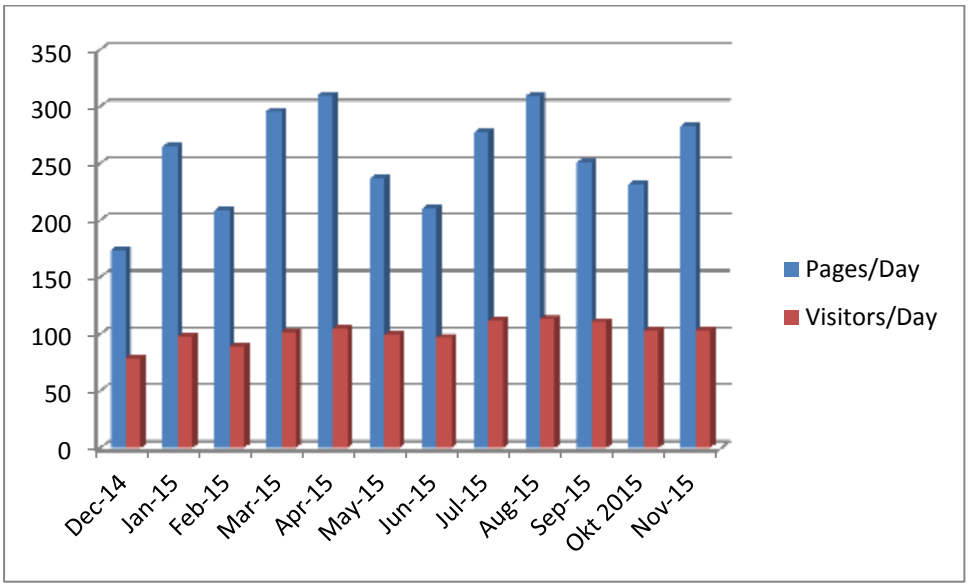
4.9. ReAAL impact indicators

4.9.1. Dissemination success

Website

The number of visitors to the ReAAL website has been stable during 2015, around one hundred unique visits per day.

Figure 36. ReAAL website visitors per day in 2015



Developer community

Figure 37. Daily active registered users in gForge, the platform developer server; categorizing users per project.

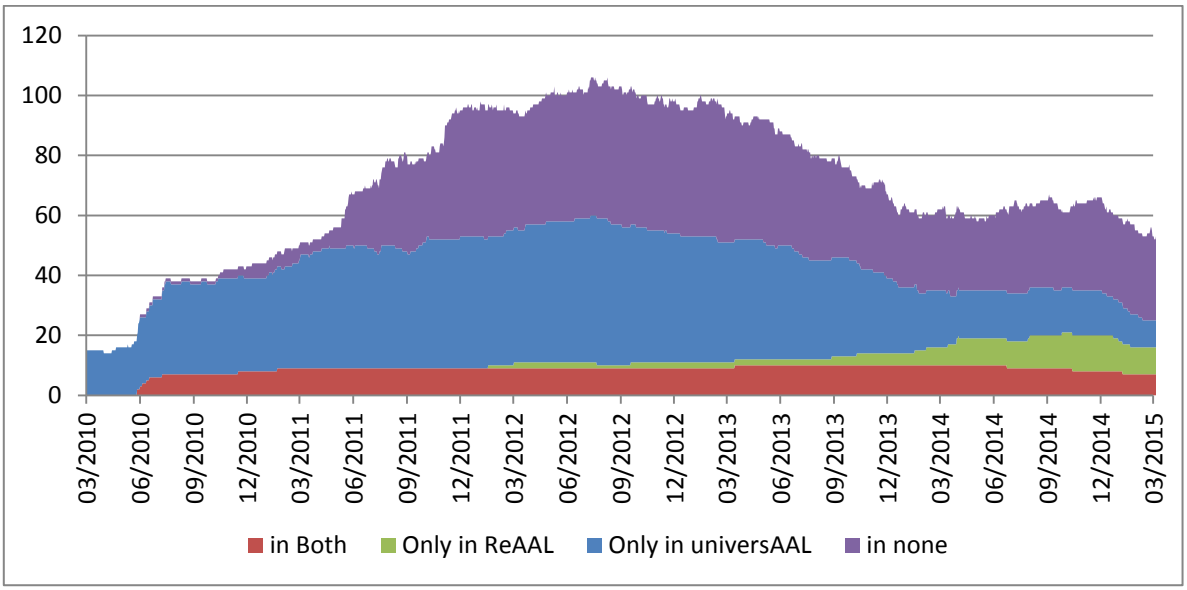


Figure 37 Shows the daily progression of the registered developer community. Users where identified as participants of ReAAL, universAAL, both ReAAL and

universAAL, and neither. A user is counted as active for every given date if its registration date is previous to the given date; and the last login date is after or equal to the given date.

The graph shows the community reached 100 developers peak during September 2012. If compared to *Figure 31*, this peak almost coincides with the most closing tracker activity ever; suggesting that the chance the platform is improved is directly related to the number of developers in the community.

The graph also shows how the number of users declines from the 09/12 peak to 60 developers around December 2013. This date coincides with the closing of the universAAL FP7 project; and the period of least activity as shown in *Figure 31*; again reinforcing the idea of the direct relation between size of the community and effort invested.

Dissemination activities

Both at pilot and project level, dissemination activities were organized, ranging from creating dissemination materials, media attention, organizing events and contributing to existing events.

Since the start of the project, ReAAL has been present at the AAL Forum with a session, workshop, training event and/or booth.

5. Analysis

This chapter provides, at this point, the very preliminary analysis deriving from the presented data, and from data that is still being analysed and not yet available in chapter 4. It is structured along the research questions.

5.1. Motivations and expectations

This section will address the first research question:

What are the reasons for the partners to join ReAAL and what are their expectations on open platforms?

The ReAAL consortium is an interesting mix of pilots, each with their own ecosystem, user group and applications. Some pilots have a technology provider in the lead, others a service provider. As a consequence, some technology providers are full partners, others are subcontracted. Their reasons, expectations and motivations might differ greatly, if you enter yourself and invest, or if you are paid for the work. Most developers admit that they just do the universAALization work because they are paid for it; the decision to use universAAL has not been taken by them, but by the organization they work for. Also for the technology providers, this project is a way to get their applications in the (European) market, which is very interesting. The knowledge of universAAL, what it was and what it could do, was not available for many of the partners who joined or who were subcontracted. Thus, it was not possible to have a clear strategy in advance. The providers who knew more about universAAL had gained this knowledge from the previous project. They were spin-offs of the research partners in universAAL.

The same holds for the service providers. Some had a clear strategy towards open source, and wanted to solve vendor lock-in, while for others being involved in an AAL project was the main reason to join. Some service providers (mainly the municipalities and BSA) have already a lot of experience in European projects in eHealth and AAL. They seem to have a better view on the need for such a platform. This is also visible in the RijnmondNet pilot, who had a different reason for being interested in universAAL: if they continue to support data exchange between patients/citizens and healthcare providers in a region, they need a standard for that.

For the project management, that was also involved in the universAAL project, this was a ‘proof of their pudding’. For Fraunhofer, this project was a chance to test their platform and some technologies they developed, ‘outside the laboratory’. They also knew better how to make optimal use of the platform.

Expectations about this project and universAAL were on a range of very high (for those who developed universAAL) to neutral (for those who did not know what universAAL could bring). However, their experiences are more important to assess.

This is an important lesson learned for the project. A communication message to explain the value of universAAL to different stakeholder audiences is needed. If this message was there from the start of ReAAL, some of the negative experiences during the past years might have been prevented.

5.2. Assessment of the universAAL platform

This section will address the second research question:

How has the universAAL platform developed through time, and what evidence is there for the quality of this platform and its potential to serve as a standard for the AAL domain?

When ReAAL started, universAAL had not finished yet, therefore there was a lot of effort from both projects to stabilize the platform (release 3.0.0) so it could be used in ReAAL. During ReAAL, several releases of the platform occurred, of which the two most important for the project were, 3.0.0 and 3.3.0, because those included the most important feature requests and bug fixes from the pilots.

The most important feature request was a solution for the partners in ReAAL to use their cloud based solutions; two components were provided to address it: the Multitenant Gateway (MTGW), and the Remote API (R-API). Although these features were also deemed relevant already in universAAL times, in fact the MTGW is based on a previous universAAL legacy component; there was no combination of platform components was able to handle the required connectivity. A vivid example is the need for R-API which is specially indicated for those cases where the universAAL middleware cannot be executed; very particularly in iOS devices. Without the R-API popular iOS devices would have not been able to connect to universAAL-based systems. Both components were first introduced for release 3.2.0 and continue to be improved to 3.3.0, when they were deemed stable enough to be used, after which only small changes have been introduced.

These developments, along many others, are interesting, because it broadens the scope of universAAL, making it interesting for more stakeholders especially in the eHealth domain. However, the downside is that there are more alternatives in the new domains, and universAAL has to compete with them.

As an example when evaluating the value of developing in universAAL over Android, compared to just developing in Android is not clear for every developer. The full benefit of universAAL is best observed in complex solutions that need service integration and interoperability. Not all pilots in ReAAL had these complex needs, and in many cases this was their first experience with AAL and semantic services. Also note that, as shown by many of our results, the potential of the open platform is only appreciated when used.

universAAL is, as a true open platform, continuously extended and improved; and it must continue to do so. In the first 1.5 year of ReAAL, the developers doing the universAALization work, found many bugs in universAAL, which have been fixed. Some developers stated that universAAL is still not mature enough. A common perception is that simpler is best, even if it does not help develop faster; and universAAL is not viewed as “simple”.

A widely shared opinion amongst the developers is that universAAL documentation has low quality: it is outdated and not easy to find. This might have directly impacted their experience in the universAALization process (see next section). So what we have seen from the results is that in order to understand the value of the platform the developers have to use it and therefore it is very important that the technical documentation guides them correctly. If it does not do that, then developers will have a hard time believing in the platform, even if they have a basic understanding of it.

However, service quality from the platform experts has been valued greatly. The developers received timely answers to their questions, and help tailored to their specific needs. In fact this support might have been the difference between being engaged by the platform and loathing it. For any open platform to sustain, a community of developers and experts who are willing to help each other is essential. Before the ReAAL project ends, decisions have to be made about the structure of this support system and the governance of universAAL.

At this point in time, the stakeholders in ReAAL are hesitant to point universAAL as the new standard. It will need more time to achieve this state. Important preconditions for this are – according to the respondents - good documentation and dissemination, and higher involvement of companies, specially known ones.

In addition, they also need to see universAAL used by many, and that there are many universAALized applications and hardware to build on.

5.3. Experiences with universAAL

This section will address the third research question:

What are the experiences of the pilots with using universAAL and which value does universAAL have for them:

- when adapting their existing applications?
- when importing an application from another pilot?
- when optimizing their application and service portfolio?

This report is limited to the adaptation phase, and can only provide a preliminary answer to the first part of this question.

Most of the developers had no previous experience with universAAL. It took quite a lot of time to get acquainted with the platform and its features. Most developers experienced a steep learning curve, which led to dissatisfaction. The fact that documentation was missing and outdated, did not help changing this experience. However, the support of the platform experts was highly valued. There were also experienced developers, but they were involved in complex applications, or they ran into complex problems at real life testing, which was challenging as well.

Overall, it can be concluded that the first investment for a technology provider to universAALize is high. This is not only visible in the universAALization costs (ranging from 17 to 60% on top of the development costs), but also in the time invested for these iterations; the universAALization phase, including all the testing, took longer than expected. Technology providers with a simple portfolio of one or two applications do not see the benefit of universAAL. For them, the return on their investment is unclear. For other technology providers, who were working on interoperable solutions in the home automation field, the value of an open platform was much more visible. For them universAAL can make things possible that were not possible before, or which were possible but only with a lot of effort. Still, they also experienced the universAAL platform as complex.

The complexity of the platform might explain why pilots, at first, made use of only a subset of components and features. They really needed expert advice to see how they could optimally benefit from universAAL. The universAALization in itself was an iterative process, and new (better) ontologies were made along the way. When universAALizing their solutions, they could only partly build on existing ontologies.

The true benefit of an open platform that speeds up the development process, is being able to reuse the work done by others. Right now, the developers in ReAAL are also contributing highly to creating this base. This is an important observation, because the best experience from universAAL comes when interoperating with existing universAAL applications, and / or hardware. For this, the community has to grow, so more universAALized applications and hardware becomes available. We assume the developers of the original ReAAL project will only experience this benefit when they start importing applications from each other.

The evaluation team needs to look deeper into the highly polarized results of the developers on the user acceptance and experienced value indicators. Although the overall picture, especially when focusing on the inexperienced developers, tends to a more negative evaluation of universAAL, there are also developers who report to be very positive.

5.4. Impact of universAAL on application and end user

This section will address the fourth research question:

What is the impact of universAAL on the application and service quality, and as a consequence on the value for the end user to support independent living?

Although the technology providers had their own methodologies and procedures in place to assure the quality of their application (for example by doing automatic tests), their applications were in different stages of maturity. This also had impact on the lab test; high impact issues arose, which were not caused by universAAL. Some of the devices had to be sent back to the pilot, but in the end, all issues could be solved. Other issues were related to the universAALization, thus the field lab testing has proven to be essential for the project to have applications that work, and to have checked that they were really universAALized.

Overall, developers agree that application quality is better, having universAALized the application. They see this quality improvement for example in the fact that the application now conforms to a standard, and that because of using ontologies the architecture is now more open. Other developers argue that for individual applications, the quality did not improve, but on the service integration level it did have positive impact. However, not all pilots have positive experiences right now, because after lab test new issues arose. These also negatively affect the quality of the services.

It is to be expected that improved application quality has an impact on the quality of the service, as experienced by the service providers and end users. For example, a service provider might experience that it is more easy to deploy and upscale the service. The data from the deployment phase and showcase evaluation, that should give more evidence on the impact of universAALization of the applications and services provided to the end user, will be analysed for the final release of this report.

5.5. The universAAL ecosystem

This section will address the fifth research question:

How has the ecosystem within and around the ReAAL project evolved, and what is needed to sustain this ecosystem around universAAL for the future?

The ReAAL project can be viewed as a bundle of ecosystems, on different levels. On the pilot level are the local stakeholders, their users, and the selected technologies. On the project level, these ecosystems interact with each other, especially in the next phase for the pilots, when they import applications from each other.

During the first half of the project, the project was mainly looking internally. The last year of the project, all pilots thought about what was needed to strengthen their ecosystem. They thought about new user groups, for example in other regions, other municipalities or service provider organizations. This expansion, which was also needed to reach the targeted user number, strengthens their ecosystem, as more stakeholders are involved. Some pilots also have meetings with policy makers in their region or country to talk about universAAL and its status after the project.

Not all pilots succeeded in strengthening the network; the Baerum pilot had to withdraw. At the same time, the pilots entering the project (Perche pilot as a replacement for Baerum and the four associated pilots) strengthened the network again.

Although there is high interest in the concept of open platforms, and the need for these developments has been discussed convincingly at places such as the AAL Forum, making it real is still a big challenge. For universAAL the next step would be to extend the community, the number of ontologies, universAALized applications and hardware. The European Commission is supporting this, by making explicit statements about the needs for using open, interoperable technologies in the new Horizon 2020 calls. universAAL is mentioned explicitly as an example.

5.6. Socioeconomic benefits of universAAL

This section will address the sixth research question:

What are the socioeconomic benefits of deploying AAL applications based on the open platform universAAL?

This is the final question of the project. Building on what we conclude from the benefit universAAL brought to the pilots (the evidence), we can provide the estimations for what it can potentially bring in any ecosystem that is interested in flexible and interoperable solutions for supporting active and assisted living.

At this point in time, the stakeholders mostly invested in universAAL; they did not reap all the benefits. The answer to this research question is in the focus of the entire consortium for the remaining months of the deployment phase.

6. Conclusions

The ReAAL consortium is an interesting mix of pilots, each with their own ecosystem, user group and applications. This has led to a dynamic project that faced many struggles along the way; some partners left, while others entered.

We see that the ReAAL project was continuously work in progress, and all technologies were under development and subject to change. There were several releases of the universAAL platform, in order to include the features needed by the pilots, and to fix bugs. While the platform was “under construction”, this was also the case for information about the platform, both in the online documentation and training. This situation had a direct effect on the work the application developers had to do, and their experience.

The first phase of the project, universAALizing existing applications can be considered a high investment for technology providers. It is expected that the return on their investment will take time, probably until after ReAAL is over. During that time, they will have to develop new services or make improvements to the existing service. Being involved in the showcase evaluation is also helpful for developers to see new benefits.

From the evaluation perspective, the ReAAL project has just begun, because now the base has been laid on which developer can build. The next steps in the project (importing applications, showcase evaluation) are crucial to have a full evaluation of the socioeconomic benefit of open platforms.

At the same time, it is essential to further build and strengthen the ecosystem; both locally, regionally, between the ReAAL pilots, and between ReAAL and other projects using universAAL.

7. Future work

One of the outcomes of the ReAAL project is to ensure the sustainability of the universAAL open platform (O3 and O8 of the DoW). A key factor for the success of this objective is to have a thriving developer community. To nourish this community with the outcomes from this deliverable will be very interesting, and relevant. For example, based on the evaluation the platform development team will work on improving the documentation.

One of the key factors we wish to research further is the polarisation on the acceptance of application developers (as shown in section 4.4.3). With these results universAAL platform community will be able to more efficiently tackle the problems that keep new developers away from the platform, while reinforcing the good practices that have convinced part of the ReAAL application developers. We will use statistical regression, Principal Component Analysis and other clustering algorithms to determine the groups and analyse what statistical variables contribute the most to this effect.

Future work will be centred on extending this report, with information gathered from deployment and operation phases; and deliver version D5.3b at the end of the project.

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