



# **PaaSage**

## **Model Based Cloud Platform Upperware**

### **Deliverable D1.7.2**

**Results of Evaluation of developers  
related to the use cases**

Version: 1.0

# D1.7.2

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## Project

Grant Agreement number	317715
Project acronym:	PaaSage
Project title:	Model Based Cloud Platform Upperware
Funding Scheme:	Integrated Project
Date of latest version of Annex I against which the assessment will be made:	8 <sup>th</sup> of July 2014

## Document

Period covered:	
Deliverable number:	D1.7.2
Deliverable title	Results of Evaluation of developers related to the use cases
Contractual Date of Delivery:	30 <sup>th</sup> of September 2016 (M48)
Actual Date of Delivery:	30 <sup>th</sup> of September 2016 (M48)
Editor (s):	Georgia Kapitsaki (UCY)
Author (s):	Georgia Kapitsaki (UCY), Achilleas Achilleos (UCY), Manos Papoutsakis (FORTH)
Reviewer (s):	Franky Vanraes (BEWAN), Christian Perez (INRIA)
Participant(s):	Eleni Constantinou (UCY), George A. Papadopoulos (UCY), Kostas Magoutis (FORTH)
Work package no.:	1
Work package title:	Technical Foundation
Work package leader:	STFC
Distribution:	R (Report) PU (Public)
Version/Revision:	1.0
Draft/Final:	Final
Total number of pages (including cover):	57

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**PaaSage is a project funded in part by the European Union.**

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## EXECUTIVE SUMMARY

This document outlines the results of the evaluation procedure of PaaSage at the end of the project execution, as well as the feedback from the training courses of PaaSage that was previously part of *Deliverable 9.4.3 Feedback on Courses*. Regarding the evaluation results the deliverable describes the evaluation procedure that follows the evaluation framework defined in *Deliverable 1.7.1*. The focus of the deliverable is on the evaluation of the PaaSage platform as captured in the PaaSage use cases. The evaluation procedure is based on an extended version of the widely-used Technology Acceptance Model and has been broken down into different levels of detail. The parts of the evaluation cover: 1) the business evaluation of PaaSage that has a higher level of abstraction, and 2) the PaaSage platform and tools evaluation. The latter has been further divided into finer levels of details for main PaaSage tools with a dedicated user interface: a) the CAMEL Textual Editor and b) the PaaSage social network.

## 1. Introduction

The current deliverable is the consolidation of the following deliverables of PaaSage:

- *D1.7.2 Results of Evaluation of developers related to the use cases*, and
- *D9.4.3 Feedback on Courses*

In that respect, the current deliverable contains in its first part information on the Evaluation procedure of PaaSage and its main steps followed with information on evaluation results and main conclusions drawn.

In the second part of the deliverable user evaluation and feedback from the PaaSage training session in the summer school in the framework of the 10th Symposium and Summer School On Service-Oriented Computing (SummerSOC 2016<sup>1</sup>) organized in Crete (Greece) is presented. This latter part serves also as an evaluation for the exposure of external individuals to the PaaSage tools and platform.

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<sup>1</sup> <http://www.summersoc.eu/>

## 2. The PaaSage Evaluation Framework

### 2.1. Target

The definition of an evaluation framework aims to provide the capability to assess the adoption and use of methodologies and tools in the current software practices of the use case partners. The evaluation framework of PaaSage was carefully created based on widely accepted models and is described in detail in *Deliverable 1.7.1* [1].

Although the above targets mainly the PaaSage use case partners, professionals outside PaaSage also participated in some parts of the evaluation framework as detailed in the remaining of the Deliverable's text. The evaluation framework of PaaSage was an iterative process where the tools (and especially their usability aspects) were assessed. In the initial stages of the evaluation the tools were accordingly modified based on the feedback.

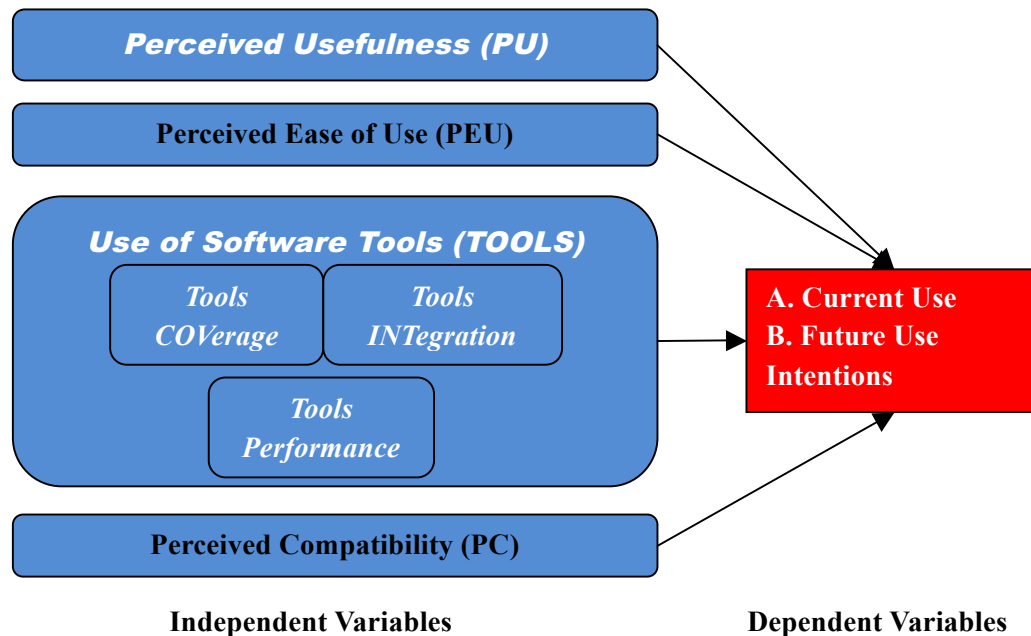
### 2.2. Extended Technology Acceptance Model and non-Functional Dimensions

A targeted review of existing research studies regarding experiences from applying Model Driven Engineering (MDE) in the industry but also from applying and evaluating MDE in research projects was performed in the framework of *Deliverable 1.7.1* [1]. Based on that survey an evaluation framework based on the widely used Technology Acceptance Model (TAM), and specifically on an extension of TAM, was defined [2][3][4].

As aforementioned the PaaSage evaluation framework defined in *Deliverable 1.7.1* [1] extends the TAM by introducing the *Use of Software Tools (TOOLS)* factor and its three corresponding sub-factors *Tool COVerage (TCOV)*, *Tool INTegration (TINT)* and *Tool MATurity (TMAT)*. The TOOLS factor is part of the COCOMO II Software Cost Estimation Model which was calibrated to include the aforementioned sub-factors that aid the evaluation of development practices that are highly dependent on software development tools [5]. The extended and adopted TAM model is illustrated in **Figure 1**. The complete list of factors and the corresponding hypotheses adopted are the following:

1. **Perceived Usefulness (PU)** – degree by which a user believes that using the PaaSage methodology and tools will enhance performance.
2. **Perceived Ease of Use (PEU)** – degree by which a person believes that using and applying the PaaSage methodology and tools will be easy.
3. **Use of Software Tools (TOOLS)** – degree to which PaaSage tools cover development activities, are highly and consistently integrated and are mature enough to address the necessary tasks.

- 3.1. **Tool COverage (TCOV)** – provides the capability to define and evaluate the coverage of activities undertaken in the software development process by the supporting tools.
- 3.2. **Tool INTegration (TINT)** – allows defining and evaluating the degree of integration of the tools used throughout the process and the effectiveness in achieving this integration.
- 3.3. **Tool MATurity (TMAT)** – allows stating and evaluating the maturity of the adopted toolset mainly on the basis of the time it is used in the market and the technical support provided.
4. **Perceived Compatibility (PC)** – degree to which the PaaSage solution is perceived as being consistent with existing values, principles, practices and the past experience of potential adopters.



**Figure 1:** The model of PaaSage evaluation: Extended TAM Model.

The evaluation framework of PaaSage in *Deliverable 1.7.1* defined additionally the evaluation on the basis of the following non-functional dimensions that were employed in a complementary analysis performed on the evaluation results as detailed in the remaining of the text:

1. **Dimension A:** Effectiveness – Usefulness of the service/component to the business.
2. **Dimension B:** Efficiency – Performance of the service/component.

3. **Dimension C:** Understandability/simplicity of the service/component.
4. **Dimension D:** Satisfaction & Attractiveness of the service/component.
5. **Dimension E:** Learnability, memorability of the service/component.
6. **Dimension F:** Use preparation & maintenance of the service/component.

### 3. The Evaluation Process

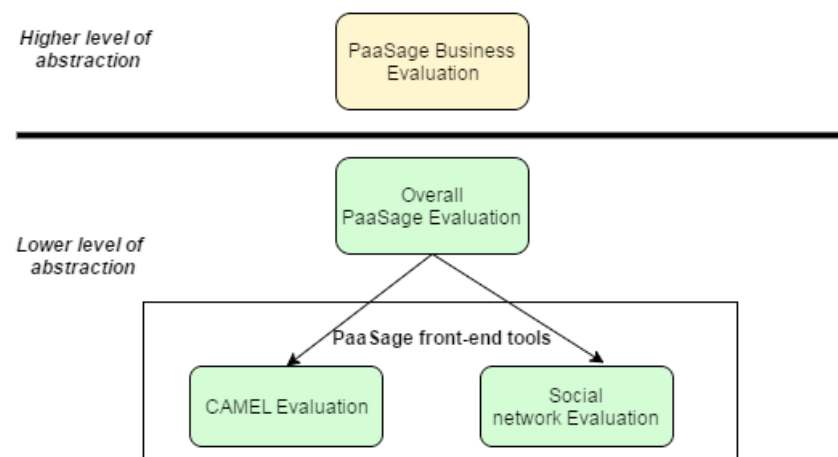
#### 3.1. Main Phases

In order to receive information from different stakeholders the evaluation process was separated into two phases with different level of detail as depicted in **Figure 2**. The higher level of abstraction is captured in the *Business Evaluation* of PaaSage from different professionals. Although the *Overall PaaSage Evaluation* was the main evaluation performed on a more detailed level, it was decided to focus additionally on PaaSage tools that have a dedicated user interface and receive feedback on users' experience with these specific tools:

- CAMEL Textual Editor
- PaaSage Social network

Due to its nature the Extended TAM Model was used in the *Overall PaaSage Evaluation*. It was not feasible to employ it in the *Business Evaluation*, since participants in this kind of evaluation were only provided with an overview of PaaSage without having the possibility to evaluate the specific tools from a developer's perspective. Moreover, the non-functional dimensions were used in the *Overall PaaSage Evaluation*, but were also employed in the framework of *CAMEL Evaluation*.

Each evaluation phase is described in detailed in the remaining text.



**Figure 2:** *PaaSage evaluation levels of detail.*

#### 3.2. PaaSage Business Evaluation

The required feedback from the partners and external participants (e.g., business stakeholders) was received via the use of Google forms and relevant questionnaires, whereas questionnaires were also handed out on paper in some cases. The requests for survey participation were either sent via email or were presented during organised

workshops that targeted business users. The questionnaire is available online<sup>2</sup>, whereas the questions used in the questionnaire are also presented in **Appendix 1**. The following workshops were used for the data collection for the *Business Evaluation*:

<b>5th ICT Summit and Exhibition – March 6<sup>th</sup>, 2015</b>	
Venue	Hilton Park, Nicosia, Cyprus
Attendees profile	Business owners, CEOs, CIOs, CTOs, CFOs,
This was a one-day event and was organised by IMH (seminars organisers). It was both summit and exhibition in relation with the following issues: Networking systems and communications, Internet and broadband services, Network and information security solutions, Telecommunication and networking solutions, Information technology (IT), Storage/Virtualisation solutions, Accounting and financial software, Cloud computing and other areas.	
<b>Tech Connect<sup>3</sup> – Cyprus 2015 – March 17-19, 2015</b>	
Venue	Filoxenia Conference Center, Nicosia, Cyprus
Attendees profile	Business owners, CEOs, CIOs, CTOs, CFOs, IT staff
This was a three day event organised by Computrain (a leader in Microsoft training) and sponsored by Microsoft. The benefits for PaaSage with the IBSAC silver sponsorship for the event were the following: <ul style="list-style-type: none"> <li>• A large booth was provided in order to have a section that was used to provide information regarding PaaSage (leaflets, marketing material, etc.).</li> <li>• A projector was provided for presentation in the booth demonstrating the features of PaaSage for interested attendees.</li> <li>• Two one hour slots (Tuesday 17/03/15 and Wednesday 19/03/2015) for presentation about PaaSage. A demo video of the Scalarm use case was also presented and explained.</li> </ul>	
<b>LLN workshop – September 15<sup>th</sup>, 2015</b>	

<sup>2</sup> <https://goo.gl/forms/KUgQ3ChFRdfvL5Sv2>

<sup>3</sup> <http://www.techconnect.com.cy/>

Venue	Louvain-la-Neuve, Belgium
Attendees profile	15 attendees, CIOs, CTOs, Application Architects
The event was an industrial workshop organized by be.wan and CETIC, in the afternoon of September, 15 <sup>th</sup> , dedicated to the presentation of the objectives of PaaSage.	
<b>From Cloud to Road<sup>4</sup></b> : -- April 11 <sup>th</sup> , 2016	
Venue	University of Stuttgart, Stuttgart, Germany
Attendees profile	Collaborators and partners of ASCS
The event “From Cloud to Road” was an industrial workshop planned by ASCS for the afternoon of 11/04, on the first day of a PaaSage meeting, dedicated to the presentation of the objectives of PaaSage. A future perspective and state-of-the art overview of CAE simulation tools and environments that are compatible with the use of Cloud-Computing and HPC were presented and discussed.	

Note that in addition to the workshops mentioned above, a distribution to different participants was performed using participants from other projects (e.g., CELAR project) and partners’ collaborators (e.g., IBSAC collaborators).

### 3.3. Overall PaaSage Evaluation

The *Overall PaaSage Evaluation* covers the whole toolset of PaaSage using the factors of the Extended TAM Model. Suitable research questions were defined in regard to the needs of adoption of the PaaSage toolset and methodology. The whole set of research questions is listed in **Appendix II** with its different sections, whereas the questionnaire is also available online<sup>5</sup>. These sections cover different aspects of the Extended TAM Model with each section being dedicated to more than one aspect with the following mapping:

- Part 2 - General PaaSage that covers: TCOV, TP, PU of the Extended TAM Model
- Part 3 - Learning PaaSage that covers: TINT, PEU of the Extended TAM Model

<sup>4</sup> <https://www.asc-s.de/en/workshops>

<sup>5</sup> <https://goo.gl/forms/gBEIUeIUwftgNyY42>



- Part 4 - PaaSage platform that covers: TCOV, TP, PEU, PU of the Extended TAM Model
- Part 5 - PaaSage adoption that covers: TINT, PC, PU of the Extended TAM Model

Part 1 covers demographic issues. In all parts of the evaluation participants were given the opportunity to make suggestions for improvements. In relevance to the six non-functional dimensions, a large number of the specified questions captures the dimensions with the following mapping:

1. **Dimension A:** Effectiveness – Usefulness. Basic related questions:

- Based on your understanding, what is the level of quality offered through the various artefacts of PaaSage, including models, code, and respective documentation?
- How well do the modelling tools provided by PaaSage support the user specification during the design activity of the cloud-based application lifecycle?
- How well do the MDE transformation tools provided by PaaSage support the related generation activities?
- How well does the PaaSage toolset support the developer's tasks (e.g., deployment, monitoring)?
- How beneficial is PaaSage for your organisation/network?

2. **Dimension B:** Efficiency – Performance. Basic related questions:

- In which degree is the development effort (design, coding, testing) reduced in comparison to using a non-MDE approach?
- How accurate do you think the decision process of PaaSage for (re)deployment is?

3. **Dimension C:** Understandability/simplicity. Basic related questions:

- Are the different types of models easy to comprehend?
- How easy is it to move from one module to another in the main flow of PaaSage?

4. **Dimension D:** Satisfaction & Attractiveness. Basic related questions:

- In which degree does the solution of PaaSage improve the quality of design by identifying/pinpointing to the modeller poor design or design errors?

- How well do the modelling tools provided by PaaSage support the user specification during the design activity of the cloud-based application lifecycle?

5. **Dimension E:** Learnability, memorability. Basic related questions:

- How adequate is the training material (e.g., documentation) for learning the PaaSage methodology?
- How easy was it to achieve an adequate proficiency level using the PaaSage methodology?

6. **Dimension F:** Use preparation & maintenance. Basic related questions:

- How easy would it be to extend the PaaSage toolset for realising additional capabilities?
- How easy is it to configure/adapt the solution of the PaaSage methodology?
- How easy is it to integrate the PaaSage toolset with other available tools?
- How easy is it to integrate the PaaSage methodology with other development practices?

Note that some questions may be partially relevant to additional dimensions, but for the purpose of further analysis the main dimension each question can be mapped to is used.

### 3.4. Usability Evaluation of PaaSage Tools with User Interfaces

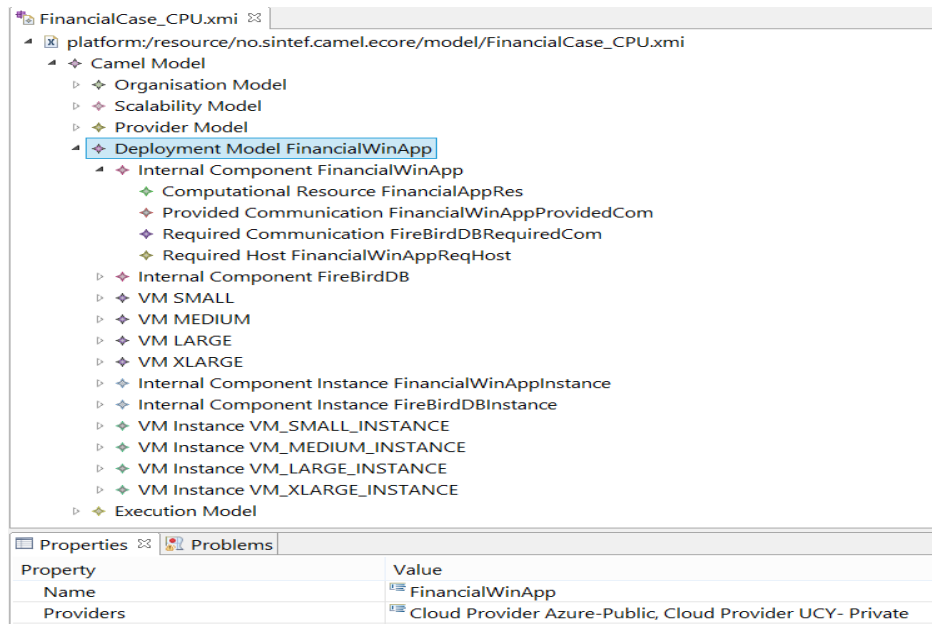
The usability assessment was performed for the two PaaSage components with graphical user interfaces, i.e., the CAMEL Editor and the social network of PaaSage.

#### 3.4.1. Preliminary Assessment of CAMEL Editor

##### 3.4.1.1. CAMEL Editor: Tree-Based Solution

The first solution of the CAMEL editor implementation was a tree-based solution, as an Eclipse Integrated Development Environment (IDE) plugin. According to the tree-based solution, the user would define the models in a node-based approach as depicted in **Figure 3**.

The tree-based solution was used by the partners of the consortium to examine its appropriateness as the CAMEL Editor solution. The tree-based solution provides several benefits to the user. Initially, the tree-based solution provides a hierarchical representation of structured data. Thus, a hierarchical representation of the defined CAMEL models provides an advantage for the visualization of the models and a structured overview which is easy to inspect. Secondly, the tree-based visualization positively contributes to comprehensibility, since it facilitates the models' inspection and therefore comprehension. Finally, the tree-based solution entails minimal cost in its implementation.



**Figure 3:** Tree-based solution of CAMEL editor.

Despite the advantages of the tree-based solution, the PaaSage members elaborated on several drawbacks of a tree-based solution through an internal discussion. Firstly, the tree-based solution does not positively contribute to the usability of the CAMEL Editor. This approach does not facilitate the CAMEL model specification to become a self-explanatory procedure. Secondly, users' evaluation disclosed efficiency issues with this approach. More specifically, the manual effort required for the model specification becomes excessive and therefore the required effort for each model specification can become prohibitive. Finally, users (application designers, business users, system administrators) were not familiar with the tree-based solution and thus considered that this approach negatively affects the process efficiency.

Overall, the tree-based solution has inherent advantages, e.g., visualization and inspection. However, the creation process is the main focus of the CAMEL Editor in the PaaSage workflow and therefore, the challenges that arose from a tree-based solution lead the consortium to consider alternative solutions (graphical-based and text-based) prior to finalizing the CAMEL Editor solution. In general, the consortium did not obtain a positive impression about the tree-based solution for the CAMEL Editor implementation.

#### 3.4.1.2. CAMEL Editor: Graphical-Based Solution

The consortium considered an alternative solution, a graphical-based approach for the CAMEL model specification task. This solution is based on the Modelio tool [6] that was developed for the EU funded project MODAClouds [7]. Modelio is a solution for developers, system architects and business architects to specify the CloudML DSL. Modelio was built on the Eclipse RCP framework with enhanced ergonomics. This solution was tested and evaluated in the context of PaaSage by two use case partners of the project, i.e. University of Cyprus (UCY) and Lufthansa Systems AG (LSY), in order to investigate the appropriateness of this solution within the PaaSage approach.

The expected benefits of using and extending Modelio as the Model Editor solution were inherent of the graphical representation. The graphical user interface was expected to reduce the required effort for the model creation. Additionally, a graphical representation for the CAMEL models increased the comprehensibility. However, the evaluation of the two partners revealed that this approach presents several drawbacks. Initially, the DSL coverage of the Modelio tool is limited for the purposes of the PaaSage process since it supports the CloudML DSL. However, the remaining DSLs need to be supported by the CAMEL Editor. Thus, substantial effort is required for extending Modelio to meet the PaaSage objectives. Additionally, this task is not included or funded in the PaaSage project according to the Description of Work. Secondly, both use case partners agreed that following the graphical-based approach does not provide any added value to the overall PaaSage benefits, since it is not research challenging. Next, the tests performed by the use case partners revealed several usability issues concerning Modelio. More specifically, the users' experiences indicated that it was not clear where to start for the model creation and that they experienced difficulties in the Modelio process for the model definition. Moreover, testing Modelio for the purposes of the CAMEL Editor proved challenging concerning the setup and the model creation process. More specifically, the users reported that they faced difficulties in acquiring the necessary supportive material about Modelio's usage. Finally, the use and extension of Modelio can prove challenging long-term, since the evolution of the features of the CAMEL editor will entail excessive effort for their implementation within Modelio.

The graphical-based approach with Modelio provides several benefits, like stability, graphical representation. However, due to the aforementioned drawbacks of this approach the consortium did not consider the graphical-based approach as the optimal solution for the CAMEL Editor implementation.

#### **3.4.1.3. CAMEL Editor: Text-based Solution**

Finally, the third solution was the text-based editor in the Eclipse IDE that was also adopted as the best solution. This solution was expected to provide additional benefits to the main target group of the CAMEL Editor, i.e., application designers, business users.

The benefits of a text-based editor were mainly derived by the IDE advantages during development. Initially, the main target group of the CAMEL Editor is expected to be familiar with IDEs. The text-based approach is an abstract form of an IDE environment and therefore, the tool is more easily understandable, reducing the learning curve. Next, the features provided by IDEs are beneficial for the CAMEL Editor's users. The features provided by this solution include auto-completion and syntax checking. In the first case, the CAMEL text-based editor has the ability to suggest a list of available configuration parameters for each model and thus facilitates the users' efficiency to complete the model definition. In the latter case, the CAMEL text-based editor highlights typographic errors and suggest alternatives and therefore positively contributes to reducing the effort needed for the model creation. Finally, the

text-based approach can be easily evolved and support the evolution of the features of the CAMEL editor.

Overall, the consortium considered that the text-based solution for the CAMEL editor implementation was the most appropriate solution in terms of usability.

#### **3.4.2. CAMEL Textual Editor Evaluation**

The CAMEL Textual Editor, which was the solution adopted in PaaSage, was exposed to different professionals in the framework of PaaSage use cases. The aim was to understand how CAMEL would be perceived for different needs and assess main features, such as usability and usefulness. Based on the above, the following procedure was used:

- The defined use cases were requested to be implemented in CAMEL Textual Editor.
- The use case participants were given a period of time to work with the different versions of CAMEL Textual Editor and explore its functionalities based on their specific needs requesting for clarifications when needed and providing feedback during this period.
- The participants of the evaluation were asked to evaluate the use of the final version of CAMEL Textual Editor based on different dimensions.
- The responses of the participants were analysed.

The evaluation procedure was carefully designed to adhere to techniques widely used in similar frameworks. It was based as aforementioned on TAM. The questionnaire employed for the evaluation is available online<sup>6</sup>. It focuses on the assessment of the following parts that correspond to the main functionality provided by CAMEL:

- CAMEL Textual Editor usability
- CAMEL Documentation
- CAMEL Deployment model
- CAMEL Requirement model
- CAMEL Metric model
- CAMEL Scalability model
- CAMEL Organisation model

Note that the first two sections refer to the evaluation of PEU of TAM, whereas the remaining are relevant to the PU of the main parts of CAMEL. Regarding PEU we performed a further mapping of the non-functional dimensions employed in the evaluation of PaaSage and main research questions from the CAMEL Textual Editor Evaluation. However, it was not feasible to evaluate dimension B (Efficiency –

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<sup>6</sup> <https://goo.gl/forms/Fwr3Lc33SGqTJj832>

Performance of the service), since its performance cannot be evaluated by its users. Therefore, the mapping is restricted to the following five dimensions:

1. **Dimension A:** Effectiveness – Usefulness. Basic related questions:
  - In which degree does the CAMEL Textual Editor fulfil your requirements and needs?
2. **Dimension C:** Understandability/simplicity. Basic related questions:
  - How do you rate the user-friendliness of the CAMEL Textual Editor?
  - How do you rate the effort required for the model creation in the CAMEL Textual Editor?
3. **Dimension D:** Satisfaction & Attractiveness. Basic related questions:
  - How do you rate the expressiveness of the textual syntax of CAMEL?
  - How do you rate the usefulness of the Textual Editor's features (e.g., input completion, syntax highlighting, error reporting)?
4. **Dimension E:** Learnability, memorability. Basic related questions:
  - How do you rate the easiness of learning how to use the CAMEL Textual Editor?
5. **Dimension F:** Use preparation & maintenance. Basic related questions:
  - How do you rate the installation and execution of the CAMEL Textual Editor?

### 3.4.3. PaaSage Social Network Evaluation

One of the main tools of PaaSage is its social network. A dedicated evaluation for the Social Network of PaaSage has also been performed. The evaluation has focused on the development of the social network and its evolution and has been performed in the framework of the development of the social network.

The following phases were used for the evaluation:

- Preliminary evaluation of mock-ups
- Evaluation of interactive prototype through free exploration (with the participation of 12 users)
- Evaluation of prototypes through scenarios and interviews

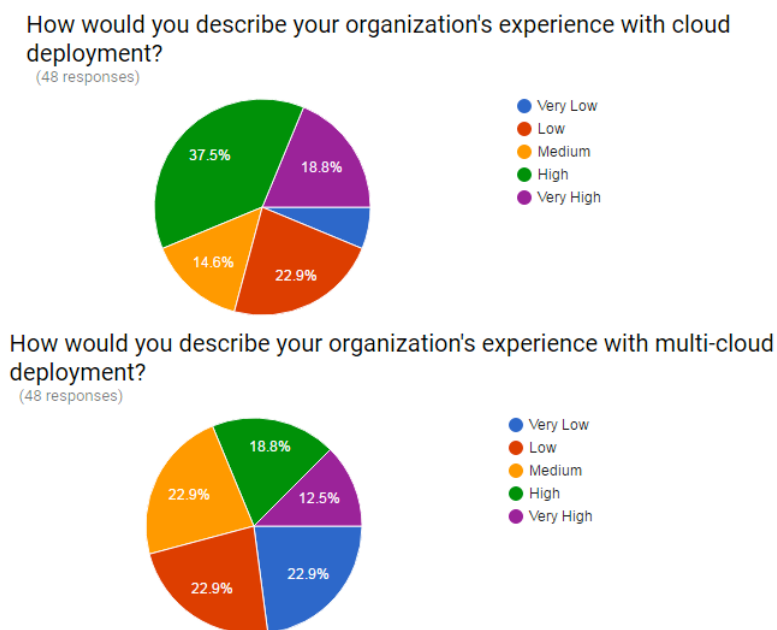
The detailed description of the evaluation and its results are captured in *Deliverable D4.1.2 (Product Database and Social Network System)* [8] and are for this reason not further detailed here. Note however, that the feedback on the training sessions that concerns the social network of PaaSage are described in Section 5 of the current Deliverable. More information on the evaluation can be found in relevant publication [9].

## 4. Results and Discussion

The results of all types of evaluation were analysed utilizing also the tools provided by Google forms and spreadsheet analysis. Due to the small amounts of collected answers, this process was preferred to other solutions that provide statistical analysis, such as SPSS and Minitab. The preliminary results of the *Business Evaluation* of PaaSage can be found in a relevant publication [10].

### 4.1. Business Evaluation Results

A total of 48 professionals evaluated PaaSage from a business perspective. In respect to demographics 85.4% male and 14.6% female professionals participated in the evaluations during organized workshops. Many of the participants are employed as software engineers (29.2%) and project managers (14.6%), whereas many indicated that they have different roles (58.3%). Most participants come from environments experienced in cloud deployment (18.8% are very experienced), whereas some also have experience on multi-cloud deployment (12.5%) as depicted in **Figure 4**.

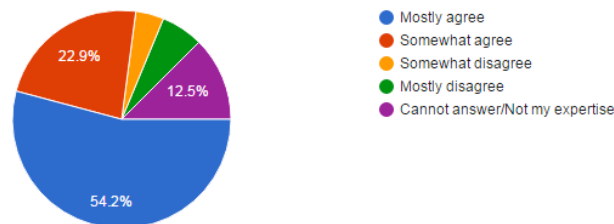


**Figure 4:** PaaSage Business Evaluation Participants experience on cloud and multi-cloud environments.

Although not all participants provided information for the name of the organisation they are employed at, some of the organisations that have answered our evaluation include: MTN business, Supernova Consulting Ltd, Microsoft, Windsor brokers, Eltoma, Andreas Sofocleous group of companies, UCLAN Cyprus, NEK, Infoscreen Ltd, Zeus fund, Logicom Public Ltd, Primetel, Bdigital Media Ltd, Brainsys, Guardis, Innovity, Sylem sprl, CAS Software AG, AXIS Progressive Development, Rigmora, Falquz Pantle & Pritz GbR, Adam Opel AG and Spicetech GmbH.

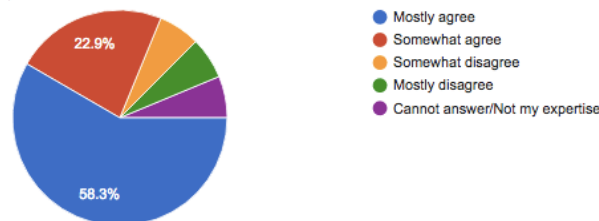
Most participants value the benefits offered by PaaSage for selecting among different cloud providers, as PaaSage allows the deployment of applications in different providers. 54.2% of the participants are very satisfied with the aspect, whereas 4.2% somewhat disagree and 6.3% mostly disagree with the statement as shown in **Figure 5**. Similar opinions were expressed by participants for the possibility of automatic deployment of applications on different cloud providers (**Figure 6**).

I think that my organization will benefit from having the capability to select from different cloud providers.  
(48 responses)



**Figure 5:** PaaSage Business Evaluation Participants view on benefits from different cloud providers.

I think that my organization would benefit from being able to automatically deploy its applications on different cloud platforms.  
(48 responses)



**Figure 6:** PaaSage Business Evaluation Participants view for automatic deployments on different cloud providers.

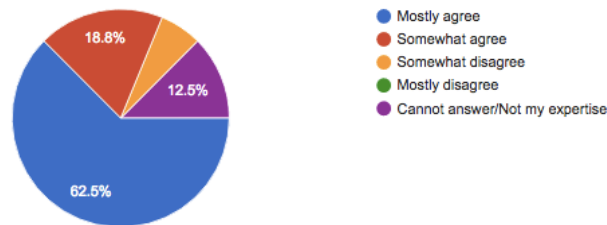
Taking into account the characteristics of available cloud platforms (e.g., costs), the data to be used and the end-user preferences or restrictions (e.g., price, location, availability, privacy, etc.) are important for many businesses for producing an optimal deployment solution. 50% of the participants indicated that they mostly agree, 37.5% that they somewhat agree, and the remaining either strongly or somewhat disagree or cannot answer (4.2% for all cases). Note that indeed there were some cases, where the participants were not able to provide an adequate answer based on their experience and expertise. Nevertheless, these cases were few and for this reason it is regarded that they cannot affect our results negatively, in terms of whether the conclusions drawn from the business evaluation of PaaSage are accurate.

Being able to modify an existing cloud deployment and move to another cloud provider is also an aspect that is considered beneficial by many professionals. The reason for this is that business requirements, financial capabilities but also cloud provider costs can change rapidly. 41.7% of the participants mostly agree with this aspect of modification, whereas 39.6% mostly agree, some disagree strongly or somewhat disagree (6.3% and 4.2% respectively), whereas some participants were not able to answer based on their experience (8.3%). Costs play a special role in cloud



deployments. This opportunity for cost reduction is valued by most participants (62.5%), whereas only 6.3% somewhat disagree with this as shown in **Figure 7**.

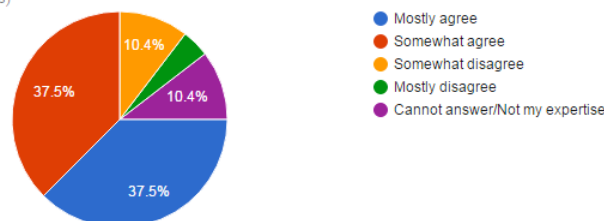
I think my organization would benefit from reducing the resource usage costs in cloud executions.  
(48 responses)



**Figure 7:** PaaSage Business Evaluation Participants view for cost reduction benefits in cloud executions.

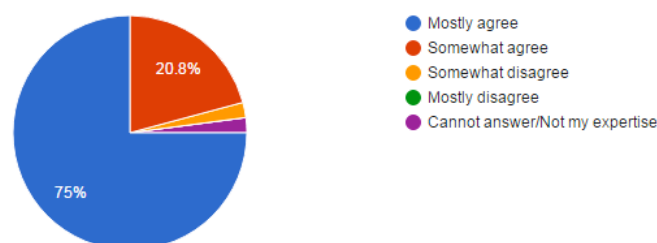
One of the advantages of PaaSage includes the use of multiple cloud infrastructures. However, not as many participants as expected view benefits in this: 37.5% agree strongly with this benefit, whereas 37.5% agree only somewhat. A small number of participants also disagree (4.2% that corresponds to only 2 participants) as shown in **Figure 8**. On the other hand, the simplification of the management of cloud services is an important advantage for most participants as depicted in **Figure 9**, where 75% of the participants strongly agree and only 1 participant (2.1%) having a different opinion.

I think that my organization would benefit from exploiting multiple cloud infrastructures.  
(48 responses)



**Figure 8:** PaaSage Business Evaluation Participants view for exploiting multiple cloud infrastructures.

I think that simplifying the management of cloud services is useful.  
(48 responses)

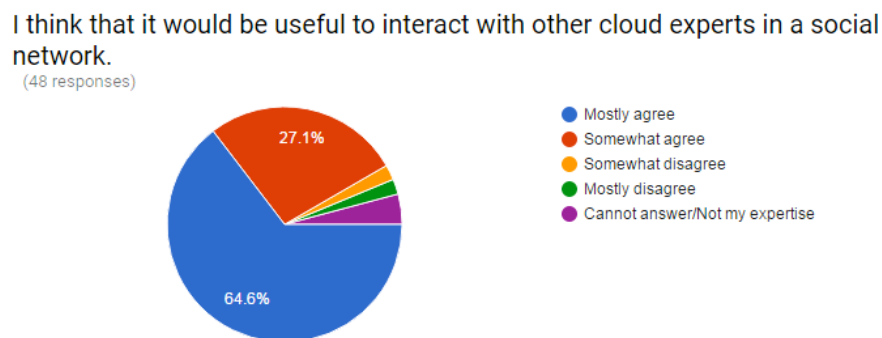


**Figure 9:** PaaSage Business Evaluation Participants view for the simplification of the management of cloud services.

Regarding the re-deployment possibilities offered by PaaSage many participants view benefits if cloud-based applications are able to self-adapt to changes in environment and requirements: 56.3% of the business professional mostly agree and 35.4%

somewhat agree, whereas some share a different opinion with 6.3% slightly disagreeing. Note that one participant was not able to answer this question. Participants expressed the same view for the possibility to use experts' previous knowledge to re-adapt cloud solutions. This aspect is also valued by most participants (the results are exactly the same in term of percentages as with the issue of self-adaptation).

Finally, professionals were asked about the presence of a social network and whether they would see benefits in its use. Most strongly agree (64.6%), 27.1% somewhat agree, whereas only two participants indicated that they either strongly or somewhat disagree (with 2.1% of the participants disagreeing strongly and 2.1% slightly disagreeing) as shown in **Figure 10**.



**Figure 10:** PaaSage Business Evaluation Participants view for the social network offering.

Based on the above the main conclusions drawn from the business evaluation of PaaSage are the following:

- A high number of participants values the ability to deploy applications in different cloud environments.
- A high number of participants values the definition of end-user preferences or restrictions (e.g., price, location, availability, privacy, etc.).
- The reduction in resource usage costs is valued by many participants.
- A high number of participants values the possibility to simplify the management of cloud services.
- Most participants value the social aspects of PaaSage. Many participants like the idea of the social network and the use of experts' previous knowledge.
- The use of multiple cloud infrastructure is an issue that not so many participants find very useful.

#### 4.2. Overall PaaSage Evaluation Results

The Overall PaaSage evaluation of CAMEL Textual Editor was performed with the participation of 20 individuals in the framework of PaaSage use cases. Participants were 85% male and 15% female with most being between the age of 30 and 40 (60%). Most participants have knowledge of PaaSage (85% of the participants are aware of PaaSage objectives), whereas a small proportion of the participants reached

have a low level of acquaintance with PaaSage (10% that corresponds to 2 participants). Regarding MDE only a few participants are experienced with 25% of participants having a high or very high level of acquaintance, most (60%) having a medium level and some (15%) having a low or very low level of acquaintance.

Regarding their professional position, most participants are experienced software engineers (50%), some are employed in operations (20%) and a few are working as system administrators (10%) as depicted in **Figure 11**. Participants were also asked about their development and database skills, where most are quite experienced, whereas 50% have more than 10 years of experience in ICT and 35% 2-5 years of experience.



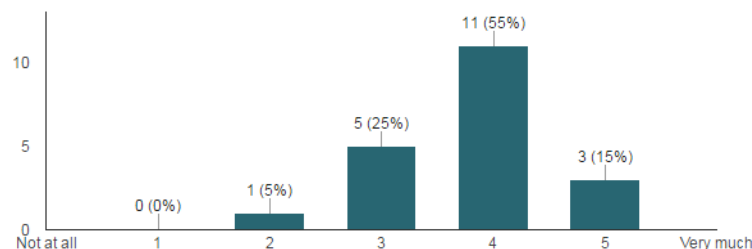
**Figure 11:** PaaSage overall evaluation participants' professional expertise.

#### 4.2.1. General View of PaaSage

Participants were initially asked some generic questions about PaaSage. One of the main important aspects of PaaSage is the adoption of an MDE approach that is considered to improve the traditional development and deployment process. This aspect is valued by most participants, as 15% believe that the effort reduction is very high and 55% believe that it is high. There is a small number however, that believes that the reduction is limited (15% of participants) as shown in **Figure 12(a)**. Multi-cloud deployment is another asset of PaaSage that is valued by most participants with 55% of the participants indicating that the PaaSage platform is very suitable for addressing this issue (**Figure 12(b)**).

3. In which degree is the development effort (design, coding, testing) reduced in comparison to using a non-MDE approach?

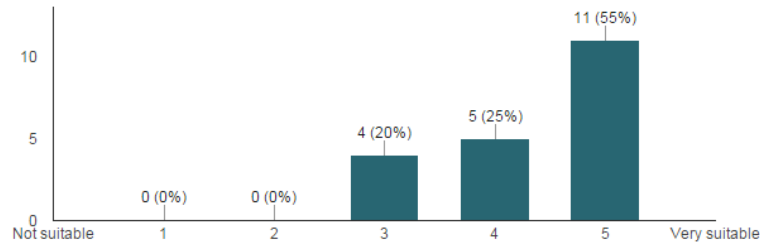
(20 responses)



(a)

4. How suitable is the PaaSage solution for solving the problem of multi-cloud deployment?

(20 responses)



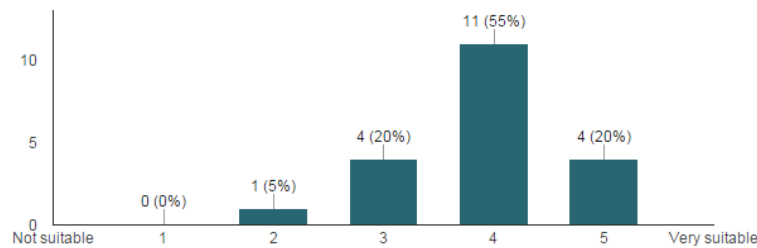
(b)

**Figure 12:** PaaSage overall evaluation participants' view on (a) effort reduction, and (b) multi-cloud deployment.

Other aspects of cloud applications can be found in adaptive provisioning and cloud bursting. Many participants find this support in the PaaSage platform with 55% and 45% of the participants indicating that PaaSage is suitable for the above aspects respectively (**Figure 13**).

5. How suitable is the PaaSage solution for solving the problem of adaptive provisioning?

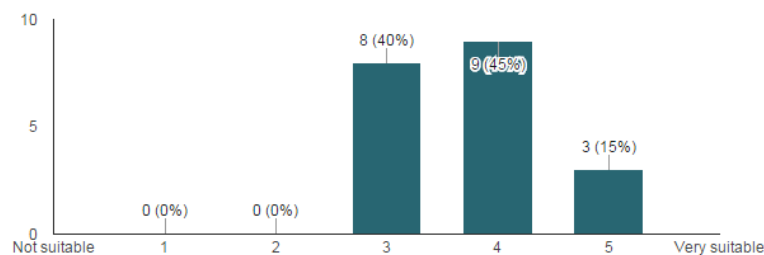
(20 responses)



(a)

6. How suitable is the PaaSage solution for supporting cloud bursting?

(20 responses)

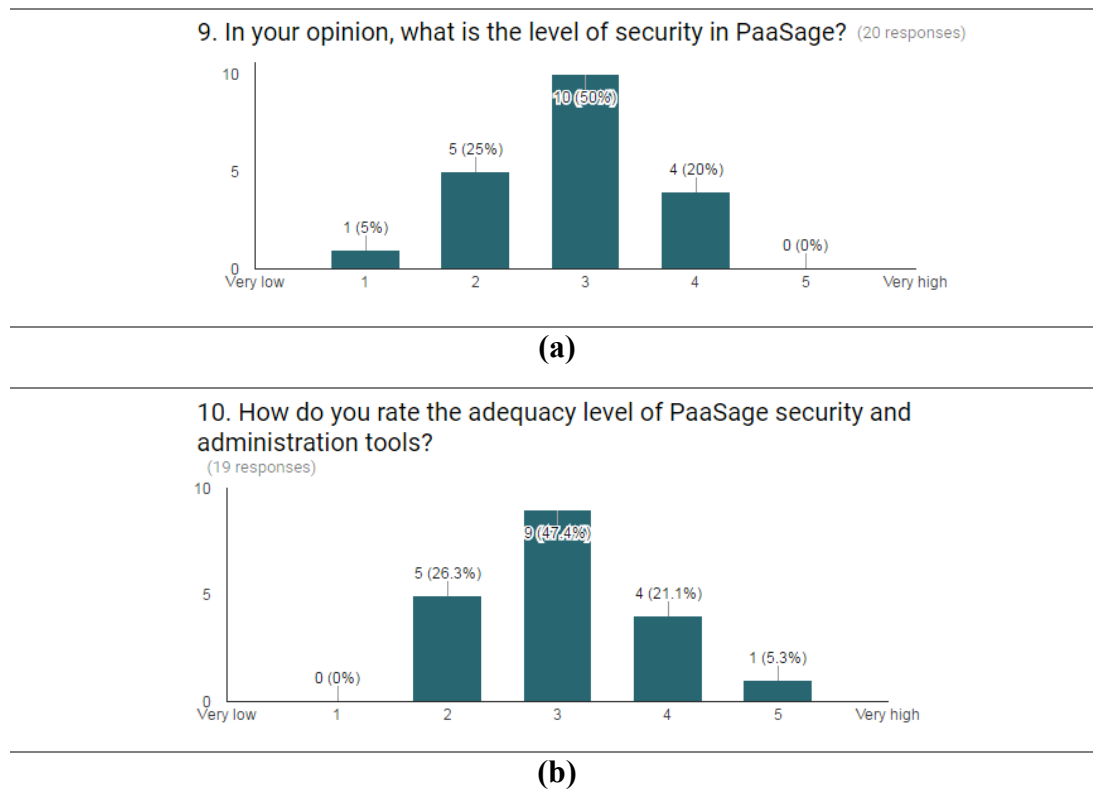


(b)

**Figure 13:** PaaSage overall evaluation participants' view on (a) adaptive provisioning and (b) cloud bursting.

The issue of security is very important on cloud. It is partially covered in PaaSage as indicated by the participants of the evaluation procedure. Most find the support of PaaSage for security on a medium level (50%), whereas many express doubts (30%) as indicated in **Figure 14(a)**. As expected from this feedback, users find the respective tools provided by PaaSage regarding security and administration issues limited with

47.4% stating that the provided tools are neither adequate nor inadequate (**Figure 14(b)**).



**Figure 14:** PaaSage overall evaluation participants' view on (a) security and (b) respective tools.

Some users have also indicated that their organisation has some requirements not covered by PaaSage: migration of components and elasticity. Future versions of PaaSage could also consider the following features that were further suggested:

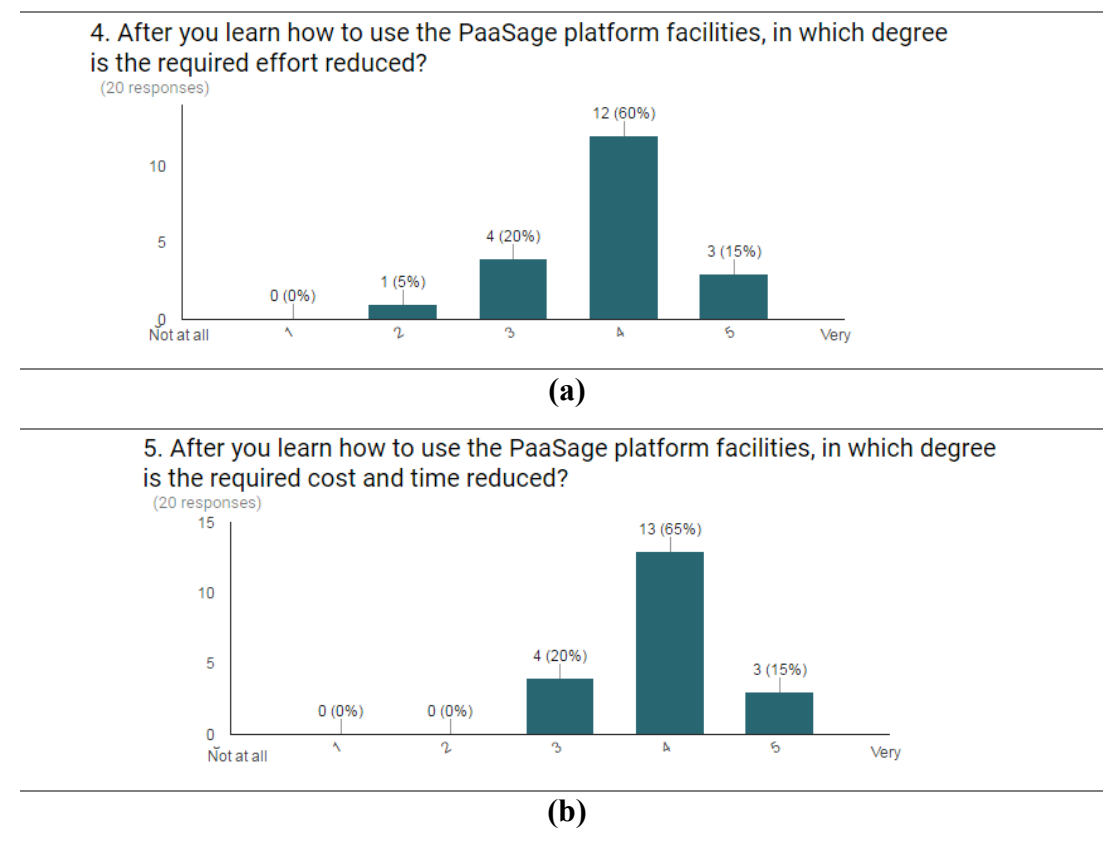
- a repository of versioned components outside the social network,
- graphical monitoring of deployed components, re-deployment and full life cycle management,
- less steps to deploy applications,
- automatic notification system about the current state of deployment,
- more elaborated error messages,
- support of other cloud providers, such as IBM Softlayer,
- improvement of end-user interfaces.

#### 4.2.2. Learning PaaSage

Most participants are happy with the material offered for learning PaaSage. The training material (e.g., documentation) for learning the PaaSage methodology is very adequate for 25% of the participants, adequate for 40%, somewhat adequate for 20% and not very adequate for the remaining 15%. Learning to use PaaSage requires effort

according to participants. Achieving an adequate proficiency level is easy for 40% of the participants, but the majority finds the procedure neither difficult nor easy (45%). Also a small number finds the process difficult (15%). Comprehending the different types of models requires also some effort, since 70% of the participants indicate that there is a degree of effort required and only one participant, i.e., 5% finding the procedure very easy.

Although PaaSage methodology and tools require some effort for novice users, once they learn how to use them, they have benefits in the reduction of required effort and in the reduction of required cost and time (**Figure 15**). When learning PaaSage the level of technical support provided by the PaaSage community (e.g., experts, social network) is high according to the participants with 10.5% rating it very high, 63.2% rating it high, 15.8% rating it medium, and 5.3% respectively rating it low or very low.

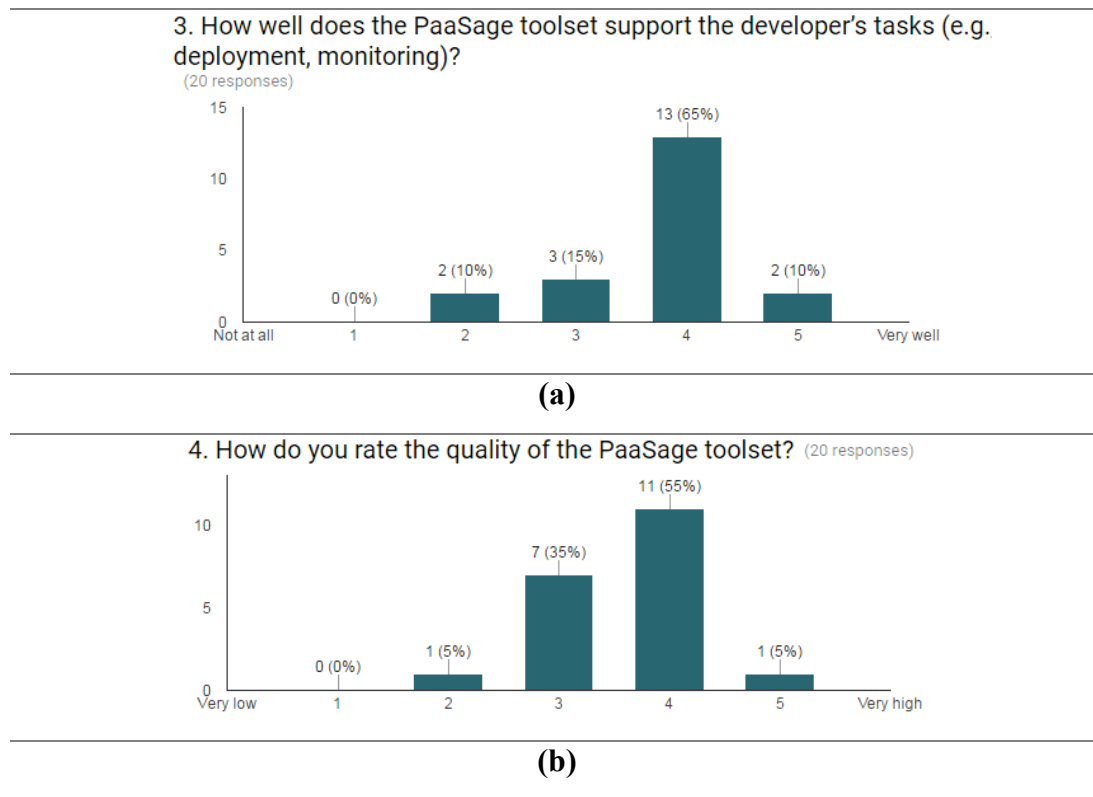


**Figure 15:** PaaSage overall evaluation participants' view on reduction of (a) required effort and (b) required cost and time.

#### 4.2.3. PaaSage Platform

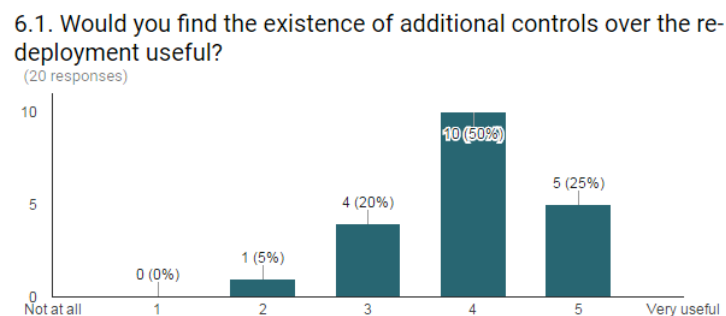
The evaluation of the whole PaaSage toolset is important in order to see how well the different tools integrate from users' view. The MDE transformation tools provided by PaaSage are considered generally good in their support to the related generation activities: 25% find the support very good, 50% good, 20% neither good nor bad, and one participant (5%) thinks the support is very low.

Most users find that the toolset of PaaSage supports well the tasks of the developers including deployment and monitoring activities (**Figure 16(a)**), whereas the quality of the toolset is regarded good for most (55% of the participants as indicated in **Figure 16(b)**).



**Figure 16:** PaaSage overall evaluation participants' view on (a) the support of toolset and (b) quality of tools.

Regarding the extension of the toolset most participants find this task neither easy nor difficult (55%), whereas some find it easy (20%) or very easy (10%) and some think that it would be difficult (15%). The accuracy of the deployment and redeployment process of PaaSage can be improved according to the view of the participants (**Figure 17**). Many find the process neither accurate nor non accurate (55%), whereas it is accurate or very accurate for 40% of the participants. One participant (5%) finds the process not very accurate.



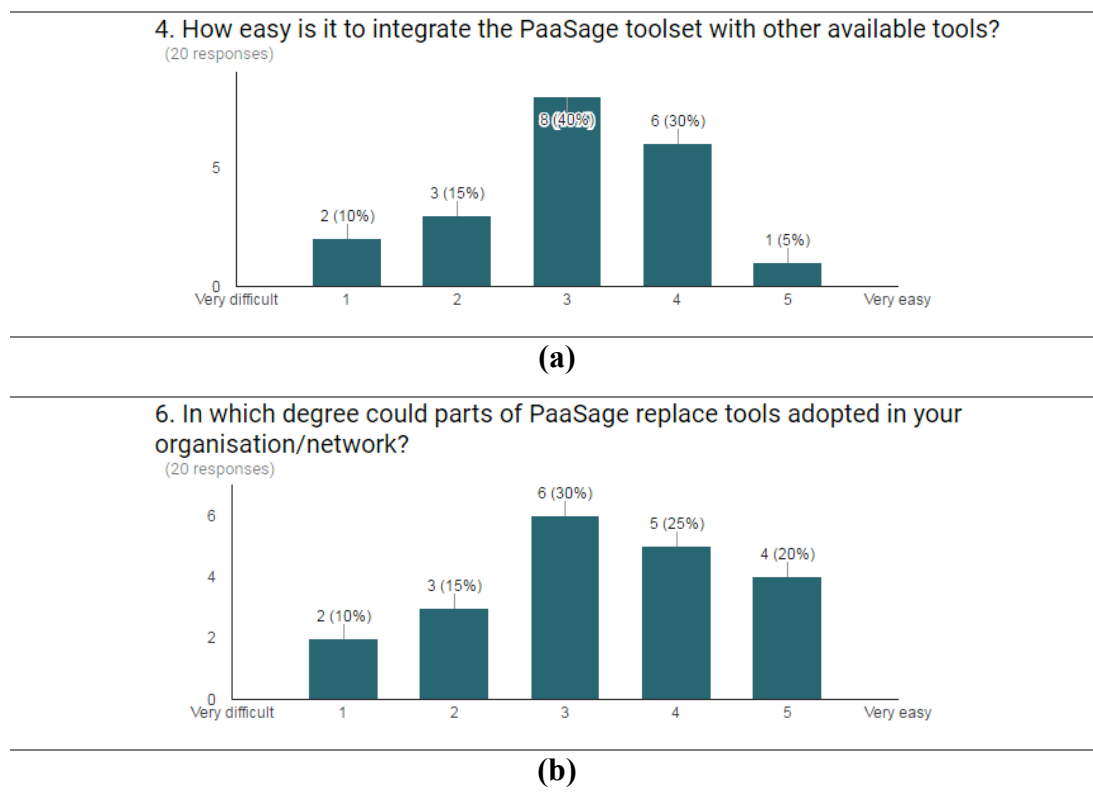
**Figure 17:** PaaSage overall evaluation participants' view on additional controls for redeployment.

Moving between different modules of PaaSage is not so easy for most. 50% find this neither easy nor difficult, whereas the process is easy or very easy for 45% of the participants. Moreover, most users (60%) would likely trust data, models and any kind of knowledge from other users of PaaSage via the offered tools (e.g., social network). Finally, the monitoring approach of PaaSage is valued as very good by 10% of the participants, good by 40%, neither good nor bad by 40% and not good by 10%.

#### 4.2.4. PaaSage Adoption

One important aspect is to see whether PaaSage and its tools can be easily used in an organisational environment or be integrated with other tools. Most participants find PaaSage in general beneficial (65%) or very beneficial (25%). However, exploiting PaaSage requires some degree of effort. 15.8% of the participants find that exploiting PaaSage is very easy, 15.8% that it is easy, 42.1% that it is neither easy nor difficult, 21.1% that it is difficult and 5.3% that it is very difficult.

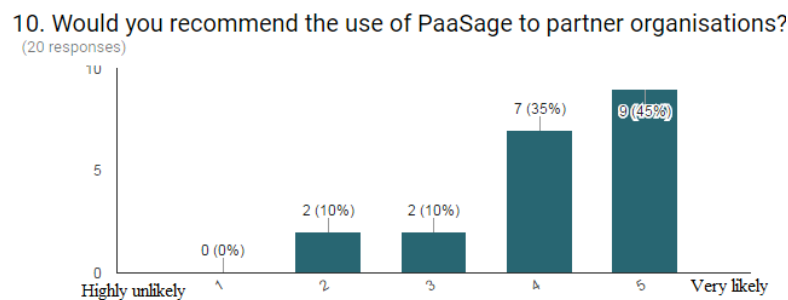
Some participants find that they could integrate PaaSage with other tools, although this would not be so easy for many of the participants (**Figure 18(a)**). Such tools can be found in monitoring and visualisation tools: Microsoft System Center, DevOps tools like Chef, dashboards like Grafana or the ELK-stack. Many participants think that PaaSage could not be easily used along with other tools used in the organisation (only 30% indicate that PaaSage could be easily or very easily be integrated with other tools), but that they could use PaaSage to replace other tools (**Figure 18(b)**).



**Figure 18:** PaaSage overall evaluation participants' view on (a) integration with other tools, and (b) replacement of other tools.



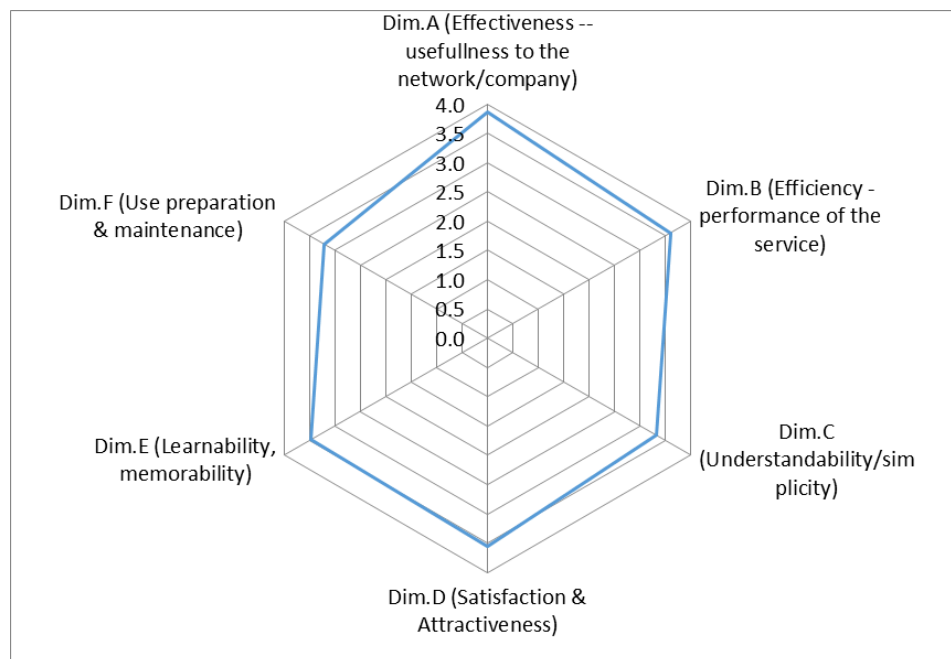
Most think that PaaSage complies well with standards with 65% thinking that it complies well or very well. Finally, most participants are likely or very likely to recommend PaaSage to their partner organisations (**Figure 19**).



**Figure 19:** PaaSage overall evaluation participants' view on recommending PaaSage.

#### 4.2.5. PaaSage on Non-Functional Dimensions

By using the six non-functional dimensions introduced in the PaaSage evaluation framework and the mapping between the dimensions and the main evaluation questions, the spider chart (i.e., radar chart) of **Figure 20** summarizes the results. A radar chart is a graphical method of displaying multivariate data. From the chart we can see that the effectiveness and usefulness of PaaSage is valued more than the other dimensions, whereas use preparation and maintenance, i.e., Dimension F, has lower values.



**Figure 20:** Spider chart for the six non-functional dimensions in PaaSage.

#### 4.2.6. PaaSage for Different User Types

As aforementioned participants were asked to indicate their professional position. As presented in **Figure 11** most participants are software engineers (60%), 20% work on operations and 10% are employed as system administrators. The results may differentiate among the different types of users: Business, DevOps (that includes

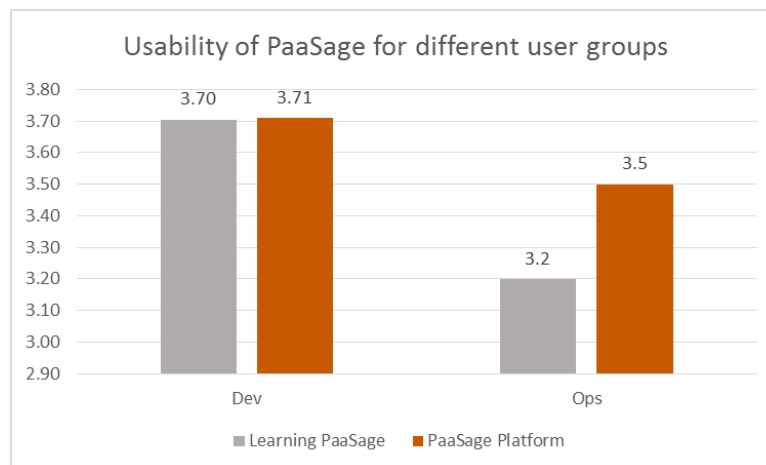
software engineers, operations and system administrators), Admin. (i.e., system administrators). Regarding business users an assessment of the usefulness of PaaSage has been provided in the analysis of the Business Evaluation in subsection 4.1 of the Deliverable.

We compare here the results between software engineers (Dev-) and operations/system administrators (-Ops) having as reference some basic questions of usability captured in the PEU dimension of the Extended TAM Model (although usability is scattered among many of the questions employed):

- Questions in the group Learning PaaSage
- Some questions from the group PaaSage platform:
  - How well do the modelling tools provided by PaaSage support the user specification during the design activity of the cloud-based application lifecycle?
  - How easy is it to move from one module to another in the main flow of PaaSage?

The results are presented in **Figure 21**. It can be seen that software engineers find more benefits in the use of PaaSage in terms of PEU in comparison to operations and system administrators.

Although some participants may have experience from more than one position, during the evaluation the indication of the main position was requested. Therefore, the accuracy of the results may have been slightly affected for users who possess more than one position (e.g., software engineer and system administrator at the same time).

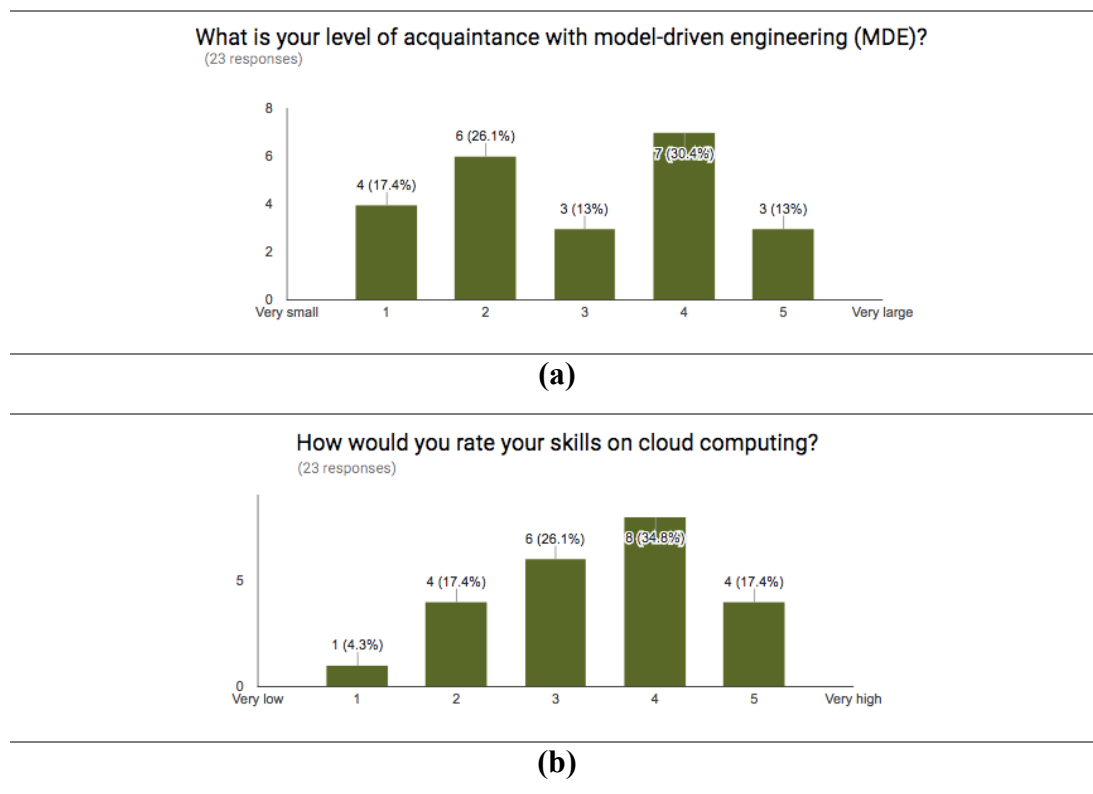


**Figure 21:** Usability of PaaSage for different user groups.

### 4.3. CAMEL Textual Editor Evaluation Results

The evaluation of CAMEL Textual Editor was performed with the participation of 23 individuals. As aforementioned participants are users of CAMEL in the framework of PaaSage use cases.

Regarding demographics participants are mostly male (73.9% compared to 26.1% female participants) and most are employed as senior software engineers (52.2%) followed by less experienced software engineers (17.4%) and experienced system administrators (17.4%). This is also reflected in the years of experience in IT, where most participants have been employed more than 5 years (60.8%). Cloud and MDE knowledge is very good in many participants (34.8% and 30.4% for cloud and MDE respectively). This is justified, since the use of CAMEL and its different parts require good knowledge of both areas. Nevertheless, a number of participants has very limited knowledge on MDE (17.4%), even though the very limited knowledge on cloud is found in only 4.3% that corresponds to one participant (**Figure 22**).



**Figure 22:** CAMEL Textual Editor participants experience on (a) MDE and (b) cloud computing.

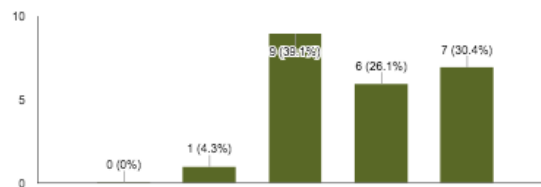
Most participants find that CAMEL covers very well the requirements of their specific use case. Specifically, most participants are very well satisfied with the coverage of the deployment, the organisation and the provider model (87%, 78% and 65% respectively), whereas the models less covered according to the participant are the security and the type models (48% and 30% respectively mention that these parts are not covered).

#### 4.3.1. Textual Editor Usability

As aforementioned PEU is one of the two dimensions of TAM. Most participants are satisfied with the user friendliness of CAMEL (47.8% rate it high and 39.1% neither high nor low). One of the good features of CAMEL is its expressiveness rated very high by some participants (21.7%), whereas the remaining participants rate it high or

neither high nor low (39.1% for both ratings). The Textual Editor of CAMEL offers some features, such as highlighting and input completion. As expected, such features are viewed very positively (**Figure 23**).

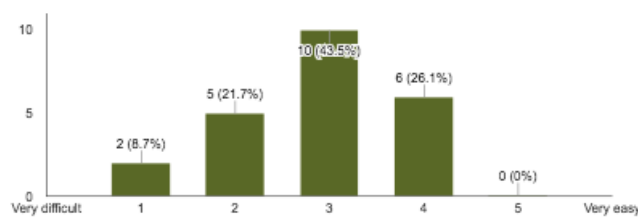
6. How do you rate the usefulness of the Textual Editor's features (e.g., input completion, syntax highlighting, error reporting)?  
(23 responses)



**Figure 23:** Participants' view for the features of CAMEL Textual Editor.

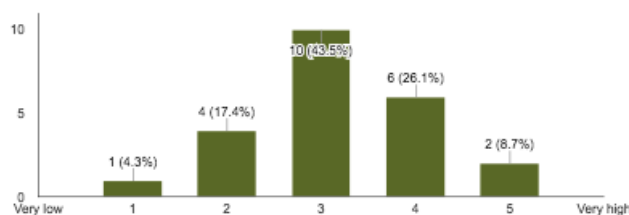
However, the downside is that some effort is required to create a model and to learn how to use CAMEL (**Figure 24**). This was expected as the use of CAMEL requires some prior knowledge.

3. How do you rate the effort required for the model creation in the Textual Editor?  
(23 responses)



(a)

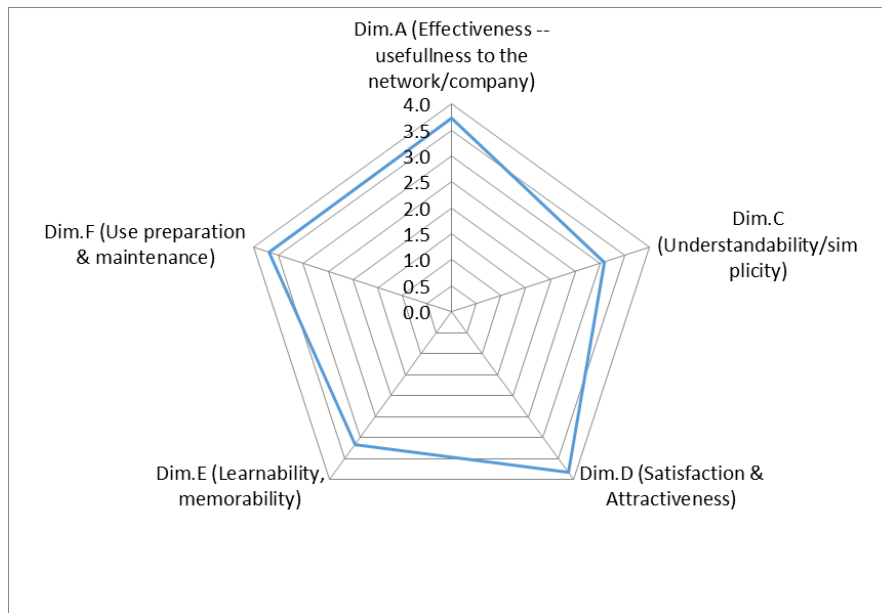
4. How do you rate the easiness of learning how to use the CAMEL Editor.  
(23 responses)



(b)

**Figure 24:** Participants view on (a) model creation effort and (b) easiness of learning CAMEL.

Using the five of the six non-functional dimensions, the spider chart of **Figure 25** is produced. Satisfaction and attractiveness of the CAMEL Textual Editor are valued more, whereas some effort is needed in order to learn how to use CAMEL (Learnability and Understandability).

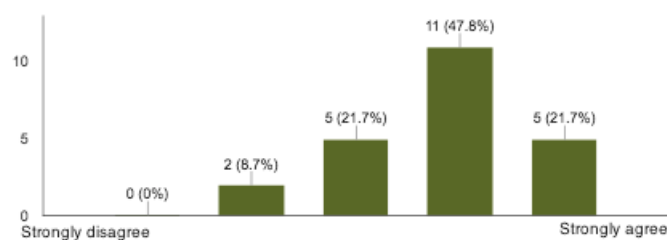


**Figure 25:** Five non-functional dimensions for the CAMEL Textual Editor.

#### 4.3.2. Documentation

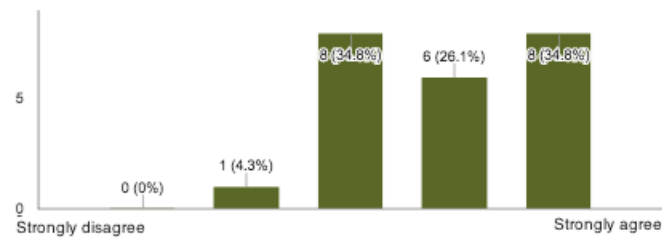
Documentation is a useful source of information on the use of CAMEL. Participants indicated that they needed to consult the documentation during the model creation: 73.9% indicated that the documentation was necessary or very necessary, whereas none indicated that it was not needed. Nevertheless, the content of the documentation was useful (indicated by 47.8% of the participants), whereas only 8.7% indicated that they could not find the answers they were looking for in the documentation (**Figure 26(a)**). The CAMEL community was very much appreciated for searching for answers in that case (**Figure 26(b)**).

2. I found the answers to my questions in the CAMEL documentation.  
(23 responses)



(a)

3. When the documentation was not sufficient, I found the answers to my questions from the CAMEL community.  
(23 responses)



(b)

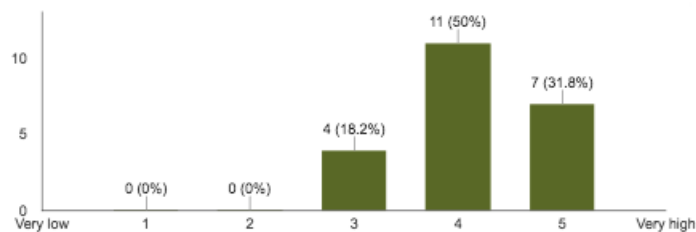
**Figure 26:** Participants view on (a) documentation content and (b) help from CAMEL community.

### 4.3.3. Deployment Model

The participants are satisfied with the level of completeness that CAMEL provides for defining internal components with 78.3% being satisfied or very satisfied and the rest moderately satisfied (21.7%). There were some suggestions by participants for defining the order of instantiation. The feedback on the level of completeness in defining component lifecycle management information in terms of specific management scripts was also very positive with 82.6% rating it high or very high and the remaining 17.4% finding it moderate.

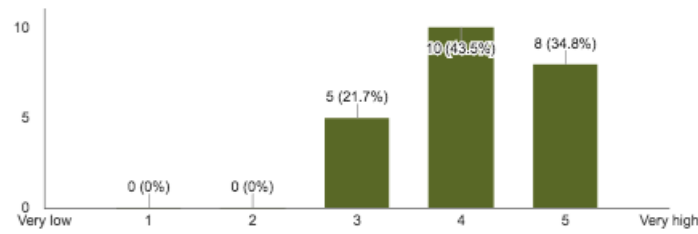
The feedback on the level of completeness in defining VMs was also positive with 78.4% of the participants rating it high or very high and 21.7% rating it moderately. Similarly, participants were satisfied for the level of completeness in defining communication requirements connecting application components noting only a need for a distinction between TCP and UDP ports (**Figure 27(a)**). Note that one participant did not provide any answer showing most probably that she has not used the relevant feature of CAMEL. Similar level of satisfaction exists among users for hosting requirements connecting application components (**Figure 27(b)**).

4. What is the level of completeness in defining communication connecting application components?  
(22 responses)



(a)

5 What is the level of completeness in defining hosting requirements connecting application components?  
(23 responses)



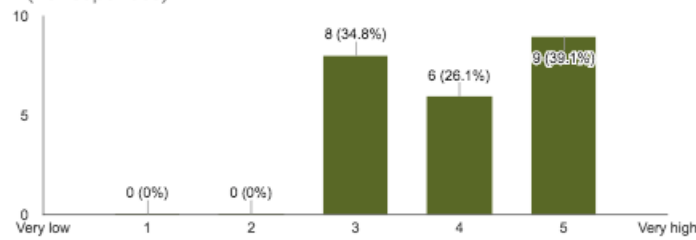
(b)

**Figure 27:** Participants view on the level of completeness of (a) communication and (b) hosting requirements connecting application components.

#### 4.3.4. Requirement Model

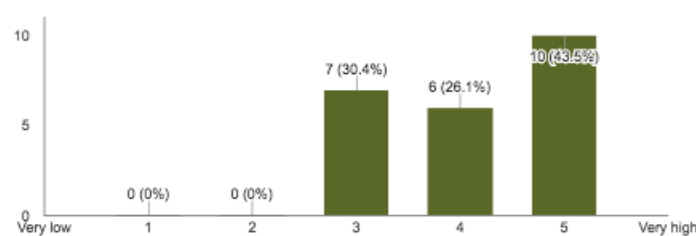
The evaluation participants are generally satisfied with the provisions provided by CAMEL for specifying quantitative and qualitative hardware requirements (the rating for the completeness of the two aspects respectively for high or very high is 65.2% and 69.6%) as depicted in **Figure 28**. Regarding improvements support for hypervisor optimisation and containers, and specifying the CPU frequency to run specific nodes with low-energy were indicated.

1.1. How do you rate the level of completeness of CAMEL for quantitative hardware requirements.  
(23 responses)



(a)

1. How do you rate the level of completeness of CAMEL for specifying qualitative hardware requirements.  
(23 responses)



(b)

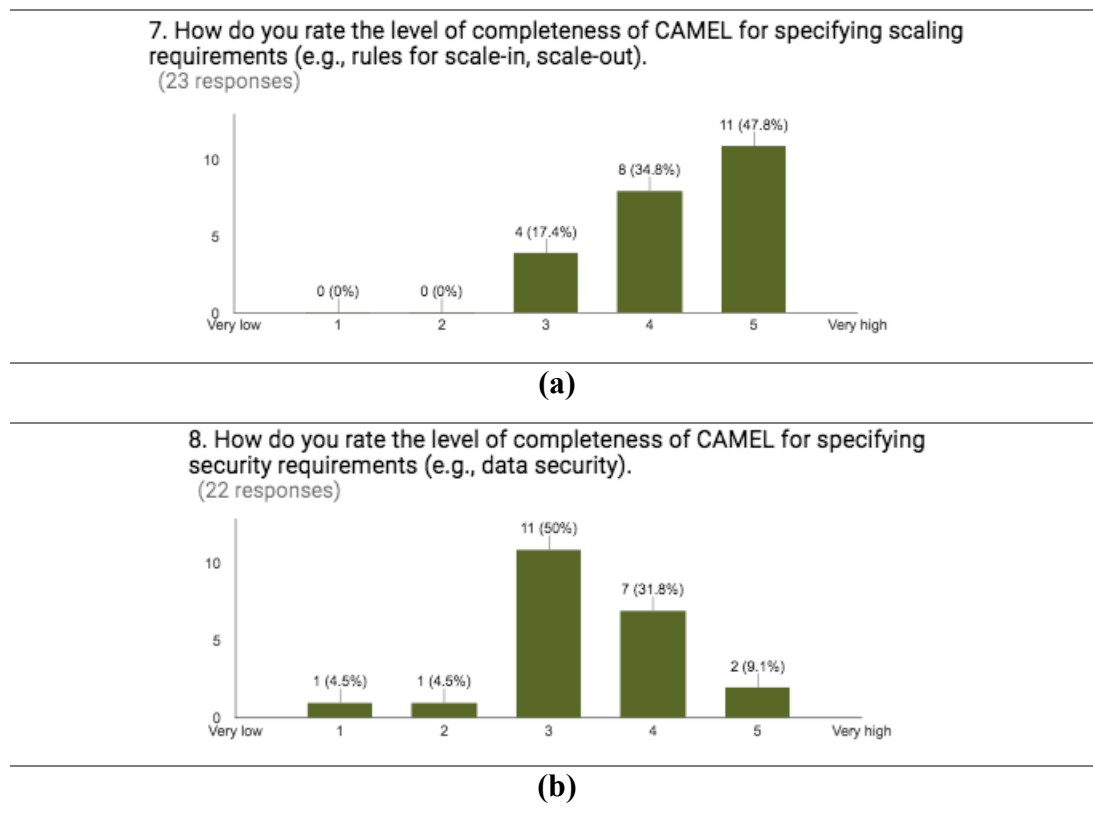
**Figure 28:** Participants view on (a) quantitative and (b) qualitative hardware requirements.

Provisions for OS requirements also received very positive feedback with 65.2% rating the support as good or very good, 30.4% at medium level and only one participant indicating the opposite opinion (i.e., 4.3%). Desired feature in this area

was the possibility to add the OS version, e.g., in the form of a drop-down list. Support for location requirements was also very positively viewed with 47.8% of the participants being very satisfied, 30.4% satisfied, 17.4% moderately satisfied 4.3% not very satisfied.

The feedback on providers' requirement was also positive with 34.8% of the participants being very satisfied, 26.1% satisfied, 30.4% moderately satisfied 8.7% not very satisfied. The provision of a list of predefined provider models was indicated by some participants as a useful feature to have. Participants were generally also positive about the optimisation and the SLO requirements.

Scaling requirements were also very positively viewed with 47.8% of the participants being very satisfied (**Figure 29(a)**), whereas the feedback for security requirements was less positive (**Figure 29(b)**). As aforementioned, indeed security is an important aspect in general for participants.



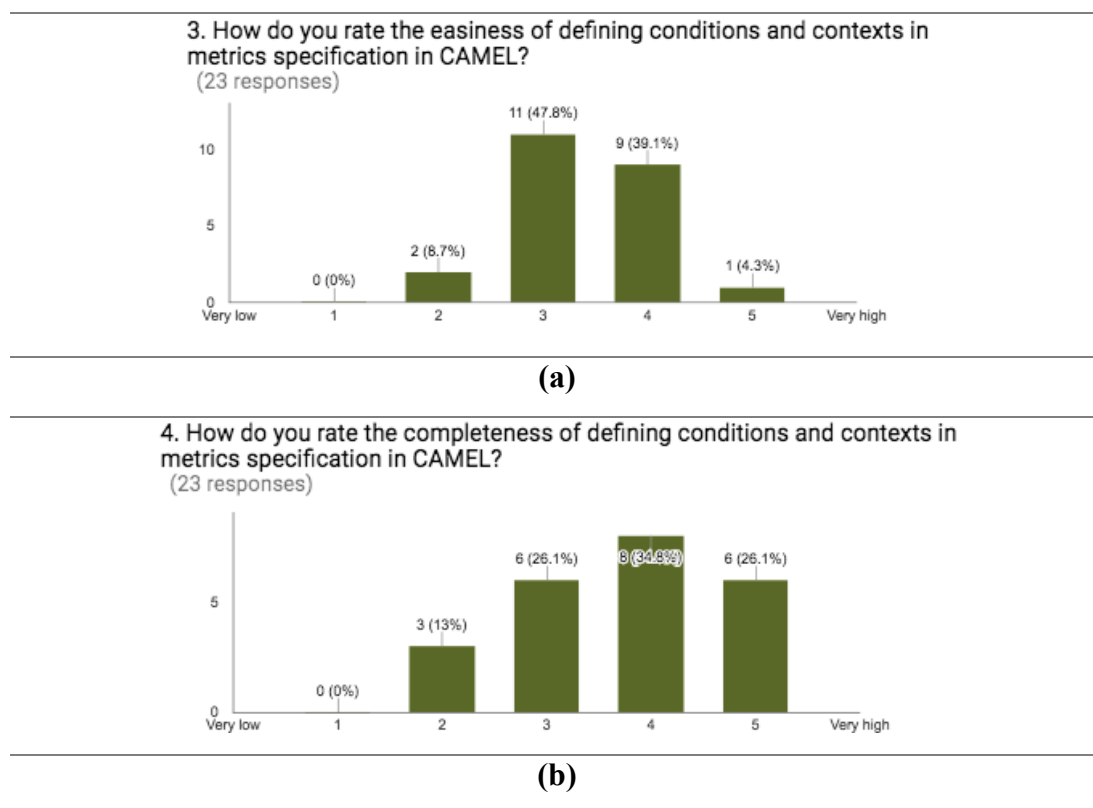
**Figure 29:** Participants view on (a) scaling and (b) security requirements.

#### 4.3.5. Metric Model

Regarding the metric model some aspects of PEU were considered. In that respect most find the monitoring metrics easy to define: 52.2% of the participants rate it as easy, followed by 26.1% that consider its difficulty being in medium level, whereas for 17.4% it is considered difficult and for 4.3% very easy. Context and conditions are also considered easy or moderately easy to define as captured in **Figure 30(a)**. The basic metric model provided by CAMEL is valued by most with 13% of the participant finding it necessary, 43.5% thinking that is quite necessary, 39.1% being



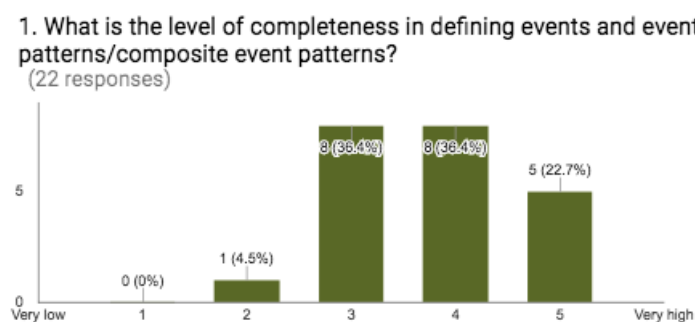
neither positive nor negative and only one (4.3%) who thinks that it is not required a lot. The provisions provided by CAMEL for defining conditions and contexts are considered complete for the majority of participants (**Figure 30(b)**).



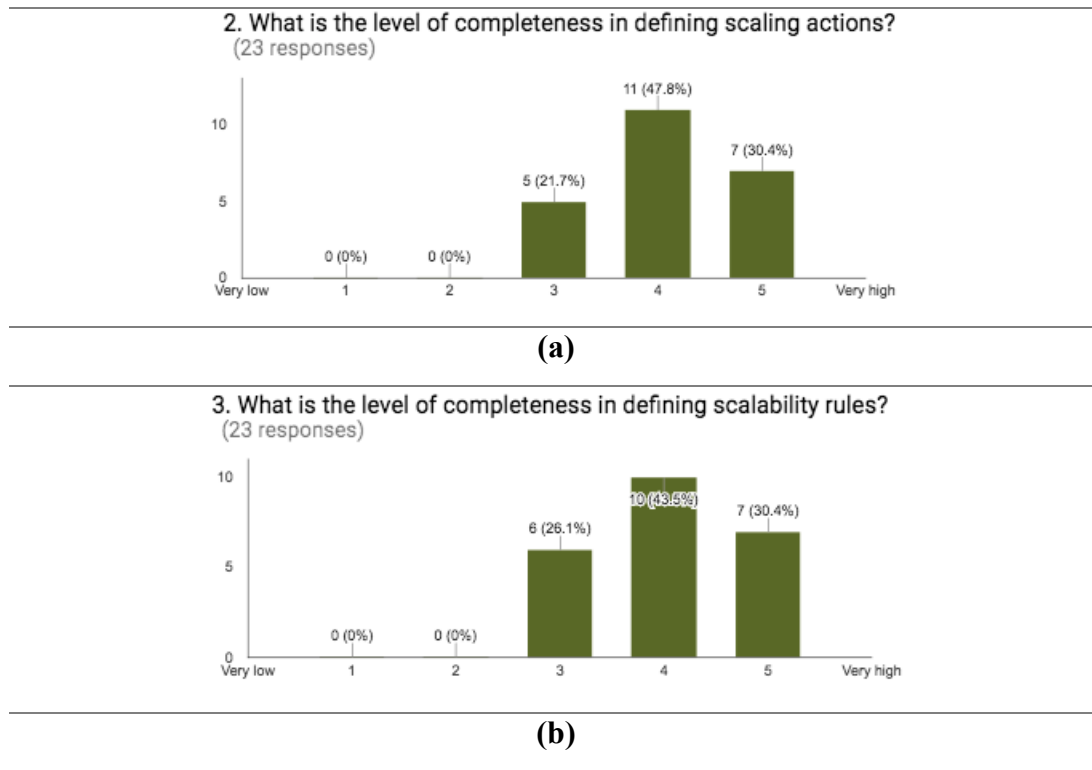
**Figure 30:** Participants view on (a) easiness and (b) completeness of the contexts and conditions provided in the metric model.

#### 4.3.6. Scalability Model

Participants are generally satisfied with the provisions for scalability rules, where the aspect of completeness in defining events and event patterns (including composite event patterns), scaling actions and scalability rules was investigated. Regarding events and event patterns, most participants are satisfied and moderately satisfied (**Figure 31**). Scaling actions and scalability rules received more positive feedback with respectively 78.2% and 73.9% of the participants being satisfied or very satisfied (**Figure 32**).



**Figure 31:** Participants' view on scalability events and event patterns



**Figure 32:** Participants view on (a) scaling actions and (b) rules

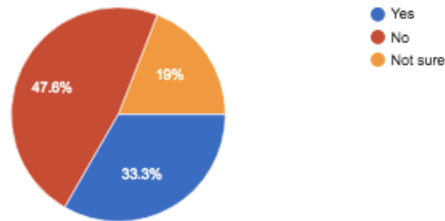
#### 4.3.7. Organisation Model

It was expected that not all participants had experience with the use of the organisation model of CAMEL and therefore, not all provided answers on this issue. Regarding the completeness in defining users for the organisation, most out of the 21 participants that provided an answer were satisfied or very satisfied: 76.2%. Similarly, most of the 19 participants that answered on the issue of completeness in defining role assignments were satisfied or very satisfied: 57.1%. Most users also found that the basic roles of admin, DevOps and business users are enough to group sufficiently the users of their organisation with 72.8% being positive or very positive. The level of completeness in defining permissions was also quite valued although only 19 participants provided an answer: 57.9% were satisfied or very satisfied and the remaining 42.1% moderately satisfied.

Users were asked about their opinion on some security properties relevant to actions that can be performed in the organisation. Regarding giving access credentials in organisation model, most participants disagreed as expected, whereas many (47.6%) would be willing to do it, if they were assured that the CAMEL platform was able to handle such cases securely (**Figure 33**). On the extension of credentials outside their organisation, most participants indicated that they would like to be able to specify permissions which grant or deny access on particular types of models that they are creating and managing for users of other organisations (61.9%), whereas 33.3% were not sure about this feature.

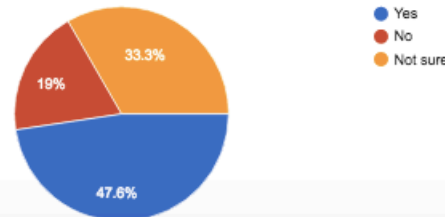
5. Do you feel comfortable with supplying access credentials in organisation models?

(21 responses)



5.1. Would you still include such information in organisation models if you are re-assured that the CAMEL platform is able to securely handle it?

(21 responses)



**Figure 33:** Participants' view for trust in models..

#### 4.4. PaaSage features coverage per use case

The following table (**Table 1**) depicts with more detail the level of coverage of each aspect of PaaSage feature in the studied use cases as indicated by the use case partners that participated in the evaluation procedure. The coverage of each model as provided by CAMEL is examined based on whether the respective feature is fully covered, partially covered or not covered. Although this Table does not assist in drawing some conclusions on the use of CAMEL, it is useful for interpreting the results further by understanding which of the features provided are required in each use case and may hence be found also in additional use cases outside PaaSage. Generally, the Provider, Deployment and Organisation models are fully covered in all use cases. The Requirement model is also almost fully covered. Models that are less frequently found in the use cases are the Security model, the Type model, the Metric model and the Scalability model.

Model Type	Industrial Use-cases (LSY, BEWAN)	Public Sector Use-case (EVERY, FORTH)	eScience Use-cases (AGH, HLRS, ASCS)	Financial Sector Use Case (UCY, IBSAC)
Requirement	Partially	Fully	Fully	Fully
Metric	Partially	Not	Partially	Fully
Deployment	Fully	Fully	Fully	Fully
Scalability	Partially	Not	Partially	Fully
Provider	Fully	Fully	Fully	Fully

<b>Organisation</b>	Fully	Fully	Fully	Fully
<b>Location</b>	Fully	Fully	Partially	Partially
<b>Security</b>	Not	Partially	Not	Partially
<b>Execution</b>	Fully	Fully	Partially	Partially
<b>Type</b>	Partially	Not	Partially	Partially

**Table 1:** Coverage of PaaSage and CAMEL features by use case.

#### 4.5. Threats to validity

In terms to *external validity*, referring to the extent we can generalise our findings, the use cases selected are representative covering various needs for cloud deployment. However, extending the use of CAMEL to other scenarios, environments and even cultural settings may affect the main results. In general, the results capture well the view of the PaaSage users in the framework of different use cases. However, the use of PaaSage outside the use cases has been partially evaluated having therefore, a negative effect on the external validity of our results.

*Internal validity* does not affect our experiments, since the main conclusions drawn are well supported and the interpretation of the results does not include ambiguity.

Note that not all questions were required allowing participant the possibility to skip questions on aspects they had no experience on. This was necessary, since not all use cases had the same requirements, and hence, not all PaaSage tools' capabilities were used by all participants. However, this may have not been communicated clearly to the participants and some may have given the medium score (3 in all the questions) for aspects they have not worked on. This may have negatively affected the *conclusions validity* referring on whether the relationship among variables based on the data are correct.

Finally, *construct validity*, i.e., the degree to which a test measures what it claims, is not affected since all questions provided for evaluation purposes were carefully prepared and cover all aspects of PaaSage tools and the different users' interactions with PaaSage.

## 5. Feedback on training sessions

### 5.1. Training session

In this section we describe the design, execution, and feedback on the PaaSage training session organized during the 10th Symposium and Summer School on Service-Oriented Computing, which took place on June 27 – July 1, 2016 in Heraklion, Crete, Greece. Coming at a time that the PaaSage tools and training material were reaching a level of maturity that permitted their use by external users, this training session was a good source of feedback for the training process itself as well as for the PaaSage project as a whole.

Wednesday, June 29	
09:30-12:00	<b>Morning Session – Session Chair: Norbert Ritter</b>
09:30-10:30	(Tutorial: Foundations of SOC): "Fundamentals of the SoC Paradigm", Wolfgang Reisig (HU Berlin) [Presentation] [Video]
10:30-11:00	Coffee Break
11:00-12:00	(Tutorial: Emerging Topics): "The PaaSage Model-Based Cloud Platform: A Training Session", Kyriakos Kritikos (ICS-FORTH), Manos Papoutsakis (ICS-FORTH) & Kostas Magoutis (ICS-FORTH, U of Ioannina) [Training Session material] [Presentation 1] [Presentation 2] [Video]
12:00-15:00	Lunch
15:00-18:00	<b>Afternoon Session – Session Chair: Ulf Schreier</b>
15:00-15:30	(Symposium): "Microservices Tenets: Agile Approach to Service Development and Deployment (Overview and Vision Paper)", Olaf Zimmermann (HS Rapperswil) [Presentation]
15:30-16:00	(Symposium): "Situation Model as Interface between Situation Recognition and Situation-Aware Applications", Matthias Wieland (U of Stuttgart) [Presentation][Video]
16:00-16:30	(Symposium): "Collective Utility in Hierarchical Structures of Collective Adaptive Systems: an Application in Transportation Systems", Bitsaki Marina (U of Crete) [Presentation] [Video]
16:30-17:00	Coffee break
17:00-19:00	Poster session @ Knossos Royal's Fontana Amorosa Restaurant

**Figure 34:** Excerpt from <http://www.summersoc.eu/program/>.

The focus of this training session was on usage of PaaSage tools and access points to the PaaSage platform, and on training users on how to use the platform to achieve multi-cloud deployments as well as to share knowledge. The technical details on the lifecycle management of each multi-cloud application was out of scope of these tutorials. In particular, the training part of the session consisted of two parts:

- i) Application modeling with CAMEL, and
- ii) Using the PaaSage Social Network and platform.

During this session, the audience had the opportunity to learn and practice how to express an application using CAMEL and how to use the PaaSage social network in order to store, share and deploy CAMEL models.

The first item on the agenda was a brief overview of the PaaSage project. The presenters talked about the need served by the PaaSage platform, the opportunities it offers, its architecture and features. Following this introduction, a three-minute video on the ASCS use case was used as a visual introduction on how a computer-aided engineering (CAE) application (described in more detail online<sup>7</sup>) can take advantage of the PaaSage platform and tools. Following this video, a twenty-minute tutorial about CAMEL took place, during which the presenters introduced CAMEL and used a real example of an application model in order to show the capabilities of the CAMEL textual editor. The audience was prompted to use an editor of their choice in order to complete some tasks on the application modeling. Real-life modeling exercises were presented such as how to express a requirement (OS, hardware, location requirement), how to create a requirement set and how to create application metrics. The need for the creation or re-use of CAMEL models for the application and the cloud providers, was highlighted.

Following in the program was a twenty-minute presentation of the PaaSage social network. The participants were prompted to practice the demonstrated actions during the tutorial in a hands-on manner. They created profiles in the social network and followed the following steps demonstrated by the presenters according to specific scenarios:

- i) Login to social network,
- ii) Browse for a specific application model,
- iii) Browse information of the chosen model,
- iv) Visit profile page of the contributor,
- v) Visit community page,
- vi) Become member of a group, and
- vii) Deployment of an application.

At the end the participants were asked to complete a questionnaire in order to rate and comment their experience.

## **5.2. Evaluation of PaaSage**

The training session described above created an opportunity for evaluation of the PaaSage social network, as well as the design and deployment of an application model. The evaluation aimed to collect subjective results rather than performance metrics. The evaluators were the participants of the main track of the 10<sup>th</sup> Symposium and Summer School on Service-Oriented Computing. At the end of the 1-hour

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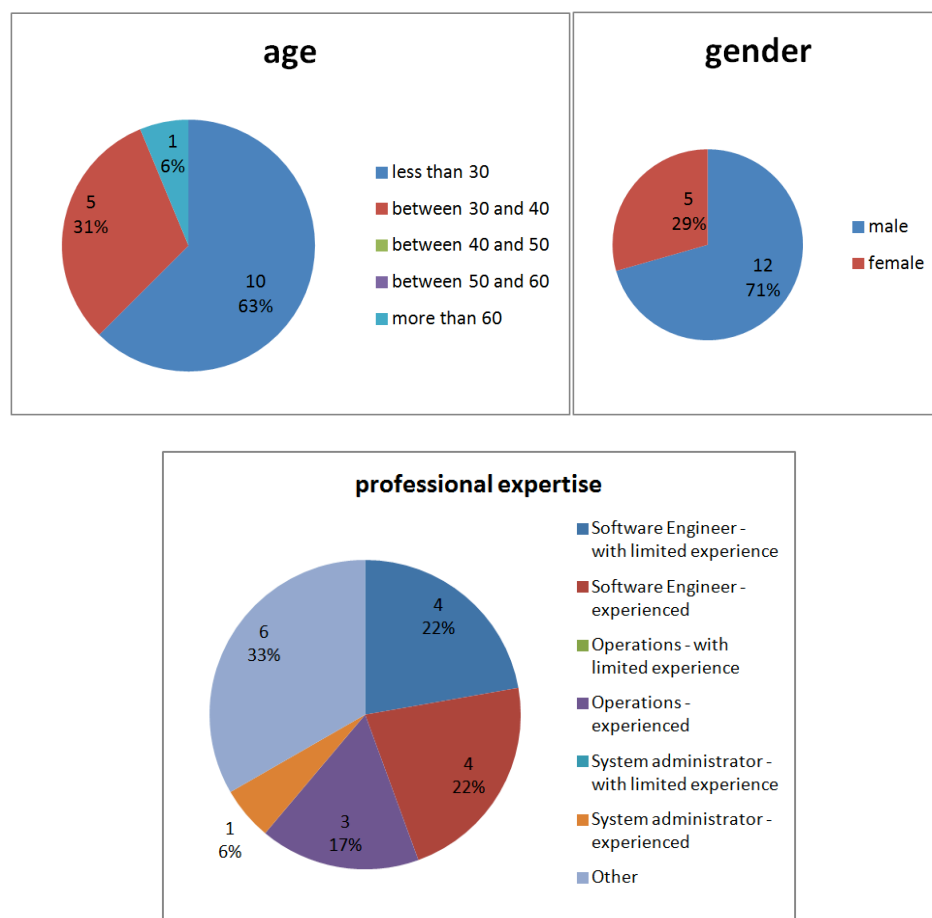
<sup>7</sup> <http://www.paasage.eu/use-cases/automotive-use-case>

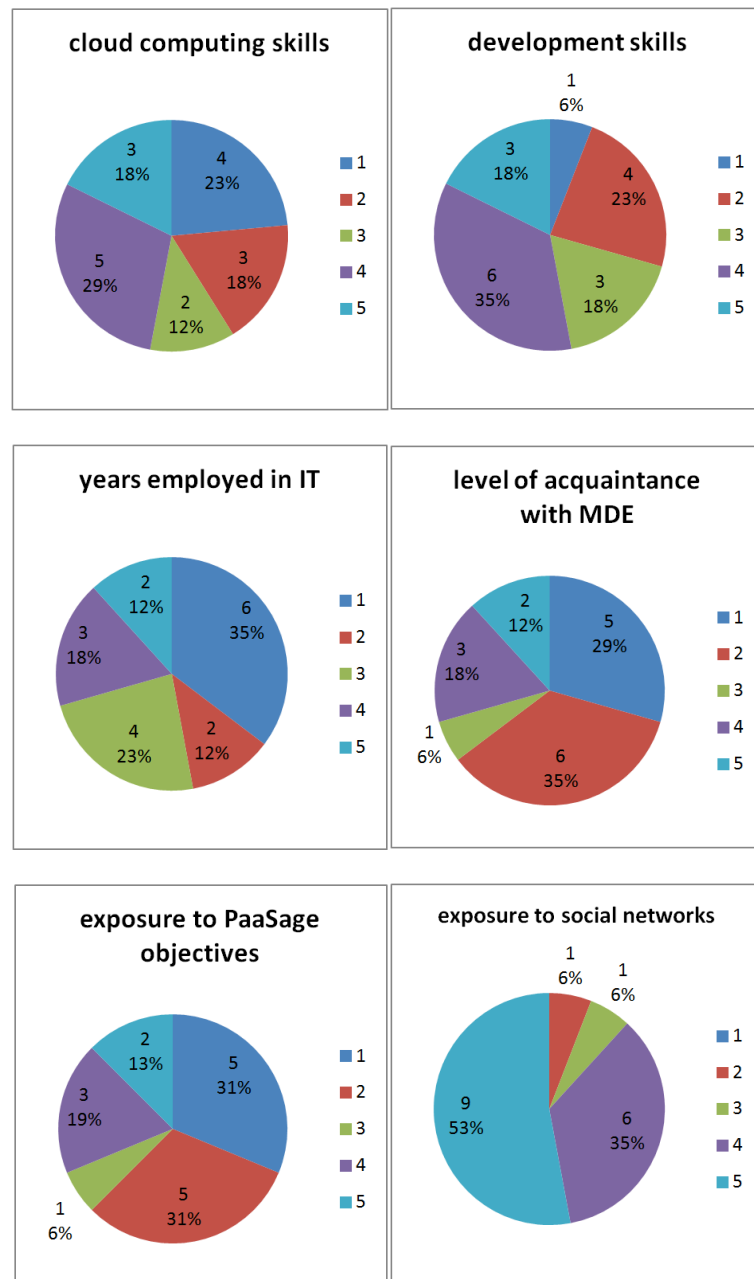
tutorial, participants were requested to fill in a questionnaire comprising the following six sections:

- i) Background information – demographics
- ii) Learning PaaSage – evaluation of the training session itself
- iii) PaaSage platform – assessment of the PaaSage toolset regarding modeling, deployment and knowledge sharing
- iv) PaaSage adoption – comparison with other tools, competitive or not
- v) PaaSage social network – overall usability rated on a five point Likert Scale
- vi) PaaSage social network – assessment of specific features (registration, finding a model, model information, community features) rated on a five point Likert Scale

Note that some questions were adopted from the Overall Evaluation of PaaSage.

Statistics regarding the participants' background information such as age, gender, professional expertise, exposure to social networks, years employed in IT, cloud computing skills, exposure to PaaSage objectives, level of expertise with MDE and development skills are provided in **Figure 35**. The numbering values shown in the figure (1 to 5) denote very low to very high.





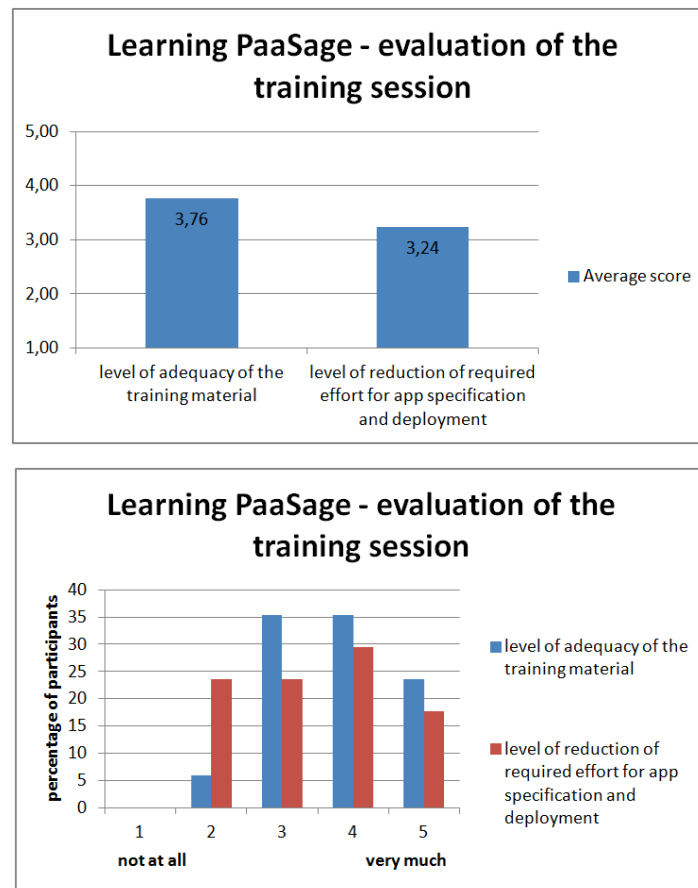
**Figure 35:** Statistics regarding the participant's background information.

The participants were asked to answer two questions regarding the evaluation of the training session. They had to rate on a five point Likert Scale the level of adequacy of the training material and the level of reduction of required effort for application specification and deployment after the training session. As we can see in **Figure 36**, 3.76 and 3.24 was the average score for the first and the second question respectively. Most of the participants found the training material relatively adequate, and a significant fraction believe that this material will reduce the required effort for application specification and deployment. The second graph of **Figure 36** shows in great detail the answers of the participants.

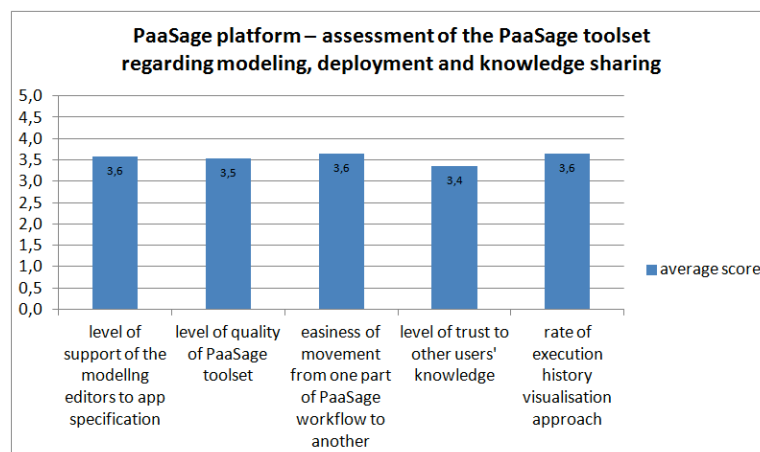
96% of the participants rated the level of adequacy of the training material with 3, 4 or 5, while the respective percent for the second question was 71%.

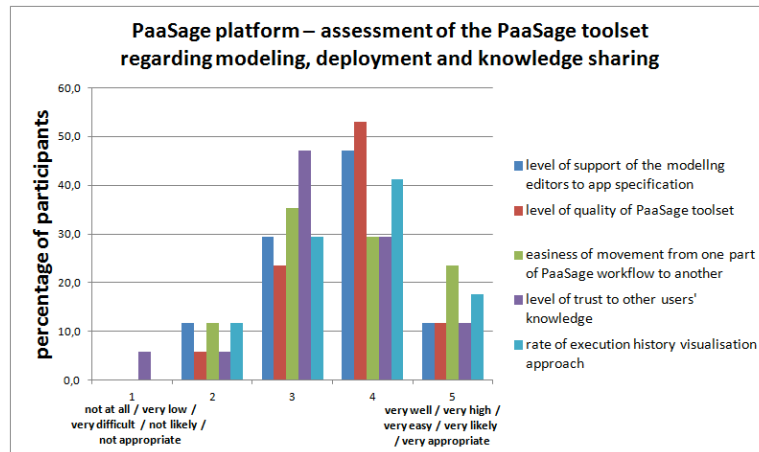


The third section of the questionnaire focused on the assessment of the PaaSage toolset as far as application modeling, application deployment and knowledge sharing are concerned. As shown in **Figure 37**, the average score of all five questions was around 3.5. The question with the lowest score was about the trust to other user's knowledge, however the distance from the highest score was only 0.2. The second graph in the Figure shows that the majority of the participants rated the five questions with 3 or 4.



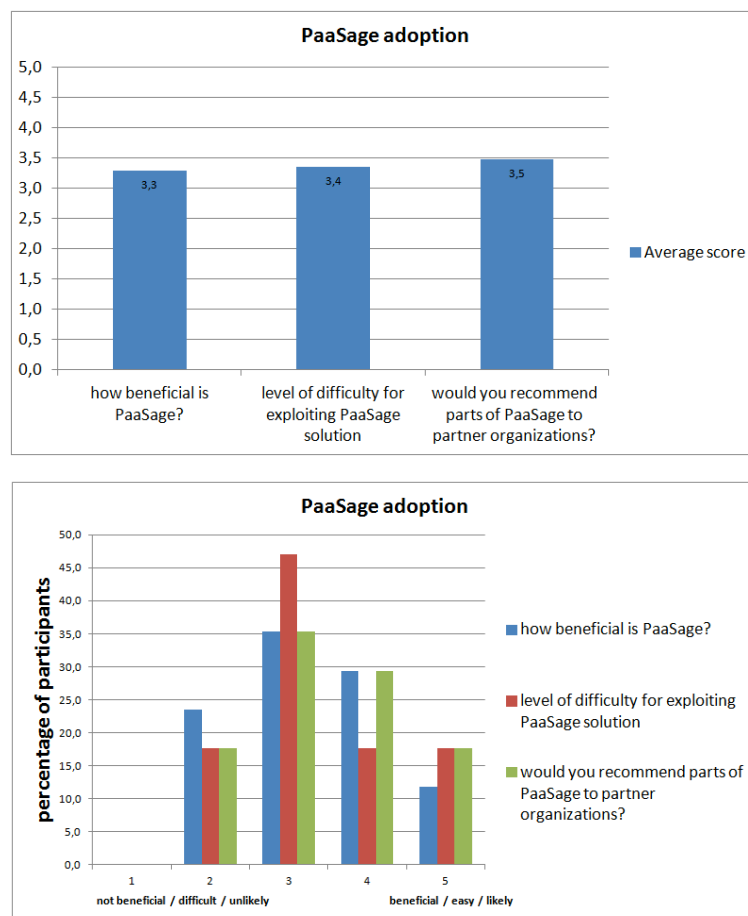
**Figure 36:** Learning PaaSage - evaluation of the training session (number of people interviewed: 17).





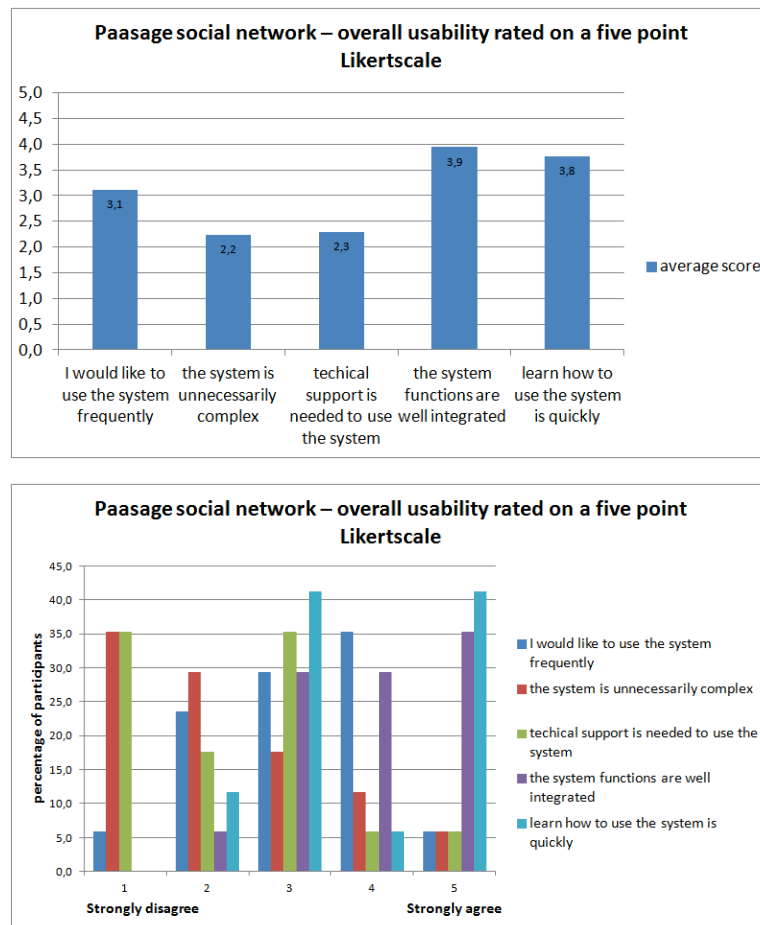
**Figure 37:** PaaSage platform - assessment of PaaSage toolkit (number of people interviewed: 17).

Three questions were included in the fourth section of the questionnaire: i) How beneficial is PaaSage for your organisation/network? ii) How do you rate the level of difficulty for exploiting the PaaSage solution? iii) Would you recommend the use of parts of PaaSage technology to partner organisations? As we can see in **Figure 38**, the average score of those questions was 3.3, 3.4 and 3.5 respectively. The second graph, which includes more details about how the participants rated, shows that the majority of them rated with 3 all the three questions while no one rated them with 1.



**Figure 38:** PaaSage adoption (number of people interviewed: 17).

Rating of the overall usability of the PaaSage social network, as shown in **Figure 39**, indicated that the majority of the participants believe that the system functions are well integrated (average score 3.9) and that they could learn how to use the system quickly (average score 3.8). On the other hand, a minority believes that the overall system is complex (average score 2.2) or that technical support is needed for the member of the social network to use the system (average score 2.3). Finally, the statement “I would like to use the system frequently” was rated with 3.1 slightly above the mean value.

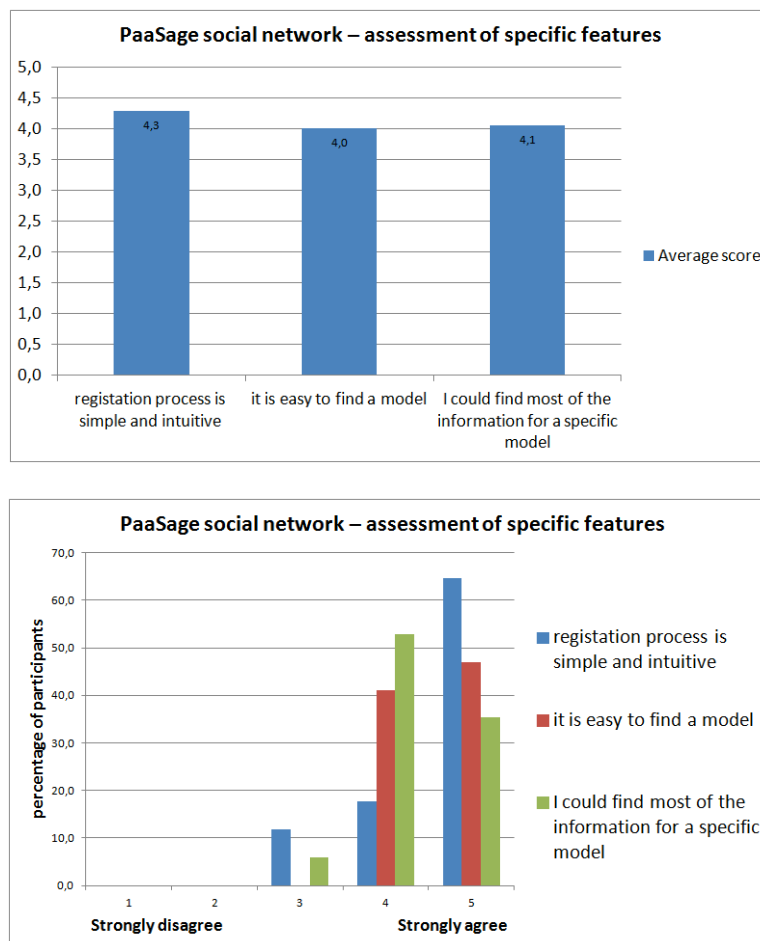


**Figure 39:** PaaSage social network - overall usability (number of people interviewed: 17).

The assessment of specific features of the PaaSage social network was the aim of the last group of questions. Registration, browse for a specific application model and the adequacy of the model information were the tasks that the questions focused on. As we can see in **Figure 40**, the average score of all three questions was really high, 4.3, 4.0 and 4.1 respectively. The second graph of **Figure 40** reveals that almost all of the participants rated these questions with 4 or 5, while only a very small minority rated with 3 while nobody rated it lower than 3.

In the very last part of the questionnaire the participants were asked to comment on the features of the social network that they liked and disliked most. According to their answers, they most commonly favored the fact that the PaaSage social network which

is intuitively built like common social networks, which makes it easy to use. On the other hand, users' responses indicated that they had difficulties using their mobile phone to visit the social network site. Moreover, a user described the visualization of the executions of an application model as complex. Finally, a user mentioned security, asking for secure pages which use the https protocol.



**Figure 40:** PaaSage social network - assessment of specific features (number of people interviewed: 17).

As a conclusion, the participants were asked to follow specific scenarios in order to become familiar with the functionality of the CAMEL textual editor and the PaaSage social network. However, at the same time they were encouraged to freely use the both tools as they wish. They rated the training session itself with an above-average overall score while the majority of them assessed the PaaSage toolkit with a score of 3 or 4. Moreover, the average score of the questions regarding the PaaSage adoption was also above average. Finally, all questions with positive statements about the social network overall usability and assessment of specific functions received solid average scores (3.8 to 4.3). On the other hand, questions with negative statements received low average scores (2.2 and 2.3).

We overall believe that the feedback received during the PaaSage training session in SummerSOC 2016 from an audience external to the PaaSage consortium having a

first time experience of PaaSage and being aided by the PaaSage training material available at the time, was quite positive. The experience gained during this training session is key to organizing effective workshops in the near future and in reaching out to potential users and adopters of the PaaSage technology.

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## **APPENDIX 1: Business Evaluation Questions**

- 1 I think that my organisation will benefit from having the capability to select from different cloud providers.
- 2 I think that my organisation would benefit from being able to automatically deploy its applications on different cloud platforms.
- 3 Taking into account the characteristics of available cloud platforms (e.g. costs), the data to be used and the end-user preferences or restrictions (e.g. price, location, availability, privacy, etc.) for producing an optimal deployment solution is important for my business.
- 4 Business requirements, financial capabilities but also cloud provider costs can change rapidly, so it would be beneficial to be able to modify an existing cloud deployment and move to another cloud provider.
- 5 I think my organisation would benefit from reducing the resource usage costs in cloud executions.
- 6 I think that my organisation would benefit from exploiting multiple cloud infrastructures.
- 7 I think that simplifying the management of cloud services is useful.
- 8 I think that it would be useful if cloud-based applications self-adapted to changes in environment and requirements.
- 9 I think that using experts' previous knowledge to re-adapt cloud solutions is useful.
- 10 I think that it would be useful to interact with other cloud experts in a social network.

## **APPENDIX II: PaaSage Platform Evaluation Questions**

### **Part 1 – Demographics**

Please indicate your professional expertise

What is your level of acquaintance with the PaaSage objectives?

What is your level of acquaintance with Model Driven Engineering (MDE)?

How would you rate your development skills?

How would you rate your database skills?

How many years have you been employed in ICT?

How would you rate your skills on cloud computing?

Name of organisation

### **Part 2 - General questions**

1. In which degree does the solution of PaaSage improve the quality of design by identifying/pinpointing to the modeller poor design or design errors?
2. Based on your understanding, what is the level of quality offered through the various artefacts of PaaSage, including models, code, and respective documentation?
3. In which degree is the development effort (design, coding, testing) reduced in comparison to using a non-MDE approach?

4. How suitable is the PaaSage solution for solving the problem of multi-cloud deployment?
5. How suitable is the PaaSage solution for solving the problem of adaptive provisioning?
6. How suitable is the PaaSage solution for supporting cloud bursting?
7. How suitable is the PaaSage solution for supporting deployment optimisation based on scalability rules?
8. Please indicate any requirements of your organisation not fulfilled by PaaSage.
9. In your opinion, what is the level of security in PaaSage?
10. How do you rate the adequacy level of PaaSage security and administration tools?
11. According to your opinion, what could be improved to add value to PaaSage?

### Part 3 - Learning PaaSage

1. How adequate is the training material (e.g., documentation) for learning the PaaSage methodology?
  - 1.1. If you think the documentation includes misunderstandings for the methodology of PaaSage or if it is missing important information, please indicate which.
2. How easy was it to achieve an adequate proficiency level using the PaaSage methodology?
3. Are the different types of models easy to comprehend?
4. After you learn how to use the PaaSage platform facilities, in which degree is the required effort reduced?
5. After you learn how to use the PaaSage platform facilities, in which degree is the required cost and time reduced?
6. How do you rate the technical support provided by the PaaSage community (e.g., experts, social network)?

### Part 4 - PaaSage platform

1. How well do the modelling tools provided by PaaSage support the user specification during the design activity of the cloud-based application lifecycle?
  - 1.1. If you think that the modelling tools do not support design activities adequately, please indicate why.
2. How well do the MDE transformation tools provided by PaaSage support the related generation activities?
  - 2.1. Please mention any MDE transformation tools of PaaSage that could be improved.
3. How well does the PaaSage toolset support the developer's tasks (e.g., deployment, monitoring)?
4. How do you rate the quality of the PaaSage toolset?
5. How easy would it be to extend the PaaSage toolset for realising additional capabilities?
6. How accurate do you think the decision process of PaaSage for (re)deployment is?
  - 6.1. Would you find the existence of additional controls over the re-deployment useful?
7. How easy is it to move from one module to another in the main flow of PaaSage?



8. Would you trust data, models and any kind of knowledge from other users of PaaSage via the offered tools (e.g., social network)?
9. Do you think that a cloud-specific rule-based approach is able to cover all possible cloud-based adaptation scenarios?
10. How do you rate the monitoring approach of PaaSage?
11. Please indicate functionality that is not supported in PaaSage or that is not adequately supported.

#### Part 5 - PaaSage adoption

1. How beneficial is PaaSage for your organisation/network?
2. How do you rate the level of difficulty for exploiting the PaaSage solution?
3. How easy it to configure/adapt the solution of the PaaSage methodology?
4. How easy is it to integrate the PaaSage toolset with other available tools?
- 4.1. Which other available tools do you envision to be coupled with the PaaSage toolset?
5. In which degree could you use PaaSage together with other tools adopted in your organisation/network?
6. In which degree could parts of PaaSage replace tools adopted in your organisation/network?
- 6.1. If parts of PaaSage could replace tools in your organisation/network, which tools are they?
7. How easy is it to integrate the PaaSage methodology with other development practices?
8. In which degree does the solution of the PaaSage methodology comply with appropriate standards?
9. PaaSage can efficiently replace other methodologies I am currently using.
10. Would you recommend the use of PaaSage to partner organisations?
11. Please indicate any standards that are missing in the PaaSage methodology.
12. Please indicate any competitive tools to PaaSage that your organisation is currently using.