FP7- FoF-ICT-2011.7.3 Virtual Factories and enterprises

"Innovative end-to-end management of Dynamic Manufacturing Networks"

Deliverable D5.1.2

Evaluation of Technical Aspects of the IMAGINE Platform, version 2

Workpackage:	5 – Evaluation and Market Deployment
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Executive Summary

This deliverable outlines the 2nd technical evaluation that provides an in-depth assessment of the technical "performance" of the generic IMAGINE platform as well as the customized platform versions by all Living Labs. This evaluation complements the 1st assessment published as D5.1.1 by considering the IMAGINE Generic Platform and all customizations from different customer's perspectives. The evaluations of technical aspects of the IMAGINE platform – as presented in this deliverable – have been assessed by each living lab, describing and cross-correlating the five individual evaluations from five customized IMAGINE platforms.

Subject of the assessments are all components of the generic IMAGINE platform plus the living lab specific extensions including system-adapters, and, additional components and services to fulfill the required functionality within the Living Lab's specific industry domain. In this way, this evaluation obtains an exhaustive and all-encompassing character of the technical software implementation, which complements the 1st technical evaluation, wrapping it up with real-life experiments and test-runs conducted by the living labs. In addition to the evaluation of technical criteria, this task also includes the assessment of total cost of ownership (TCO) from each individual living lab. Although these are best-guess estimates, they provide sufficiently detailed basis to define all efforts in operating and maintaining the customized IMAGINE platforms and act as a valuable preparatory input when judging on the business value on the IMAGINE solution in the IMAGINE Business Case Task (Task 5.3).

The evaluation was conducted systematically and standardized for all Living Labs through an online questionnaire that has been used by evaluators on evaluation sessions, technical meetings with customers, or on fares and workshops to gain access to a wider audience. The evaluation is based on widely-accepted evaluation standards considering security, interoperability, functionality, performance, etc. but also allowed customized questions to account for the assessment of specific aspects found in only in some industry sectors.

As evaluation results and the technical assessments reveal, there are differentiates views of perceiving the IMAGINE platform and the developed DMN solution for the IMAGINE industry sectors. Use cases differ in their application domain, the evaluation focus, the use of IMAGINE components, and the choice of evaluators, and accordingly their evaluation ratings. Technical platform aspects of the IMAGINE platform which received a high and good scores are interoperability, learnability, and extensibility whereas stability, reliability and security need to be improved in some platform instantiations to satisfy the market demands. Also localization issues should be considered to create a higher acceptance in certain market segments.

Variations are also noticeable with respect to the Total Cost of Ownership as the IMAGINE Living Labs vary in their business models and accordingly their use of components, licensing for external systems, maintenance personnel, use of infrastructure, etc. They represent the full range starting as low as 10 000€ up to 680 000€ of costs in the 1st year which need to properly targeted in the individual business cases of the IMAGINE partners. This again shows that there no IMAGINE solutions which

"fits it all". Solutions can only be successfully marketed to the market by understanding the market needs and provide adequate, highly customized solutions.

The major outcome of this task is that, five different and customized IMAGINE platforms have been evaluated by experts from related industry domains, stressing technical highlights of the technical implementation. Based on this IMAGINE partners are enabled to benefit from evaluation results by stressing industry relevant platform aspects which received a high score and push ahead the commercialization using the platform's most valuable unique selling points as part of the DMN concept. Hereby, this task further delivers the input needed to propagate the business value of the IMAGINE approach through the IMAGINE Business Cases, propelling the individual IMAGINE Business models and individual exploitation. Based on the costs of "owning" a platform identified in this deliverable, the IMAGINE Business Cases (Task 5.3) will analyze the benefits and most pertinent financial indicators to quantify the impacts on various stakeholders.

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1 Introduction

1.1 Purpose and Scope

This deliverable (D5.1.2) covers the evaluation of technical aspects of the IMAGINE Platform and reports on the technical evaluation of the IMAGINE platform including the required individual customizations for each Living Lab. It is hence supplementing the picture obtained from the 1st evaluation (cf. D5.1.1) by extending the view on the platform capabilities in a more "customer"-centric approach, leaving space to technically assess domain specific extensions. Whereas the focus of the 1st evaluation was on common aspects of the generic IMAGINE Platform and considered foremost classical evaluation aspects like security, interoperability, performance, etc., the 2nd evaluation is intended to assess the technical feasibility of the customized platform instance to support the business issues of an industry domain. In this sense it will deliver a complete view as adapters implemented, additional components and services implemented by each Living Lab in WP4 will play considered to a large extend.

In addition to technical assessment of the customized platform implementations, this document addresses the total cost of ownership (TCO) which estimates the costs that must be accounted for throughout the lifecycle of the IMAGINE platform including costs incurred by operation, licensing, maintenance, vendor lock-in, etc. TCO information delivers valuable input to the IMAGINE business Cases as they must be opposed to Total Benefits of Ownership (TBO) which are further elaborated in the individual IMAGINE Business Model and exploitations.

1.2 Relation to other Work Packages

The present document is the 2nd evaluation work package 5 that assesses the technical performance of the integrated i_platform. The main input for this report is obtained by assessing the individual software implementations and customizations accomplished by the different living labs in WP4. This assures that all expectations and requirements from WP4 can be scrutinized and used as feedback to evaluate different industry domains.

The present deliverable provides the second version of the evaluation as an additional output to Task 5.1: "Evaluation of Technical Aspects of the IMAGINE Platform, version 1", complementing the previous evaluation by the assessment on the customized IMAGINE platforms. Results of this deliverable are used as input for the deployment and exploitation plan to support the end-to-end DMN management for the integrated IMAGINE platform.

As the technical evaluation tasks is concurrent to Task 5.2 "Evaluation of the end-to-end DMN management approach, Version 2" both evaluation tasks have been planned in accordance to well thought schedule, guaranteeing the alignment of results and allowing a concurrent execution. Both tasks produce results that will directly support the work in Task 5.4 by providing TCO and user-oriented assessments to leverage the individual IMAGINE business cases.

The total cost of ownership assessed during this task will also influence the work of task 5.3 "IMAGINE Business Case" by delivering the costs which need to be compared versus the benefits in order to calculate the net added-value from using the IMAGINE platform that will be used as a marketing instrument when advertising the IMAGINE platform.

An overview of involved work packages and tasks is displayed in Figure 1-1 in terms of a PERT diagram.

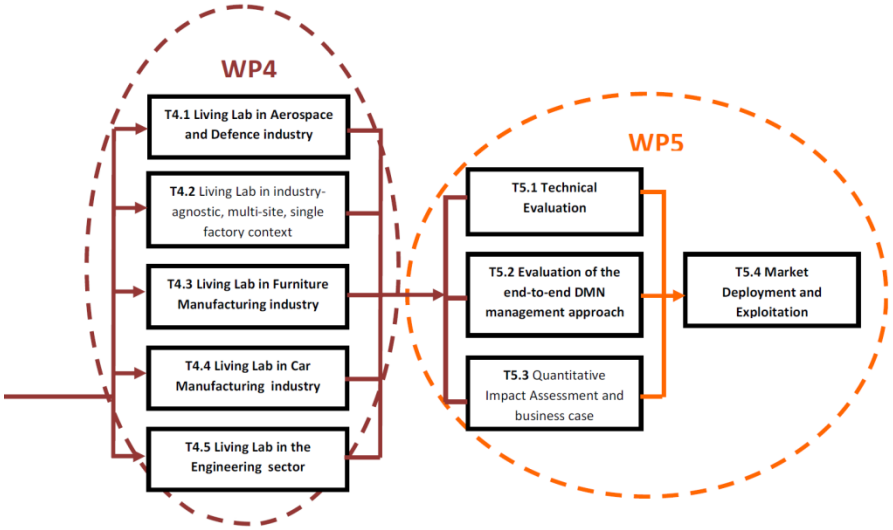


Figure 1-1: Relation of the Task Platform Evaluation to other tasks and work packages

1.3 Structure of the Document

This deliverable is structured as follows: Chapter 2 will introduce the basis of the evaluation methodology explaining the fundamental evaluation steps and the basis of the online assessment chosen. In addition, an overview of the total cost of ownership (TCO) is provided focusing on the perspective of the Generic Platform. In addition all industry specific TCOs are stated from the living lab partners that account their individual scenarios. Thereafter in Chapter 3 the evaluation is described in detail, giving arguments for the choice of evaluation criteria, the modalities of the assessment and the actual technical evaluation that is the core of this deliverable. The evaluation is discussed in the subsequent Chapter 4 covering the evaluation results, details about the assessment, explanations, and a GAP analysis that highlights the deviations between the 1st and the 2nd evaluation. Eventually, Chapter 5 concludes this document by providing a summary about the evaluation where general aspects and findings are highlighted and an outlook is given.

2 Evaluation Methodology

2.1 Methodology & Goals

This section describes the evaluation approach and the underlying methodology. The evaluation consists of a multi-stage approach, which is derived from the design stages of the i_platform, amalgamated into an integrated evaluation methodology. The course of action is to create a top-down evaluation process that merges user expectations and data requirements to a standard evaluation structure. In order to collect, document and analyze the requirements and aligning them in a comparable manner, a questionnaire has been developed.

1st Step – Selection of Evaluation Participants

The evaluation is following a multi-layer approach where in the 1st step the core evaluation team is selected. As opposing to the 1st evaluation the selection of evaluators is not restricted to IMAGINE participants but extended to include external entities, customers, special interest group (SIG) members, and alike, obtaining a heterogeneous group of evaluators which is covering a large external knowledge and experience basis intended to capture a broad spectrum of attitudes and opinions. The participation of colleagues external to the IMAGINE project is also admissible but should be an exception as these might be biased. To optimally prepare evaluators for the assessment and make them familiar to the technical platform, participants are trained in the IMAGINE architecture, the design of the platform, the DMN methodology, to make them aware of the platform's capabilities.

2nd Step – Requirement Definition and Evaluation Objectives

This step covers the identification of requirements and objectives that differ between all evaluation participants since the living lab partners and in particular their evaluators come from different industry domains and hence have different settings in mind. As a fact objectives greatly vary as the application domains and deployment scenarios will range from SMEs with little security awareness and no present IT infrastructures up to profoundly regulated, multi-site companies with highly automated processes. Hence Living Labs are required to formulate an evaluation process which ensures that all relevant objectives will be covered by the assessments.

For the platform evaluation a set of industry standards has been selected which are in general considered for the evaluation of IT- and software systems. In addition to the 1st evaluation, Living Labs have the opportunity to change this set of questions according to their needs. By doing this, they were optimally prepared for the assessment to focus on the group of evaluators and the assessment event.

3rd step –Technical Evaluation

The actual assessment of the technical instances is conducted in this step and evaluators have to have access to the IMAGINE platform system including all the related services and dependable software services on which the operation of the platform relies. Findings are documented using the prepared questionnaire. Following, the questionnaires are analyzed and evaluated in the context of the specific industry sector.

2.2 Total Cost of Ownership

Total cost of ownership (TCO) is a financial estimate intended to help buyers and owners determine the direct and indirect costs of a product or system throughout its lifecycle. It is a management accounting concept that can be used by managers to better inform themselves before they decide matters within their organizations, which allows them to better manage and perform control function.

In order to compute the total cost of ownership of an operational IMAGINE Platform several factors need to be taken into account. The different costs that contribute to the total cost of ownership of an operational IMAGINE Platform have been identified by the consortium and are analyzed hereafter and are summarized in Table 2-1.

The TCO for the IMAGINE platform is nothing fixed but a flexible mean of calculating the costs of "owning" the IMAGINE platform over a time period. A formula is used to express this properly and allows not only computation of the current costs but also costs with respect to the future investment.

$$TCO_n = C_{GenericPlatform} + C_{Customization} + \sum_{i=0..n} C_{Operation/Maintenance(i)} + C_{Personnel/Training(i)} + C_{Others(i)}$$

The TCO_n denotes the Total Cost of Ownership as a sum for the next n years. As it is only a rough estimate, it doesn't consider inflation, missing interest rates, and considers static wages and costs which is an idealistic consideration. In particular wages are difficult to obtain and estimate as they depend on company and economic conditions which are outside the course of this consideration.

The above formula uses two main ingredients for its computation: the upfront costs for licenses, hardware ($C_{GenericPlatform}$) which account for the generic platform, and customization costs ($C_{customization}$); on the second hand yearly costs are considered which depend on the years of operation like platform operation and maintenance, personnel and training, and other costs. Note, that depreciation and scuffing are not part of this costs and will not be considered for the investment.

The cost of operation of the IMAGINE Platform, which is the sum of all costs that are needed to run the IMAGINE Platform. These costs include the license fees for the proprietary components that have been used, such as the MashZone dashboard, webMethods Integration Server and Broker, Oracle databases and the cost of hosting the IMAGINE Platform as a cloud instance on a dedicated server with 4 cores, 32GB RAM and 2 Terabytes of hard disk space. An additional cost potential Vendor lock-in needs be considered which accounts for cost that might become relevant when switching from one commercial solution to another one in the future.

Furthermore the total cost of ownership of IMAGINE Platform include the cost of the personnel required to operate the IMAGINE Platform. The operational personnel cost needs to consider the cost of the business related operations of the IMAGINE Platform, for example the cost of hiring a DMN Manager as well as the cost of the technical related aspects of the IMAGINE Platform usage such as the cost of contracted or permanent IT personnel.

This cost could also be potentially increased by additional cost for implementing and running the IMAGINE DMN Methodology.

In addition the cost for maintaining the IMAGINE Platform are considered, including services related to the maintenance of the IMAGINE Platform software, such as bug fixes, system updates, service upgrades to account for changes within the company infrastructure, and security updates.

Finally customization costs of the IMAGINE Platform taken into account. This cost includes the cost of implementation of the custom adaptors for the integration with the IMAGINE Platform. The cost of the adaptors implementation could be further analyzed as the sum of the costs to customize the blueprints, the cost to connect to the integration server, and the cost to connect the adaptor to production systems. It should be noted that the cost of the adaptor implementation is expected to vary as it is dependent to the different needs of production systems that need to be integrated and the needs of the particular industry. Furthermore the existence of other similar adaptors can further reduce the cost of the adaptor, since adaptors could be reused or modified easily. In regards to customization potential costs for systems upgrade or systems migration should be also taken into account.

Finally the cost of implementation of domain specific applications should be considered leveraging the IMAGINE Platform functionality and technology stack. This cost is also expected to vary in a similar way as the cost of the adaptors as it is highly dependent on the manufacturing industry and the desired customized functionality.

Table 2-1: IMAGINE Platform TCO Analysis

IMAGINE Platform TCO	
Generic Platform	***Licenses***
	Integration Server, Broker, MashZone
	Licensing Costs per Partner
	Oracle DB Licenses (optional)
	Cloud Hosting
	Hetzner 32GB RAM, 4C, 2TB
	Hardware
	Infrastructure
	Others
Customization	***Adapter Implementation***
	Blueprints
	Integration Server
	Production Systems
	System Upgrades
	System Migration
	Domain Specific Implementations
Personnel	***permanent***
	Technician
	Certified Technician
	Engineers
	DB Administrator
	Software Developer
	Software Architect
	contracted
	Technician
	Certified Technician
	Engineers
	DB Administrator
	Software Developer
	Software Architect
	Platform Operation
	DMN Manager
	DMN Administrator
	Training
Maintenance	***Other Maintenance***
Vendor lock-in	***Software***
	Technology
IMAGINE Methodology	***Customized Methodology***

2.2.1 Generic IMAGINE Platform R3

The costs that comprise the TCO of the IMAGINE Platform have been discussed in section 2.2. These costs included costs that are both applicable for the generic IMAGINE Platform as well as costs that are applicable for customized version of the IMAGINE Platform. Given the fact that the TCO of the

IMAGINE Platform can vary due to reasons such as the particular customization context, the country of operation, the manufacturing industry, the functionalities used and others. This section aims to capture the TCO that is applicable in the context of the customized IMAGINE platforms that are described in section 2.2.2. In order to try to account for the differences in the rate of employees in different companies and countries the operational cost has been calculated in Person Months where possible. Exact costs in euro where used in cases where the cost is known, like the dedicated hosting server cost, the cost of licenses and maintenance for the IMAGINE Platform generic components. It could be mentioned that the actual cost of ownership for the generic platform mentioned here is valid to the context of the Living Labs customized platforms and assumes usage of the complete generic IMAGINE Platform system. The cost of ownership for the generic IMAGINE Platform components can be found in Table 2-2.

In order to derive the aforementioned costs the following conditions apply. The bundle price of the software licenses for the Software AG proprietary products is dependent of the Customer, Application fields and final pricing can only be needs achieved after negotiation with the appropriate pre-sales department. However Software AG offers a three years startup program with free licenses followed by a smooth ramp-up phase where license costs can be reduced up to 90%. These are the costs that have been calculated in Table 2-2.

Also INTRASOFT offers two pricing options. The first pricing option allows to all Living Lab partners royalty free use of the developed components for the first two years after the end of the project in order to allow market entry. From Jan. 2017 the fee will be 1.5% of the revenue made via commercially using I_Platform as a service. An amount of 1.5% of revenue made via installing i_Platform as a service is also valid for all new users/clients outside the consortium. The second pricing option costs 11.000 Euro per license per year. Price includes maintenance and hosting. A license is required for every user of the IMAGINE Platform. The total cost shown in Table 2-2 takes into account pricing option B.

Licensing costs and applicable licensing programs for the commercial components within the IMAGINE platform are displayed within the following figure.

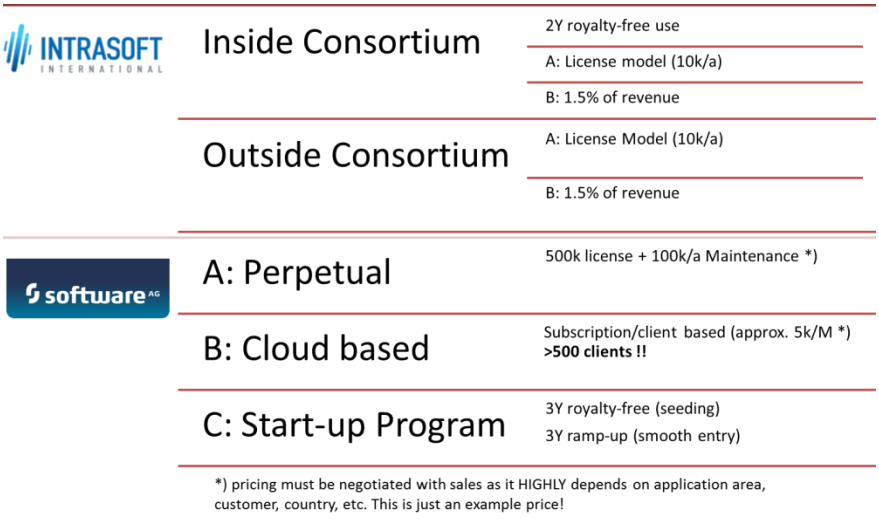


Figure 2-1: Licensing Programs for commercial software components

Table 2-2: Cost of Ownership (TCO) for the Generic IMAGINE Platform

	Total (inside Consortium)			
	Initial Costs [€]	**Yearly Costs [€]**	**Initial Labor [PM]**	**Yearly Labor [PM]**
Operation IMAGINE Platform				
Generic Platform	0	0	0	0
Licenses	0	0	0	0
wM IS, Broker, MashZone	0	0	0	0
Licensing Costs per Partner ($C_{GenericPlatform}$)	0	11000	0	0
Oracle DB Licenses (optional)	0	0	0	0
Hetzner 32GB RAM, 4C, 2TB ($C_{GenericPlatform}$ + $C_{Operation}$)	50	600	0	0
Hardware	0	0	0	0
Infrastructure	0	0	0	0
Others	0	0	0	0
Personnel				
Permanent				
Technician	0	0	0	2
DB Administrator	0	0	1	0,5
Software Developer	0	0	1	2
Software Architect	0	0	0	1
Contracted				
Technician	0	0	0	1
DB Administrator	0	0	0	0,5
Software Developer	0	0	2	8
Software Architect	0	0	1	1
Platform Operation				
DMN Manager	0	0	1	12
DMN Administrator…. Etc.	0	0	2	2
Training	0	0	0	2
Maintenance				
Other Maintenance ($C_{Maintenance}$)	0	4700	0	0
Vendor lock-in (C_{Others})				
Software	0	2500	0	0
Technology	0	0	0	0
IMAGINE Methodology				
Customized Methodology	0	0	2	0,75
SUM	**50**	**18 800**	**10,00PM**	**32,75PM**

The aforementioned total cost of ownership of the generic IMAGINE Platform that is applicable in the context of the Customized Platforms can be used to provide an estimation for the TCO in other cases as well. The TCO_1 – representing the costs for operation the platform for 1 year – sum up to 18 850€ plus personal costs which are not part as they heavily differ between countries, the industries, and the level of experience. However, a case specific analysis would be needed if very precise results are needed.

2.2.2 Customized Platforms

The following sections provide the accountable costs for each industry sector by assessing the individual costs required for operating, maintaining, extending, and licensing the IMAGINE components. In some scenarios where the platform is ought to be publicly available this also includes training of IMAGINE participants to become familiar with the platform and the use of external hosting facilities.

2.2.2.1 TCO for the Industry Agnostic Sector (Fraunhofer IPA)

The IPA IMAGINE LL platform has comprised of the basic parts of the generic IMAGINE platform R3 and its extension forming R4 with additional adaptations and an extended user interface. Each of the main building blocks of the platform, a) the open source platform server hosting the IMAGINE portal, the Blueprint repository and the Production repository, b) the Software AG WebMethods Integration Server and c) the Nagios based monitoring repository is hosted inside a private VMware vSphere virtualization platform with virtual servers for each server component with the following specifications:

IMAGINE portal + Blueprint & Production Repository server:

- Intel Dual Core 2,6 GHz Xeon Processor
- 8 GB RAM
- 50 GB HDD
- Ubuntu

Software AG's WebMethods Integration server:

- Intel Dual Core 2,6 GHz Xeon Processor
- 8 GB RAM
- 50 GB HDD
- CentOS Linux

Nagios monitoring repository server:

- Intel Single Core 2,6 GHz Xeon Processor
- 4 GB RAM
- 40 GB HDD
- CentOS Linux

The IPA single factory component adapter (SFCA) is an additional server component which can be either hosted locally on a physical server or in a cloud environment on virtualized hardware to perform its tasks. It's designed to be as lightweight as possible and can be deployed on a relatively cheap Intel NUC mini pc. The SFCA acts as the single connection point between a partner's

production site and the imagine platform. It is collecting and processing monitoring and tracking information from the production site's manufacturing equipment and IT systems and provides this information to the IMAGINE platform's system respectively the IMAGINE integration server. Since development of the customized platform is still ongoing, a connection to a live production system is not recommended, which is why for the purpose of testing and demonstration this data is being generated by emulated equipment. Since the SFCA can be extended it is possible to implement and integrate it with additional standardized interfaces like an OPC UA server component to provide data from live production equipment. It provides a separate user web interface which can be used to manage available site equipment and tracking tasks.

An SAP ERP adapter has been implemented to provide the user during the DMN configuration phase with live information via additional portlets on the IMAGINE platform to extend the available functionality of the generic i_Platform. This adapter can also be used to push dynamic data either directly to the Partner Blueprint inside the Blueprint Repository or to the provided monitoring interface of the generic IMAGINE platform.

The following TCO contains all license fees which an external industrial customer needs to pay if he wants to operate an IMAGINE IPA LL instance including the full functionality. Since Fraunhofer IPA is a research institute our own non-commercially operated platform has an substantially lower TCO, since some partners like Software AG offer indefinitely free licenses for academic and research partners. Also the cost of our own hosting service which has been developed to cater to the specific needs of industrial users is significantly lower for our own purpose of development, demonstration and exploitation.

Table 2-3: TCO for Industry Agnostic Sector

Pos.	Description	Initial Cost	Yearly Cost	Comment
1	INTRASOFT component licensing cost		15200 €	IMAGINE Portal, PRC, DMN Configuration, DMN Design BP Repository, Production Repository
2	Software AG component licensing cost	500 000 €	110 300 €	SOFTWARE AG webMethods IS server + MashZone Dashboard
3	Infrastructure/Hosting cost		16 000 €	Virtual Fort Knox high security private cloud environment
4	Platform Rollout and Configuration	5 000 €		4 days of work (engineer)
5	Platform Maintenance		4 800 €	
6	IPA Blueprint Management Interface		600 €	
7	IPA SAP Simulation component		600 €	
8	Siemens Plant Simulation License:	3 000 €	11 000€	This back-end component is needed for the SAP Simulation component. The initial cost is needed for the configuration and adapter integration.
9	IPA SFCA – standard customization and adaptation	2 000 €	600 €	
10	IPA SFCA – individual adapters and customization	3 000 € (8 000 € for a new adapter)		Individual adapters for specific production IT systems which need to be integrated. Cost per adapter.
11	IPA BLE Tracking Solution	5 000 €	1 200€	Initial Cost contains 10 Sensor Hubs for BLE tracking.
12	**Sum of IPA Components**	**18 000 €**	**34 800 €**	**Cost for IPA components only**
13	**Total sum (TCO_1)**	**518 000 €**	**160 300 €**	**Cost for ALL components**

The IPA components are modular and can be combined as required; therefore the total sum will be reduced if a specific component is taken out by its stated cost.

2.2.2.2 TCO for Aeronautic and Defense Industry (AIRBUS/EADS)

The case of Airbus Group Innovation is different than the other Living Lab, as a specific implementation of the i_platform has been developed, the cPlatform, which is based on the same i_platform architecture, but which is based on the principle of relying only on open source and free components.

The motivation is related to the targeted exploitation of the cPlatform: it must constitute the infrastructure for assessment of manufacturing PLM standards and of their implementations by an open community, in order to support required interoperability for the establishment of a secured and dynamic manufacturing network. The platform is consequently an experimentation platform, and not a platform aiming to be used and deployed in operations.

In addition, it should be possible the cPlatform to be replicated, hosted, operated and maintained by different organizations, being enterprise, international working group of experts, universities, etc. with a minimum cost of ownership.

An exploitation consists in deriving a more robust platform to be used in operation was also considered, by replacement of components of industrial quality with fully functional Community Edition and with an Enterprise Edition. Such enterprise editions will improve the robustness of the components, making it possible to tune the platform in order to make it more scalable. Such exploitation is out of the scope of the Aeronautic Living Lab, which aims prior to support establishment of a consistent set of Aeronautic and Defence PLM manufacturing standard in order to enhance Dynamic Manufacturing Network.

The additional costs to consider are those related to human resources for the platform set up, administration and evolution. The roles to consider are the following

- Network administrator
- Application infrastructure administrator
- Portal administrator
- Process architect
- Information system architect
- Software architect
- Developer

The required skills for these roles were designed in order to be easy to develop by different means:

- Selection of well documented open source software components with active community and training material available (e.g. Liferay, ProxMox, etc.)
- Assessment of these components in terms of easy learning – e.g. OpenESB was selected after LAAS experimenting during courses usage of different ESB by students, and collecting back the best candidate
- Architectural choice related to existence of studio for easy development of complementary components and for integration with legacy applications to be integrated with the cPlatform. E.g. Portlet components is supported by a studio including Vaadin and associated plug-in
- Architectural choice related to component based design relying on mature open standards, in order to allow users of the platform to reuse already existing components in place of those

selected by the Aeronautic LL within IMAGINE. It allows preservation of the investment concerning already used software product (e.g. PostGresQL database replacement by Oracle).

Different economic models can be envisaged for exploitation of the cPlaform, which will depend on the way the concerned communities want to collaborate.

A current exploitation is related to establishment of test bed for manufacturing PLM standards by the SIP project. A basic infrastructure is provided, and different kinds of partnerships are proposed, for research or for assessment of a standard. Cost is calculated in order to secure the capabilities related to exploitation of the platform (less than one person full time). The following are the TCO details for Aeronautic and Defense Living lab:

Table 2-4: TCO for Aeronautic and Defense Living lab

Description	Initial Cost	Yearly Cost*	Comment
Licensing	0	0 €	No costs licensing as all the components are free and open source
Cloud hosting	300 €	7 200 €	Costs for hosting 3 physical cloud servers used to deploy the required virtual machines hosting the LL components.
Operational Platform management and maintenance		18 000 €	2 PM per year (pure administration)
LL Platform support for operations		100 000 €	10 PM per year (training, evolution with continuous integration of functional components)
Total sum (TCO_1)	**300 €**	**125 200 €**	**Cost for ALL components**

* rough estimation considering 1PM mean cost is 9000 KEuros and Cloud hosting prices of the configuration used during IMAGINE

2.2.2.3 TCO for Automotive Sector (CRF)

On top of the TCO of the Generic IMAGINE Platform R3, the Customized Platforms (IMAGINE R4) TCO for the Automotive LL includes the required resources, the customization costs to operate and run the platform and any specific adapter implementation. In particular the following costs have been identified:

Resources for customization:

- webapp graphical interfaces: they have been already developed in the course of the project. No additional cost is needed.

- webapp interface to MES/ DMN emulator: they have been already developed in the course of the project. No additional cost is needed.
- webapp interface to IMAGINE: they have been already developed in the course of the project. No additional cost is needed.

During the industrialization phase, additional requirements may be identified, leading to additional customization cost, depending on the entity of the customization required.

Table 2-5: Summary of TCO for CRF

Description	Comment	Costs
Resources for installation	• at server side: one day per year • at client side: 1 hour per year	600€
Resources for training	• at server side: half a day per year • at client side: 1 day training per user	817€
Resources for maintenance	• at server side: 2 days per year • at client side: 2 days per year + license cost Tecnomatix per year	7 180€
Additional costs per user	Additional costs per user	1 635€
	Total TCO_1 per User	10 232€

2.2.2.4 TCO in Furniture Manufacturing (AIDIMA)

Technicians inside AIDIMA – with a strong background in manufacturing and IT – assessed the Total Cost of Ownership (TCO) model, taking into account all-necessary aspects (personnel and monetary resources) mandatory to setup, run and maintain the platform, as well as to provide different IMAGINE Services, mainly, for the associated companies to AIDIMA.

To be easier the estimation the costs are divided into different categories:

1. Operation. No cost for licensing and hosting as it is free of use all the developed components for the first 3 years after the end of the project in order to allow market entry. From Jan. 2017 it will be 1.5% of the revenue made via commercially using i_Platform as a service.
   It needs only about 500€ (AIDIMA) of costs for Infrastructure maintenance.
2. Customization of the Furniture Living Lab. The cost for continuing with the implementation of the Adapters and specific implementations is around 39.400€ p.a. This is decomposed in 2 parts:
   a. Around 8.000€ p.a. (AIDIMA) and 11.400€ p.a. (UNINOVA) specific new implementations in the Adapters or system upgrades
   b. Around 20.000€ p.a. (AIDIMA) for specific implementations accessing to specific legacy systems (ERP, excel files, AP236 standards, etc.) to upload product and process data to the Furniture Living Lab.

3. Maintenance. There are personnel from UNINOVA with costs of 22.800€ p.a. dedicated to maintain the Furniture LL Adapters services, update procedures, information or knowledge, and functionalities. From AIDIMA for maintenance of the web services. Mainly in AIDIMA the high cost in maintenance is related to the introducing of catalogues product and process data and one IT technician for analyzing how to upload such big amount of data from specific ERP systems and also for the maintenance of the integration web services. This is needed because the Living Lab must have hundreds of manufacturers/suppliers and thousands of products to be really a good service for the companies. Thus some subcontracting would be required to accomplish this last task. Costs related to AIDIMA about maintenance are around 11.920€ p.a. (AIDIMA).
   There are also costs related to infrastructure maintenance, which are included in Operation.
4. Vendor Lock-in. No cost at all.
5. IMAGINE Methodology. No specific cost apply.

The estimated total TCO_1 after year 1 for maintaining the Furniture Living Lab after the project conclusion would be:

- For UNINOVA: 34.200€ p.a., which represents 4.5 MM per year in personnel
- For AIDIMA: 40.420€ p.a. + 1,5% of Revenue

The total cost of ownership for the furniture domain consist only on operating costs (i.e. the only costs which account are occurring on a yearly basis meaning that $C_{GenericPlatform}$ and $C_{Customization}$ are both equal 0) and no initial investment is needed.

$$TCO_1 = \sum_{i=0..n} C_{Operation/Maintenance(i)} + C_{Personnel/Training(i)} + C_{Others(i)} = 74\,620€$$

2.2.2.5 TCO for Engineering Sector (University of Warwick)

The UoW customization is in the form of two adapters, both of which are external to the i_Platform.

The first is a stand-alone application for creating and uploading partner profiles. On the generic platform, no form or graphical user interface (GUI) is provided for the purpose of entering partner data to create a partner blueprint, and so only a Living Lab customization can make the platform usable. The UoW User Interface provides such an interface and includes the ability to control the ontology of various fields in order to maintain integrity and consistency.

The second adapter is a bridge between UoW's WMCCM platform and the i_Platform. This adapter naturally requires the WMCCM platform to be used alongside the i_Platform, and functions in such a way that WMCCM's partner search would be used in preference to the i_Platform's Product Requirement Composer and Supplier Search Component, with the i_Platform being used to manage and control the resulting DMN.

- Additional Required Resources (i.e. additional to generic i_Platform:
  - UoW User Interface
    - Standard PC
    - License

        - Free to Consortium Partners
    - Initial labor
        - 0.5 PM
- CCM Bridge
    - CCM Platform
    - License
        - Free to Consortium Partners
    - Initial labor:
        - 0.5 PM
- General
    - Validation Staff
        - Yearly: 6 PM
        - Office space: serviced office hot desk

2.3 Evaluation Aspects

2.3.1 General Questions

The evaluation was designed to obtain not only the assessors feedback on technical questions, but also their background as this provides additional information to analyze and interpret the evaluation results of the platform. For this reason the questionnaire requests the evaluator's relation to the project, whether he is external or internal. Internal evaluators are for example employed by a company participating in the IMAGINE project but do not necessarily work in the IMAGINE project, e.g., a colleague from another department. In contrary, external entities are people outside the IMAGINE consortium, having previously no particular knowledge about the IMAGINE platform, the methodology, the concept of dynamic manufacturing networks, etc. and need special training in order to comprehend the principles of IMAGINE.

In addition the Partner Name – to which the evaluator is affiliated – is queried to obtain a rough grouping of the industry domains. However, it is also feasible, that a Living Lab invited evaluators from a foreign industry domain or a different discipline, setting another focus within the evaluation. This affiliation has been further broken down by asking about the role of the IMAGINE partner for which the evaluation is done. Here, a selection of the following three profiles is possible:

- Technical Partner, IT Company, System Integrator or similar
- Living Lab, Manufacturing Company, End-user or similar
- Academic Partner, University, Research Institute or similar

To obtain a rough clustering of the participants the questionnaire contains field to question the manufacturing sector of the evaluator. These are usually similar to the industry domain of the Living Lab but not necessarily the same. For the Manufacturing Sector we offered the following choice:

- Aerospace and Defense Industry
- Semiconductor Industry
- Furniture Manufacturing Industry
- Car Manufacturing Industry
- Built-To-Order Engineering Sector
- Not applicable

- Other

To estimate the impact of the evaluation on the results, participants are additionally asked to provide their proficiency. This will help in the analysis of the evaluation results to ensure that experts in the relevant areas were participating with sufficiently deep background and expertise to correctly judge on the implementation of the IMAGINE platform. The following answers are possible where the "Other" field offers a user text and multiple answers are admissible.

- Manufacturing
- IT Technologies
- STEP
- ISA 95
- Other

To argue on the meaningfulness of the results, participants were eventually asked to provide their origin in the "Representative of..."-field. In the general evaluation template we provided the following fields for this:

- Large Enterprise
- Small-Medium Enterprise (SME)
- Other

2.3.2 Functional questions

Underlying the evaluation a set of categories has been chosen as it is commonly used in benchmarking of industrial software systems [3], [1]. In addition, the ISO standards for System and Software Engineering [5], [6] were used to reflect best practices for the definition of the applied criteria. Hereby all essential functional and extra-functional aspects are covered which are potentially important in the context of the i_platform. Eventually this set of criteria has been taken into account when designing the questionnaire template, the basis of all conducted assessments which have been shared with the living labs. Taking this template as a starting point, each Living Lab partner had the possibility to extend the common set of questions and evaluation criteria as needed, bringing domain specific considerations into the assessment but at the same time dropping questions our which are not relevant for its industry sector (cf. Figure 2-2) or the kind of the evaluation audience.

As the set of evaluation categories has already been described in detail in the 1st Technical Evaluation Deliverable (D5.1.1), we refrain from repeating ourselves here.

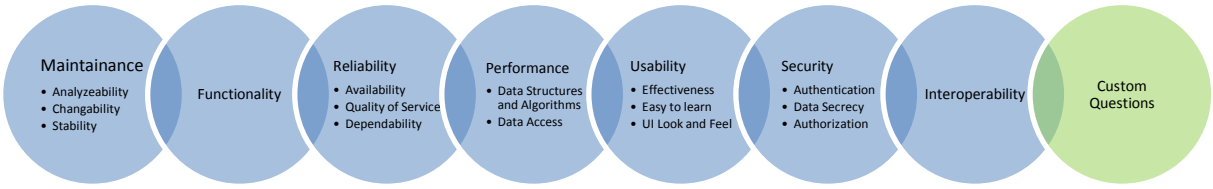


Figure 2-2: Criteria from the 1st Evaluation (blue) extended by custom criteria (green)

2.4 Online Assessment

As usually the distribution of evaluation questionnaires and afterwards the collection of the results is a tedious process, we were looking for a suitable way of sharing the questions between partners in a convenient and digital form, taking full advantage of online assessments available on the market. Eventually the decision has been taken in favor of Google Forms as it has proven to be flexible, and reliable, offering this service at no charge.

To allow the evaluating partners with the highest flexibility a generic evaluation template has been developed that could be adapted and adding custom questions. At the same time it was possible for each living lab to drop questions to shorten the evaluation (and respectively the time needed for the assessment) and make it thus more appealing to evaluators on exhibitions and fares. A template of the Generic Evaluation questionnaire is displayed in Annex C and as a live, working version available online (availability last checked on 1st October 2014):

IMAGINE 2nd Evaluation Assessment (generic template)

https://docs.google.com/forms/d/1F-DLxpjh7hwVKss1ZBgFanCIU2Sb7CBbvL0HzWVD-Pc/viewform

3 Evaluation of the IMAGINE Platform

3.1 Industry Agnostic

3.1.1 Evaluation Parties

Additionally to the internal evaluators consisting of the extended IPA IMAGINE LL team a group of external evaluators from Fraunhofer IPA's business segments have been chosen. These evaluators represent five different industrial sectors:

- automotive industry
- electronics and micro system technology
- power industry
- machinery and plant engineering
- medical and biotechnology

These evaluators are experts in their respective fields and have been used to point out the benefits as well as the weaknesses or gaps of the imagine methodology, respectively its implementation in the form of the IPA IMAGINE LL platform, which is providing extended functionality of the generic IMAGINE platform with emphasis on multi-site single factory production. The current implementation of the IPA IMAGINE LL which has been developed in the course of the IMAGINE project is primarily designed for a multi-site single factory scenario in the semiconductor industry context, since the way a large semiconductor company operates it fits the approach the approach proposed by the IMAGINE methodology the best. Because of the original "industry agnostic" nature of the IPA LL we have used the input of our experts originating from the described industrial sectors find the gaps and to project which additional changes in our implementation would be necessary to accommodate the specific requirements of another industry branch.

These evaluations have taken place on site at the Fraunhofer IPA campus during private sessions. Each evaluator has been given an extended presentation of the IMAGINE project, the IMAGINE methodology and the IMAGINE platform design respectively the IPA IMAGINE LL implementation and its features. Deviations from the generic online questionnaire have not been done, since we for one thing believe that the questionnaire provided by our evaluation task leaders is very suitable and thorough putting the emphasis on the most important factors and for another thing we wanted to maintain a grade of comparability with the other LLs and their customized platforms as high as possible for our further internal evaluations in the process of further improving the IPA IMAGINE LL platform.

3.1.2 Identify Requirements/Objectives

Since the IPA IMAGINE LL is depicting multi-site single factory context in semiconductor manufacturing, the major requirements in this LL are the ability to share information between production sites to create transparency and provide this information in near real-time. Semiconductor manufacturers often use different plants to perform different tasks during the production process of their products, e.g. the production of a memory module. The complex front-end processes are normally performed in countries with high personnel qualification and cost, while testing, assembly and further processing of the product is being performed in low-wage countries. Coordination and

transparency within this supply chain, especially horizontal integration and vertical integration on site are the basic requirements which need to be fulfilled for this task. The generic IMAGINE platform provides an integration server with adapter which can be used to upload data about the production process to the IMAGINE platform. This integration server can be used to provide either customized adapters for data input or its already available interfaces can be used to create new custom adapters for various production IT systems to connect them to the i_Platform.

Therefore the knock-out criteria which have been identified for the evaluation are:

- Interoperability
  - Can the system be connected to other IT systems, respectively production IT systems like MES, ERP, CRM, WMS etc.?
  - Is it possible to interconnect various production sites with the i_Platform functioning as an interoperability hub?
- Usability
  - The usability has been assessed from the point of view of a user, who is using the platform as intended for DMN management, monitoring, and profile management and from the view point of an administrator and developer, who needs to maintain the building blocks of the platform and/or develop additional components.
- Extendability
  - Extendability has been assessed from the point of view of a user who needs additional functionality.

The following criteria would be knock-out criteria for a system in production mode, but cannot be applied to a system, which is still under ongoing development and is operating in the form of a prototype demonstrator. The assessors stated their thresholds for a productive environment and gave their assessment to the demonstrated platform as it is. This means, expectations and results may differ as the demonstrated platform is not in a technology readiness level (TRL) that is able to be operated in a real productive environment. This has to be taken into account, when analyzing the results of the assessment.

- Security
  - Security is being assessed, weak points will be identified and additional security features to increase the provided security features would be implemented in a live production system. The required security features also depend on the specific use case which is being investigated respectively according to the needs which need to be performed.
- Reliability & Stability
  - Stability and reliability are the most vital criteria in an industrial application, which is why most applications in an industrial context need to certified for a specific use. In the case of this prototype demonstrator we have asked the assessors to rate this criterion on the basis of a live system, to be able to identify the gaps and weaknesses.

3.1.3 Thresholds and Acceptance Values

For the evaluation of the evaluation results we have chosen to prioritize and arrange the evaluation criteria as follows. The criteria are arranged by importance, with the most important at the top:

Table 3-1: Important criteria for the evaluation

Rank	Criterion	Importance	Comment
1	Interoperability	Very High	Most Important criterion, since the system needs to be interoperable with various production systems
2	Stability	Very High	Recommended stricter rating for extended gap analysis
3	Security	Very High	Recommended stricter rating for extended gap analysis
4	Reliability	Very High	Recommended stricter rating for extended gap analysis
5	Usability	High	Related to efficiency
6	Extendability	High	Flexibility of the system, ability to add new functionality or to modify existing one
7	Portability	High	How high is vendor lock-in?
8	Efficiency	High	Heavily business related
9	Understandability	Medium	-
10	Learnability	Medium	-
11	Look and Feel	Low	-

The thresholds for stability, security and reliability have been set by most assessors between 4 and 5, with 5 being the highest possible rating indicating utmost importance. Interoperability is a knock-out criterion which is directly influenced by the architectural and technological decisions which have been made during development. Too essential gaps in this criterion would be very hard to fix or to improve on. Usability and efficiency have been found to be closely tied together, with usability having direct impact on efficiency. The importance of these criteria is still high, thresholds and ratings were expected to spread relatively wide, since every individual has their own understanding of this topic, which has been confirmed by the evaluation results.

3.1.4 Investigated Systems

The emphasis for the IPA IMAGINE LL evaluation has been mainly put in two places. On the one side, there is the viewpoint of a regular user, for whom the platform needs to be as user friendly, functional and stable as possible. On the other side there is the system integrator/administrator,

responsible for customizing and maintaining the platform. For this party the customizability, interoperability and stability of the platform is crucial. This evaluation has been performed on the overall customized IPA IMAGINE LL platform. Additionally to that each part and building block of the platform has been tested an evaluated to determine their standalone behavior, functionality and stability.

Additionally to these systems an SAP ERP System has been connected to the IPA IMAGINE LL platform instance and emulated equipment via the SFCA interface. Since the overall platform is based on standard web technology it was possible to connect these systems via web services and implement the required additional user interfaces directly into the IMAGINE platform portal in the form of Liferay portlets. This way these systems can be accessed from any location if needed. This is aspect of the evaluation leads to a high rating regarding interoperability and functionality, since any required functionality can be added by extending the generic platform with additional systems and components.

3.2 Aerospace and Defense Industry

As mentioned several times, the case of the Aeronautic LL is particular, as Airbus Group Innovations and LAAS developed their own implementation of the i_Platform, the cPlatform, in order to support the DMN methodology adapted to the Product Aircraft design process, while the other LL were concentrated on the production process. The considered product is not the physical product, but the virtual (or digital) product.

In addition, the cPlatform is an experimental platform aiming to support PLM manufacturing standards and their Implementation. Concerned standards are ISO manufacturing standards dealing with Product & Process data exchange, sharing and Long Term Archiving. They are of strategic importance if willing to establish required interoperability within the targeted DMN. As a consequence, interoperability is a key topic for the Aeronautic LL, as considering that a DMN can't be establish without usage of standardized communication protocols (e.g. ISA95), standardized services (e.g. OMG's PLM services) or standardized process (e.g. VDA Change Management Process) at the applicative layer, with appropriate links with the technological layer standards (e.g. eXtended Markup Language) and business layer standards (e.g. ISO 15288 – System Engineering process framework).

The approach adopted for establishing interoperability in the Aeronautic LL is derived from the ATHENA Interoperability Framework (AIF), which consider that interoperability of enterprise applications must be establish at technology, applicative and business layers, and that strong decoupling of technological and business aspects is important. For doing so, the approach promoted by AIF and adopted by Aeronautic LL is to produce an SOA infrastructure on top of which the Business logic is deployed. It is realized by mean of a combination of Model Driven Approach, Enterprise modeling, Service Oriented Architecture and ontology. Aeronautic LL specific contribution is related to addressing not only interoperability, but interoperability in combination with other quality of a system such as security, scalability, agility and user-friendliness. Also, a richer set of functional components constituting the Service Oriented infrastructure where the business logic will be deployed is provided, each being based on an open standards and being initially a standalone component which was integrated by Aeronautic LL partners. Finally, the DMN methodology provides a new way of assessing standards and their implementation, combining data, service and process interoperability,

and considering not only interoperability between two applications, but between all the applications constituting the nodes of the Dynamic Manufacturing Network.

Within such a context, it is important to clarify what exactly is evaluated and in order to respond to which need. It is important to distinguish the cPlatform as a software product, and deployments of instances of the cPlatform within an operational environment. The expected qualities of the evaluated platform can be reach by design (architectural principles aiming to achieve a given quality) and by instantiation (depending on how the platform was deployed and tuned, and using which capability).

For aeronautic LL, two instantiations were realized, one on a development and testing environment hosted by the LAAS, and a second for integration and experimentation by end users on an environment hosted by Airbus Group Innovations. These two environments are on the Cloud, relying of rented machine as service with usage of virtualization servers. As a consequence, it is possible to experiment WEB based collaboration with interconnection of front office Enterprise Applications behind a firewall to the cPlatform. The access to the applicative resources by persons in organizations and segregation of these resources are achieved by the mean of portal technologies and standards. Middleware communication is ensured by means of an Enterprise Service Bus. Each of these operational environments includes sets of information which are to be administrated for evaluation purpose. It concerns the evaluation/testing data sets, which are strongly related to use cases and evaluation scenarios. It is important to consider that producing such test scenarios and test data sets is very resource consuming for those willing to perform the experimentation.

As it has a cost and has required resources were not in the project, the evaluation of the cPlatform was mainly done through design analysis, through unitary component testing and through integration testing. Note that several components are by themselves an output as they can be exploited standalone (e.g. ASB, collaborative portal, ArchiMagine, Sharkine, etc.)

In parallel, the output of the project is exploited within a new dedicated project, Standard Interoperability PLM, which will provide a Manufacturing PLM standards test bed, and a methodology derived from DMN methodology for producing set of Uses cases, test scenarios and test data in order to support implementer forums for PLM standards. The cPlatform is currently assessed and extended by the SIP project team.

Finally, as explained in the section for total cost of ownership, ability to deploy, exploit, maintain and change the platform is also an important requirement, reason why availability of development capabilities (DMN studios) and associated methodology for extending the platform and integrate external application was considered.

3.2.1 Evaluation Parties

The evaluation of the cPlatform includes evaluation of the development capabilities, including DMN designer (ArchiMagine Modeler), DMN Workflow modeler (Jawine) and DMN studios for development of some component to be integrated within the cPlatform.

C: cookbook, UiP: Usage in Project; T-Tp (Training and TP); I(ap): integration inside application ap; E: enactment

Table 3-2: EADS/AIRBUS evaluation plan

	Evaluation parties	IMAGINE internal	IMAGINE partner internal		Airbus Group Internal	External					
		Aeronautic LL IMAGINE internal	AGI	LAAS	SSC	ASD SSG	ISO SC4 TC184 community	SIP project	Education	Open Webinar	Other
Type of evaluation	Evaluated component					Interview Jean Brangé	Interview of Frédéric Darré	Interview of Thomas Vosgien, Kevin Letutour			
Unitary	AAC	C		Interview							
	ASB	C		Interview							
	DMN Designer	UiP, C, I in ArchiMagine	PLM standard analysis		Training Archi	Blueprint ArchiMate		Training SIP team, usage for the methodology	Training + TP workflow		
	DMN portal	UiP(cPlatform V1)	System engineering showroom	Usage of ASD SSG and AP242 portals		Usage for ASD SSG portal	Usage for AP242 web site		UiP		
	DMN workflow system	I(contract manager)						Training,	Training + TP Archi		
	Virtualization server	UiP, C							UiP		
	Studio ESB	UiP (ASB, ACC)									
	Studio portal	UiP(sharkine, archimagine)									

Integration	DMN workflow system	I(Malik Khalfallh, N. Figay)									
	ArchiMagine Publisher	I (Malik Khalfallh, N. Figay)									
	DMN service oriented execution platform	E(at LAAS and AGI), C Code Diop , Ernesto Exposito, N.Figay						E (at UR-SystemX)			
	cPlatform	E (AGI), C Nicolas Figay						E (at IRT-SystemX) Nicolas Figay			

3.2.2 Identify Requirements/Objectives

The main requirements and custom criteria intended to evaluate the Aeronautic and Defense LL are indicated in the following table:

Table 3-3: Requirements and custom criteria for the aeronautic and defense LL

Main nonfunctional requirements	Custom criteria for aeronautic and defense LL
Interoperability	Ability to set up interoperable and secure infrastructure for assessing PLM standard within extended enterprise
Security	Ability to integrate and assess aeronautic PLM standards and their implementation
Reliability	
Usability (understandability, learnability, look and feel)	**DNM Methodology criteria**
Efficiency	Extensibility
Maintainability (stability, extensibility)	Adaptability
Portability	

3.2.3 Thresholds and Acceptance Values

Concerning acceptance values for the Aeronautic Living Lab, it was asked the external parties to provide their expectation for usage in operational processes for an industrial solution, knowing that

the cPlatform provided by IMAGINE Aeronautic LL will not necessarily reach these values without additional efforts and investment.

What is important is to identify the delta between what the cPlatform proposes by default, what is missing to reach expected quality and what will be the additional extensions of the experimental cPlatform if willing to experiment how to reach such level of acceptance for specific business cases and assessment scenarios.

E.g. security may require in industrial context applying very strong and expensive security policies with systematic usage of recognized certificates for each person in organization and for each applicative component distributed on a specific node of distributed heterogeneous network. Such need was not implemented in the cPlatform, as it is going against targeted experimentation usage by an open community at an acceptable price. But the cPlaform was designed in order allowing such extension through the choice of used component solutions, for which it was studied that such need can be covered. At the business layer, the selected portal solution is based on an enterprise application which supports usage and parameterization for usage of certificates for users and application components. At information and communication layer, the network solutions and operating system used also allows to find free components allowing implementing usage of certificates for the used machines. So if a strong requirement for making the cPlatform infrastructure supporting authentication based on trusted certificates, it is already identified that it is feasible and how it should be done. It was not done because it implies first all the people making experimentation should have a certificate, but it is not always the case, and the cost will be very important if willing to create such context only for experimentation purpose within the scope of IMAGINE. But in future exploitation, if partners are willing to make this extension and to fund it for experimentation, it is possible. If partners are willing to extend cPlatform of usage in operation, certificates based security is supported by the platform infrastructure and components.

In Section 4.1, acceptance values in operations and score of the cPlatform are provided, and then the analysis of the delta. This analysis is based first on the content of the following section, describing how the investigated LL systems specification fit with criteria related to expected quality of the whole system. Analysis is based second on the feedback of the interviewed parties. For each delta, analysis identified gaps and how they can be addressed if needed with the cPlatform.

3.2.4 Investigated Systems

The evaluation of our LL was carried out by taking into account different systems or components operating at the different infrastructure, application and business layers:

Technology Layer:

- Autonomic Access Control (AAC): The AAC is used to define the access control policies and manage the authorizations following the RBAC model. Is implemented based on SOA approach. The component enables to Intercept user's access request to a resource, evaluate the authorization decision, and enforce the decision taken.
- Autonomic Service Bus (ASB): The Autonomic Service Bus is a technology-level component intended to self-manage the integration infrastructure, based on the continuous monitoring and adaptation of resources in order to guarantee performance and scalability

- ArchiMagine: ArchiMagine is constituted of the Archi modeler extended for needs of IMAGINE for obtaining the ArchiMagine model designer, and of the ArchiMagine publisher.

Application layer:

- DMN Designer: The DMN designer is realized by ArchiMagine, JaWine and Contract Manager software components, which have been designed and developed by Airbus Group Innovations for the IMAGINE project.
- DMN Manager: The DMN manager is realized by the DMN portal and the DMN workflow engine.
- DMN Workflow System: The DMN workflow engine allows enacting the cross-organizational workflow models generated by the means of the contract manager.
- DMN Service Oriented Execution Platform: The DMN services oriented execution platform includes the Autonomic Secured Service Bus and the virtualization server.
- DMN studio: It includes the Portlet Studio and the ESB studio.

Business Layer:

- DMN methodology adapted and extended for design of a manufactured product: DMN methodology is a set of practice related to the definition of a DMN, including network of industrial partners collaborating through a cross organizational process, and including network of applications supporting this process as well as the technologies which realize these applications. By mean of the cPlatform, it is possible to design a DMN and to qualify actual capabilities of the collaborating enterprises for being able to run it.

These systems were specified and implemented in order to provide service levels compliant with the expected requirements acceptance values:

Table 3-4: Components and their Interoperability requirements for the aeronautic and defense LL

Components	Interoperability
AAC	It is implemented based on Web Services. XML extension language is used to specify and enforce authorization policies.
ASB	The ASB is based on a JBI-compliant ESB and the autonomic manager components have been developed following a SOA/WS-based interoperable approach
ArchiMagine	It is allowed through support of ArchiMate 2 by Archi solution, and by ensuring communication between the different stakeholders implied by interoperability.
DMN Designer	DMN Designer consists in providing models based on open standards: Open Group' ArchiMate 2 for enterprise modeling, Workflow Management Coalition' XPDL for Enterprise Workflow Models and ISA 95 for qualification of expected capabilities. It facilitates interchange of business information for integration purpose, without being specific software product dependent.
DMN Manager	DMN portal relies on open standards for portals (OASIS WSRP, JSR168, JSR 286) and workflow engines. So integration of applications from other enterprises participating to the DMN is facilitated. DMN workflows can be managed through a workflow client integrated with the portal as a portlet.

DMN Workflow System	DMN workflow engine is based on Wfmc's standards, implementing different standardized interface of an enterprise workflow system. So import from workflow designers is possible based on XPDL 2, and connection to application can be made through WAPI.
DMN Service Oriented Execution Platform	The execution platform relies on ESB open standards, making it possible the interconnection using standardized services for the manufacturing domains, such as PLM Services or any services related to manufacturing.
DMN studio	DMN studio is based on open development platform, making it easy to extend functionalities of the cPlatform and to produce standard based components
DMN methodology adapted and extended for design of a manufactured product	Goal of the DMN methodology is to support establishment of an operational interoperability based on the usage of the PLM standards elected by Aeronautic, Space & Defence community (c.f. ASD SSG). Applying ISA95 principles, expected properties of capabilities supporting cross organizational processes are defined for establishing interoperability, then actual are qualified according these properties.

Table 3-5: Components and their Security requirements for the aeronautic and defense LL

Components	Security
AAC	The AAC administration requires user authentication
ASB	The autonomic manager and the Enterprise Service Bus administration requires user authentication
ArchiMagine	Security is supported by ability with ArchiMate to establish communication between security officers and the other architects concerned by interoperability and security.
DMN Manager	The portal component provides controlled access to the resources of the cPlatform, implementing RBAC approach
DMN Service Oriented Execution Platform	Execution platform provides a secured infrastructure. The virtualization server includes protections of machines over the internet while protection of applicative component is made by the mean of the AAC.

Table 3-6: Components and their Reliability requirements for the aeronautic and defense LL

Components	Reliability
AAC	The use of ASB mechanisms enables to monitor the AAC and react to specific events when necessary.
ASB	The ASB integrates the adequate mechanisms intended to monitor and diagnosis potential anomalies and to execute corrective actions (e.g. resources tuning, clustering, etc.) in order to provide a fully reliable service.
ArchiMagine	ArchiMate publisher allows each kind of actors (role) to access the current and future DMN architecture blueprints.
DMN Workflow System	The DMN Workflow manager allows to monitor execution of instance of processes, and to take corrective actions if any issue with the process.

DMN Service Oriented Execution Platform	While ASB and AAC provides ability to react to some events related to communication through the bus, virtualization server provides monitoring means allowing to react when complementary resources are required for the machines. This is partially automated for the virtual machine container, which can grow automatically. It is also enabled by architecture, with ability to deploy the machines on an elastic Cloud infrastructure.

Table 3-7: Components and their Usability requirements for the aeronautic and defense LL

Components	Usability (understandability, learnability, look and feel)
AAC	A web-based administration user interfaces are provided. Moreover, a dedicated editor is uses to define and update the policies. The use of RBAC to manage user privileges ensures flexibility and simplicity.
ASB	The ASB provided web-based administration user interfaces. Moreover, it integrates a friendly dashboard allowing to visually managing the provided services and resources.
All the components	Establishment of cookbook and training support.

Table 3-8: Components and their Efficiency requirements for the aeronautic and defense LL

Components	Efficiency
AAC	Several decision points are deployed in order to reduce the response time
ASB	The ASB integrates the adequate mechanisms intended to monitor and resources usage and the increase of demands in order to execute adaptive actions (e.g. resources tuning, clustering, load balancing, etc.) in order to provide a scalable service.
ArchiMagine	Some Archimate 2 views are dedicated to establishment of interoperability.
DMN studio	Dedicated studios were identified in order to make it easy and fast to develop extra components for integration of enterprise applications to the i_Platform.

Table 3-9: Components and their Maintainability requirements for the aeronautic and defense LL

Components	Maintainability (stability, extensibility)
AAC	The SOA approach and the distribution of services make the extension of the system easier.
ASB	The ASB provides a JBI-compliant plug and play architecture intended to facilitate the maintenance of available components as well as to allow the extension of new components (e.g. binding components, service engines, etc.).
ArchiMagine	Ensure by the choice of Archi, its documentation and its architecture.
All the components	Clearly defined and document architecture and methods, based on open standards and open source technologies

Table 3-10: Components and their Portability requirements for the aeronautic and defense LL

Components	Portability
AAC	It is implemented based on Web Services and is deployed on any virtual infrastructure.
ASB	The ASB has been developed to be deployed on any virtual infrastructure. It is based on JVM and OpenVZ open standards
ArchiMagine	Implemented with Java (can run on any OS supporting Java) , JavaScript technologies (can run on any web browser) and portlets (can be ported on any PDM supporting portal standards
All the components	Usage of technology that can be run on any Operating System (Java) by default. Usage of virtualization technologies allowing to move and distributed applicative servers dynamically on different machines.

Table 3-11: Components and the Aeronautic specific criteria

	Aeronautic specific criteria	
Components	Ability to set up interoperable and secure infrastructure for assessing PLM standard within extended enterprise	Ability to integrate and assess aeronautic PLM standards and their implementation
AAC	Contribute to establishment of security but also interoperability (reconciliation of different security policies) at service bus layer.	
ASB	Contribute to maintenance of security and interoperability an autonomic way.	Contribute to connection of PLM applications of the partners of the DMN more easily.
All the components	Demonstrated through deployment and usage of the cPlatform for the SIP project or for other projects	Demonstrated through use cases and adoption of the approach for the SIP project, which will use cPlatform as infrastructure for PLM standard test bed and apply DMN methodology adaptation of Aeronautic LL for usage of the test bed.

3.3 Automotive Industry

The Automotive living lab developed in WP4 addresses the business continuity of an Automotive DMN. The global automotive industry, already threatened by the economic crisis, is probably among those who suffer more from interruptions of the supply chain, whether of a short or medium entity. In the last period, example of business interruptions have been experienced (such as tsunamis, floods, volcanoes, acts of terrorism) and the industry is thriving to implement recovery methods, while maintaining JIT/ JIS strategies, lean supply chains, low levels of stock and the complexity of the network. New research and innovations are needed.

The Living Lab developed in partnership between the IMAGINE partners, Reply and CRF intends to address these issues. The evaluation of the Living Lab is described in the following sections and allows to demonstrate from one side the feasibility of the approach followed with IMAGINE in term of adopted technologies and from the other side how the proposed solution provide actual added value to the company and DMN manager.

The automotive LL demonstrator has been described in a previous IMAGINE deliverable (D4.4v2 - Living Lab in the Car Manufacturing Domain Report_final). The figure below illustrates the structure of the Living Lab demonstrator.

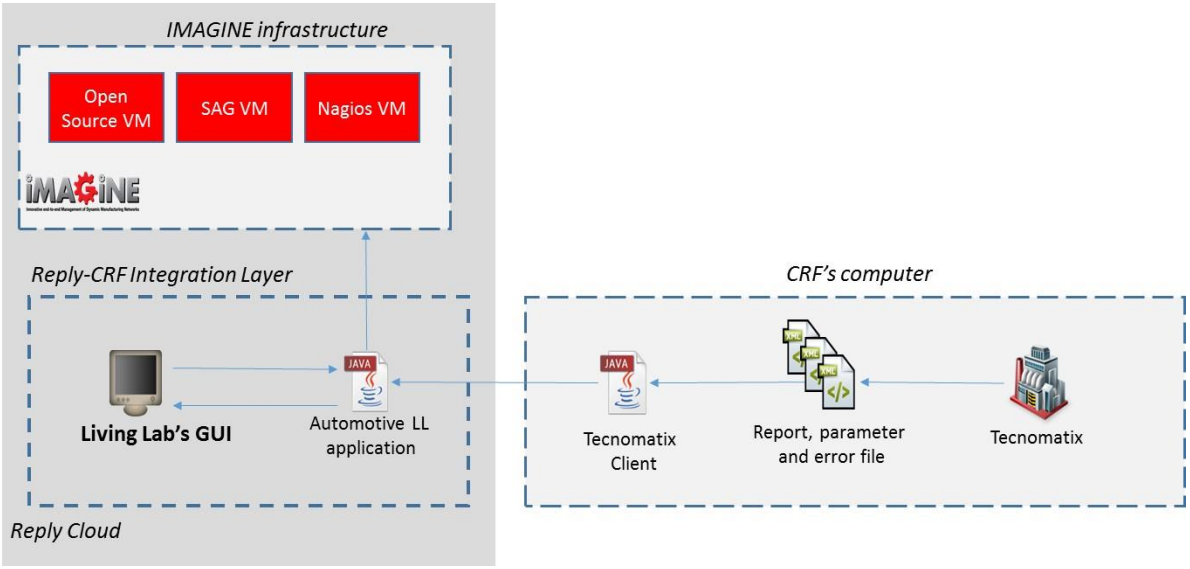


Figure 3-1: Detailed architecture of the LL

The tests reported in this document have been performed on the web application interfaces, which communicate with respectively the IMAGINE platform for monitoring and reconfiguration of the DMN and the DMN emulator in CRF. Tests have been performed with 12 users, involved in different ways in the project. The tests are analyzed in the following sections.

3.3.1 Evaluation Parties

The following chart reports the evaluators of the platform:

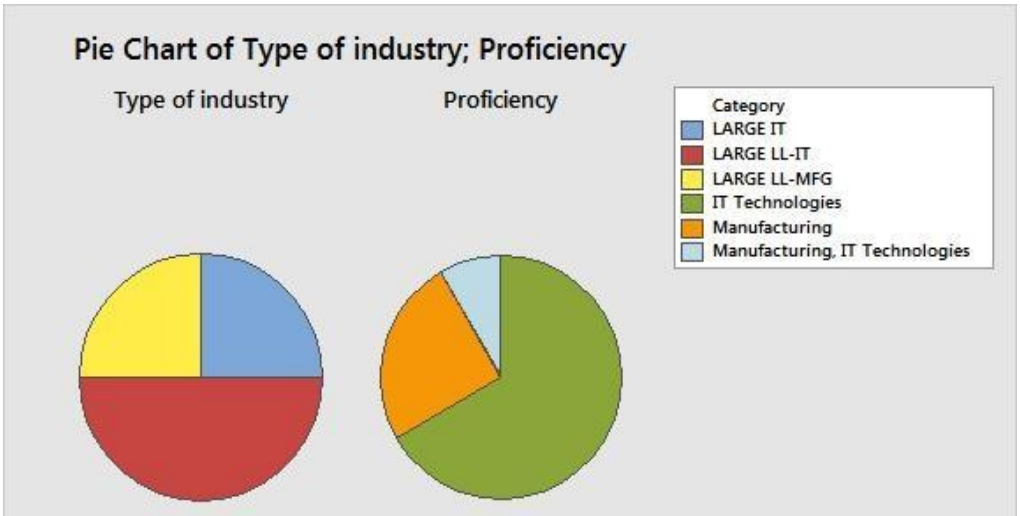


Figure 3-2: Type of industry and proficiency of the evaluators

All evaluators belong to large companies, whether operating in IT or in Manufacturing. A majority of the interviewees have specific background and competences in IT (66%). Experience on Manufacturing is shared by the remaining 33%, along with an 8% in both areas.

The assessment took place using the online questionnaire, from the interviewee's desks. A crash course on the phone (1h) on the IMAGINE LL was given to the people not belonging to the LL (external).

The assessment sessions were performed in September 2014 and no differences were made to the generic questionnaire.

Discrepancies in the evaluators answers

An analysis, reported below, has been performed to evaluate the differences in the evaluators' answers. The evaluators have been grouped in:

- Large IT: this group includes IT persons belonging to external parties (not involved or developing directly the AutoLL);
- Large LL-IT: this group includes the people in charge of the AutoLL, form the IT point of view, whether belonging to FIAT or to Reply;
- Large LL- Manufacturing: this group includes the persons in charge of the AutoLL, form the process point of view, belonging to FIAT.

The analysis has been performed following the traditional statistical approach:

- Analysis of means
- Analysis of variance
- Tests of equal distribution

Figure 3-3 below display the interval plot (an interval centered around the mean and displaying the variability of the sample) for three evaluations of variables:

- Interoperability
- Requirements for Interoperability
- Difference (delta) between the effective Interoperability and the Requirements

The visual indication is that there is no significant difference between the groups, though there seems to be a reduced variance for the Large LL-IT group and an increased variance for the Large LL-MFG Group. This can indicate an increased certainty, resp. uncertainty, on the evaluation from the former, resp. the latter. This effect will be tested and displayed in the following figures.

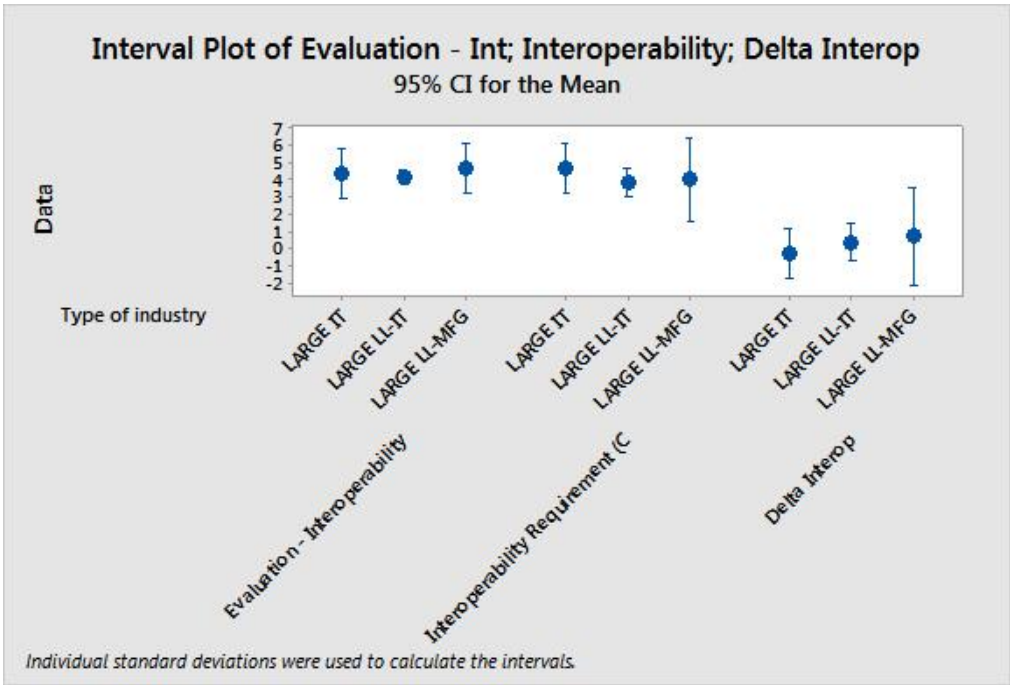


Figure 3-3: Evaluation of Interoperability for the three groups of interviewees

The intervals in Figure 3-4 shows an overlapping of answers between the different groups and thus do not indicate major discrepancies.

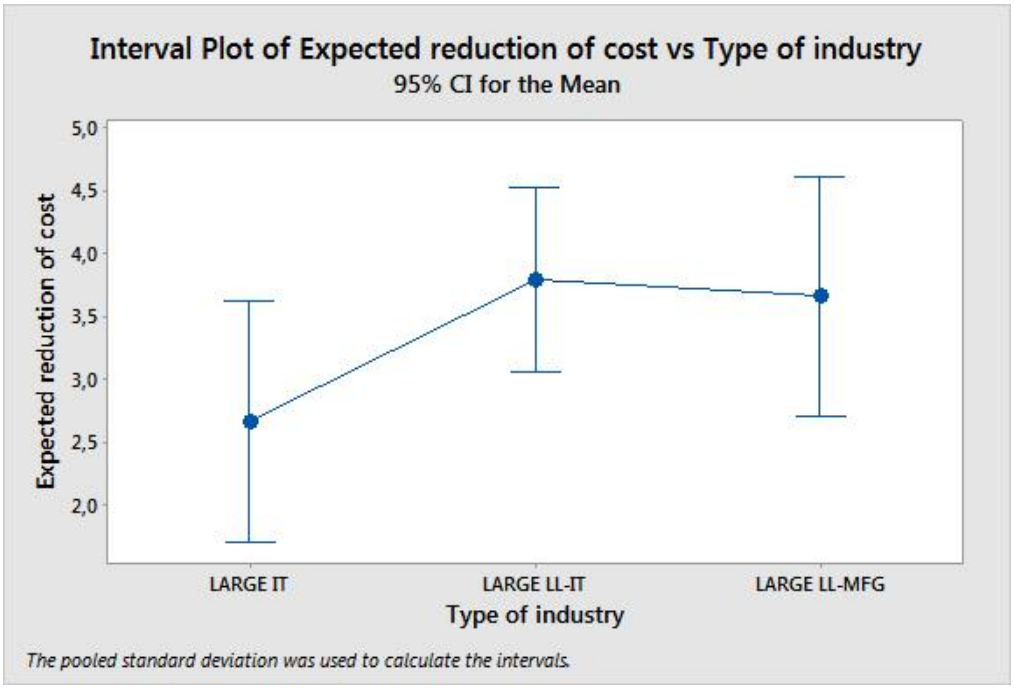


Figure 3-4: Expected reduction of cost for the three groups

Figure 3-4 above reports the test of equal means for the three groups and the variable "Interoperability Requirement". The test results (blue dot being inside the interval) suggest that the means are equal.

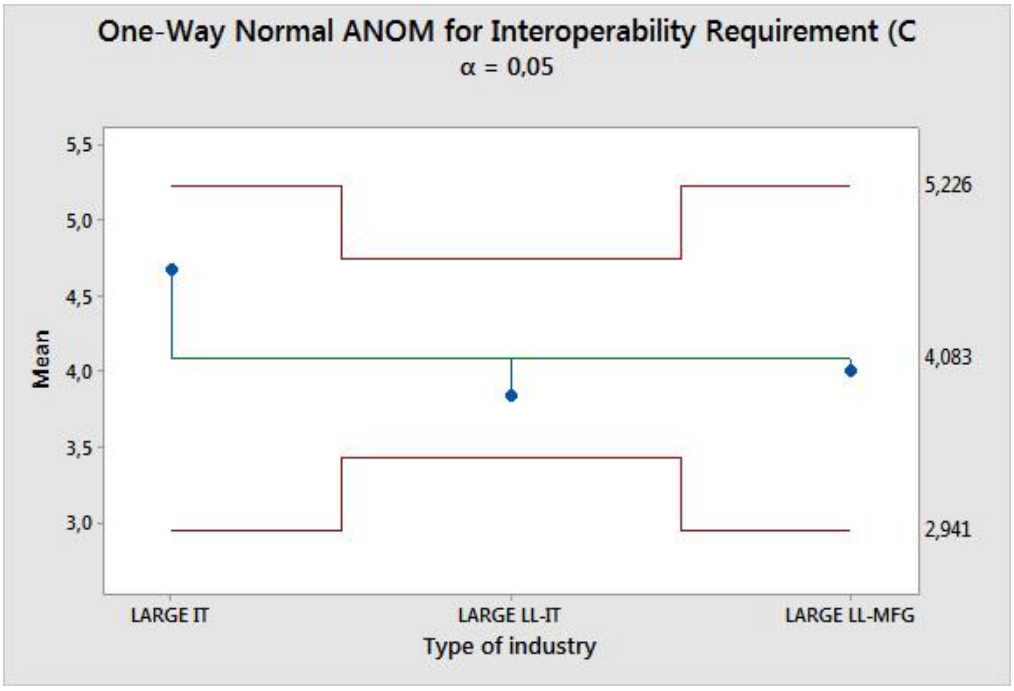


Figure 3-5: Analysis of means for the three groups of interviewees (Interoperability)

Figure 3-5 above reports the test of equal means for the three groups and the variable "Delta Interoperability". The test results suggest that the means are equal, indicating no sensible differences.

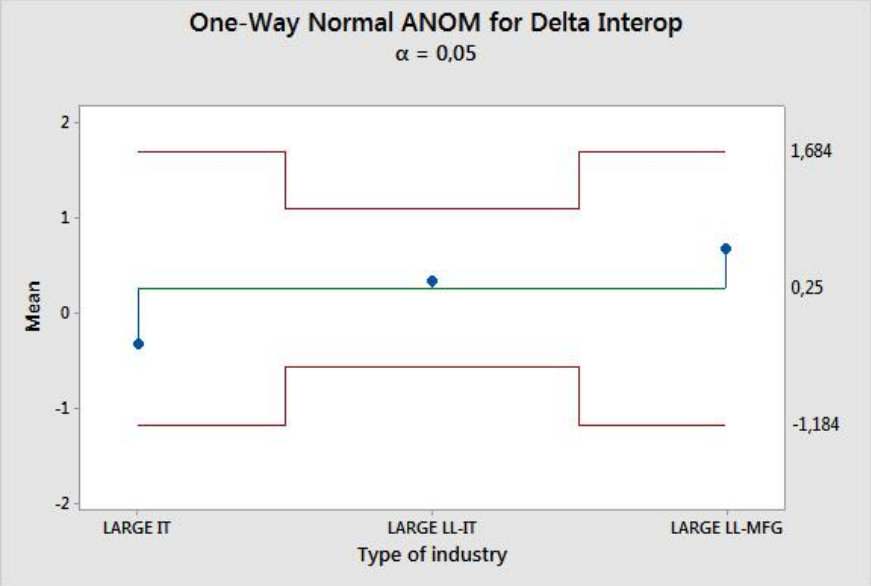


Figure 3-6: Analysis of means for the three groups of interviewees (Delta Interoperability)

In the same way Figure 3-7 indicates an equality of means for the variable "Expected reduction of costs" for the three groups.

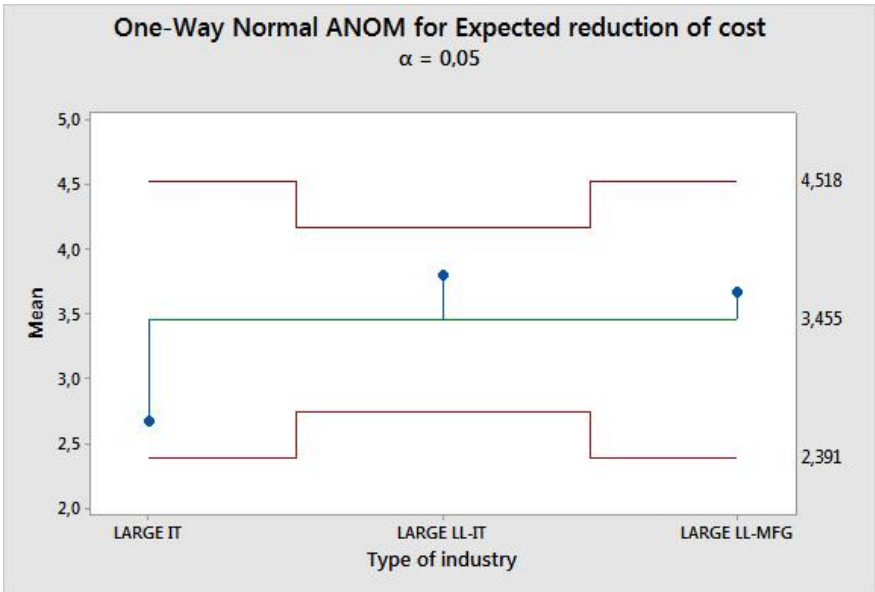


Figure 3-7: Analysis of means for the three groups of interviewees (Expected reduction of cost)

Analyses of the variances have been performed –for example in Figure 3-8 below – which do not indicate that the variances are different for the three groups.

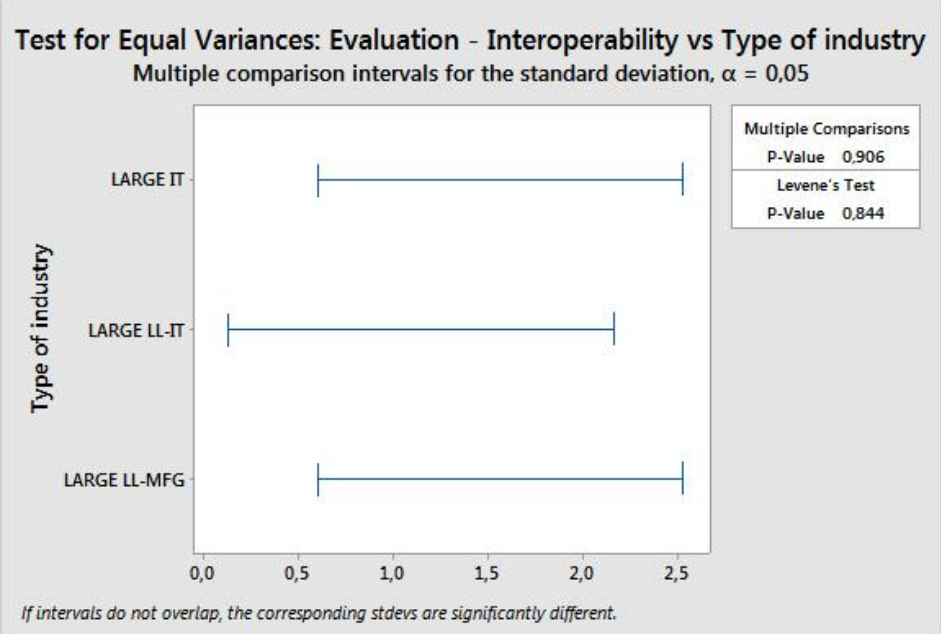


Figure 3-8: Variance for the three groups (Interoperability)

In conclusion of the analysis, the three groups have been merged into one and the following analyses performed independently of the variable "Type of industry".

3.3.2 Identify Requirements/Objectives

The requirements identified are the following:

Table 3-12: Requirements/ objectives for AutoLL

Interoperability	Stability
Security	Extendability
Reliability	Portability
Usability	Operational Improvement
Understandability	Clarity
Learnability	Adaptability
"Look and Feel"	Data Availability
Evaluation Efficiency	Monitoring

3.3.3 Investigated Systems

The Automotive living lab system is recalled in Figure 3-1 and composed of three macro-components:

The IMAGINE platform

This is the i_Platform hosted onto Reply's cloud system. The system setup has been chosen to simulate the as-a-service delivery model, where an IT provider with manufacturing knowledge can

host multiple instances of i_Platform for different Partner groups on a cloud-based computing environment. This approach reflects a contemporary application delivery and maintenance method which gives larger flexibility and lower CAPEX impact for all the participants.

The Plant Simulation subsystem

The FIAT network hosts the Tecnomatix Plant Simulation (plus the license) and the Tecnomatix-side AutoLL agent which is responsible of interfacing Tecnomatix with the integration layer. For network restrictions, all ingoing ports are closed, so it was necessary to design and develop the communications between the integration layer and the agent taking advantage of HTTP responses to the agents' requests and polling techniques.

The Automotive living lab integration layer

This layer is responsible for handling the communication between IMAGINE and Tecnomatix, the errors occurred during the supply chain, the DMN reconfiguration and the communications to the DMN manager.

It is composed of a Java-based web application which exposes the functionalities through REST interfaces (required by the Tecnomatix-side AutoLL agent) and a web-based graphical user interface.

In terms of a cloud-based, loosely coupled system architecture, the REPLY/CRF setup emphasizes some of the abovementioned requirement dimensions. In fact, Monitoring and Interoperability are the main highlights, while also Security requirements have posed some challenges while integrating the different data networks between FIAT Intranet, REPLY intranet and cloud system subnets (some of them virtual networks among virtual systems) and the Internet.

3.4 Furniture Industry

3.4.1 Evaluation Parties

In the third week of July, a dedicated workshop about the use of the IMAGINE Platform in the furniture domain occurred (Figure 3-9). This presentation took place in Valencia with UNINOVA and AIDIMA as organizers and more than twelve attendants. Members of AIDIMA plus one representative of an external furniture company mainly composed the audience.

The event gave a global vision about the IMAGINE project and the platform developed so far, including technical aspects about the software used, specially related to the adapter specifically developed by the furniture living lab. Furthermore, a live demo was presented in order to illustrate and demonstrate the use of such tools to the audience.

The workshop was ruled by a specific adapted course, which was developed to better fits the audience profile. Its objective was firstly to introduce the IMAGINE project idea, the DMN concept definition and its related achievement or implementation into the so-called IMAGINE platform. Specific technical and business details about the furniture context and needs were also introduced to then present the developed functionalities through a live demo able to show the competences, skills and added value that such platform application would capable of offering to the furniture industry business case.

Such demo followed the various DMN lifecycle phases. It started by emphasizing how furniture enterprises' legacy systems would be integrated with IMAGINE Platform, plus all the administrative steps required to run and rule the platform in the furniture domain.

Thus, it showed what a SME willing to use the IMAGINE i_Platform needs to accomplish. This includes steps as: the subscription of the company to the Furniture portal; the publish of enterprise's information in the i_Platform, which for an advanced integration solution will require the development of specific web services to enable an automatic access to public (business) information of the enterprise's legacy systems (e.g. ERP).

Finally, it showed how to create and manage a DMN through the IMAGINE platform, highlighting how manufacturing orders would be handled between the various DMN participants/actors.

Figure 3-9: Photo taken from the Evaluation Workshop

Towards the end of the workshop and, in order to take advantage of the event, a questionnaire to technically evaluate IMAGINE platform, was delivered to the attendees. To clarify the questionnaire objective and solve any possible doubts, a small introduction about it was presented to the audience. It included some guidelines about what are the expected values for each field and which questions shouldn't be answered. Despite having an online version available, the questionnaire was printed out and distributed among the participants in paper to ease its filling up process in the moment.

The delivered questionnaire was the same than the general and generic IMAGINE 2nd evaluation questionnaire defined in the project. However, it was asked to the external (in relation to the IMAGINE project) participants do not answer some of the questions, as mentioned before, which represents a slight customization of the generic questionnaire to the furniture LL.

The defined questions that didn't need to be answered, were those related to the evaluation of reliability, stability and portability, mainly because the audience didn't received enough information to qualify them to provide specific feedback about such topics. However, participants were invited to introduce their opinion about each of these topics importance or relevance in relation to the developed systems. Additionally, the section about the technical evaluation of Custom Criteria was also to not be answered, for the same reason.

After the collection of the different filled questionnaires in paper, its data (answers) were manually introduced in the online questionnaires form (Google) in order to have all the answers centralized

enabling a better overall assessment of the feedback. Some members of the audience were technical people with previous knowledge or even involvement in the IMAGINE project, but others not, they came from other areas as industrial production or business, which at the end resulted in an interesting, effective and significant feedback about the developed platform.

3.4.1 Identify Requirements/Objectives

The main challenges or requirements that this industrial sector needs to tackle to adopt the End-to-End manufacturing concept, which represents the main goal of the IMAGINE project, includes: communication data exchange; multisite furniture cluster creation in collaborative production networks; tracking and monitoring of productivity improvement; innovative partners search and new business opportunities identification; and management of unexpected situations. So, the goal is to have a platform that would facilitate the connection of different legacy systems of each production partner. Also, once having such several enterprises connected, the platform would become a place where new synergies between companies may arise, reaching new business opportunities. Moreover, the time needed to create new products and catalogues would be reduced increasing the level of innovation. On the other hand, the decision-making process would be improved due to the offered simulation mechanisms. Additionally, the supply chain can be optimized while composing the production network, by having a higher-level of control and supervision of the production activities due to the DMN monitoring capabilities, enhancing the capacity to react to unexpected situations, and thus increasing the service quality offered to customers.

The technical knock-out criteria is related to the characteristics that have direct impact in the technical integration of the IMAGINE platform with legacy systems to enable and ensure the most possible dynamic re-configurability of the DMN, which when needed, with the minimal required action from the users. The other point is related to multi-language usability that in this case is a must to have Spanish language as the interface language. Without such language will be impossible to market a tool abroad a community that only uses Spanish in their business. These requirements are met in the distributed questionnaires.

3.4.2 Investigated Systems

The evaluation has been done on the tools involved in the architecture proposed for the furniture living lab. Regarding the interfaces, this includes the IMAGINE Platform and the custom adaptor developed for the furniture case. On the other hand, some tools were also involved such as the web services application and both legacy systems considered in this living lab: ERP (furniture ERP) and CATe (cataloguing software based on the AP236 standard).

Some description about the software involved in the furniture living lab can be found below:

GdP (Process Management) is an ERP focused in the furniture industry. This has a modular design and it covers all the enterprise areas regarding the production environment – sales, technical office, warehouse, purchases, manufacturing orders, assembly, delivery, etc.

CATe (CATalogue-e) is a tool specially developed to define the product catalogues compliant with the ISO 10303-236 standard in an easy way. This tool permits the creation of catalogue structures

comprising price lists, inclusion of fabrics and finishing, product configurations, properties, and all kind of information needed for a furniture product. CATe is an application developed by AIDIMA that allows a complete management of product catalogues for the furniture sector covering all of its major needs.

The furniture LL adapter developed to establish the connection between the legacy systems and the i_platform is presented in the central part of the Figure 3-10. In the left part it is the IMAGINE platform and in the right the enterprises' legacy systems. At the top there is the furniture platform portal, which is composed by a set of portlets. Some are provided form the IMAGINE platform and others more customized for this industry (furniture) from the adaptor element.

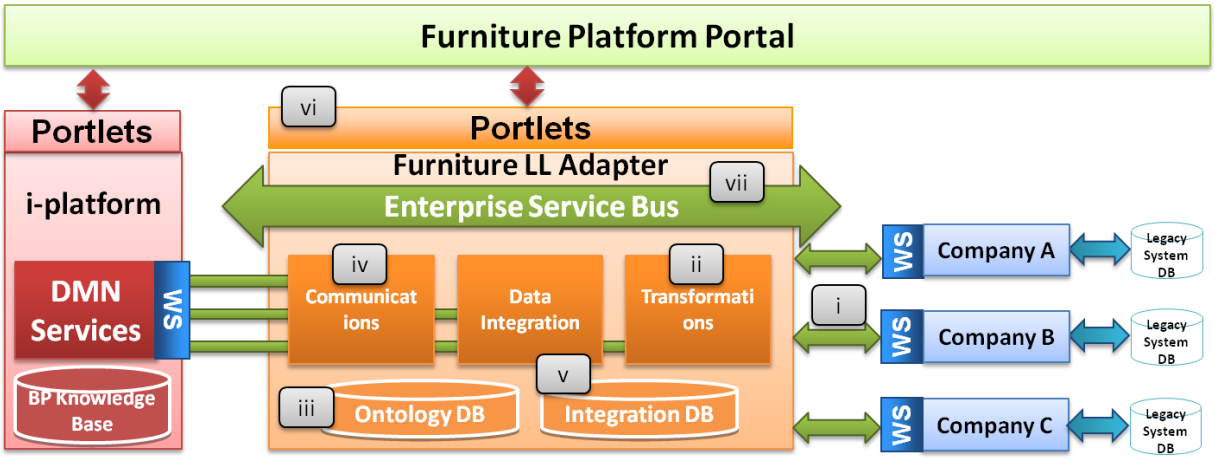


Figure 3-10: Furniture LL adapter Architecture

In order to create a bridge between the legacy systems with the blueprint it was developed a service oriented framework that for the implementation took in consideration the following points (illustrated in the architecture of the adapter at Figure 3-10):

i. the use of Web Services (WS) to access information from companies' legacy systems and databases to update the blueprints
ii. the need to transform data to/from the blueprint structure;
iii. the use of an ontology to standardize domain-related information such as product categories, material types, manufacturing domain, etc.;
iv. do the connection with the i_Platform and enterprises;
v. the need to align/relate systems matching knowledge, e.g. orders are handled both in the i_Platform and legacy ERP's concurrently;
vi. the need to have a customized view of the platform answering to each partner's requirements;
vii. the Enterprise Service Bus (ESB) that does the management of the WSs used to exchange the data between the different companies and the platform.

Knowledge is used to describe or explain the manufacturing products and processes. Companies can use that knowledge to support some important actions depending on the pursued goal, thus

giving the platform a way to maintain and relate the categorization of the different companies. Since the platform will work with different companies in a DMN, and each has its own nomenclature, there is a need to agree on the categories used in the platform, standardizing search criteria to describe the business of each company, e.g. market sector, material type, etc. It is also used to classify the type of material and product. Due to this requirement, the adapter envisages an ontology model (Ontology DB) to represent the reference categories and concepts for each industrial domain.

Web Services are responsible for the interconnection of the information between the different manufacturing partners, and the platform provides a common WS interface with the methods defined according to the defined Blueprint model implemented in SPARQL language, allowing interrogation of amalgamated datasets to provide access to their combined information. Web Services application for the composition of the Blueprint information. This application contains a set of methods to retrieve the company information stored in the databases of the referred ERPs in order to feed the blueprints of the IMAGINE Platform. This is done through transformations available at the specific adapter developed for the furniture living lab.

The furniture portal integrates various portlets. Portlets are web components, like servlets specifically designed to aggregate the context of a composite page. Portlets provide the user interface of the portal by accessing distinct applications, systems, or data sources and generating mark-up fragments to present their content to portal users. In this case it aggregates specific functions to support the DMN creation and management. These portlets are on the top of a Liferay kind portal. Liferay Portal is a free and open source enterprise portal written in Java and distributed under the GNU Lesser General Public License and proprietary licenses, which allows the user to create custom web content in independent window container the so called portlets.

3.5 Engineering Sector

The UoW Living Lab is focused on Engineering SMEs and WMG's teaching programs are based on extensive in-house expertise in manufacturing and manufacturing management. Our evaluators were therefore chosen from groups with experience and interest in all aspects of manufacturing management.

The UoW team planned an evaluation roadmap commencing from successful deployment of the i_Platform on our local server environment, progressing through testing and refinement of demonstration scenarios to a series of evaluation workshops with supply chain postgraduate students, external evaluators, and culminating with the MAN Group (Midlands Assembly Network), the group of ten independent SMEs that UoW have worked closely with during the IMAGINE project.

Our selected external assessors included acknowledged manufacturing experts with experience from senior automotive manufacturing directors, Fellows of the Institution of Mechanical Engineers, and expertise from the Manufacturing Technology Centre, and also assessors with experience working in and supporting SME manufacturers. Our engagement with the MAN Group is at top director level of each group member, ranging from £3m to £20m turnover.

The execution of the roadmap was thwarted by issues with the deployment, reliability and stability of the local i_Platform, and with the time available to complete this exercise squeezed between the deadline and platform readiness it was concluded our original plans could not be fulfilled, and so we reverted to an alternative approach in order to secure relevant feedback and responses.

Our alternative plan engaged our assessors in virtual assessments of the methodology and i_Platform, utilizing video which could show the platform more effectively than was possible with a live demonstration. It was our judgment that given the state of the platform, the holiday period, and the tight remaining timescales that this was the only practical way of achieving external involvement in the evaluation. This approach yielded some responses, and to supplement these further we organized a seminar open to all in WMG, consisting of video and presentation.

Assessments took place during weeks 37, 38 and 39.

We made some slight changes to the generic questionnaire to better qualify the respondents with regards to our Living Lab.

Figure 3-11: Photos taken during the evaluation event at University of Warwick

We changed the order of presentation, asking questions about the methodology before asking questions about how well the i_Platform supported that methodology, which we concluded was a more logical sequence. We added a question at the end of the methodology section asking the respondent to confirm if they wanted to complete questions related to the technical implementation of the IMAGINE Platform. This was because we realized not all respondents would feel able to express an opinion on technical aspects of the Platform.

Question 5 (Proficiency) was modified as follows. The first response was changed from "Manufacturing" to "Manufacturing Management" and an additional option of "ERP/MRP" was added to help provide clarity and recognition of particular expertise.

Question 6 (Representative of…) was augmented with two additional options, "Academic", and "Retired".

The optional question 7 was changed from "Evaluators Name" to "Years in Manufacturing Industry" as a useful indicator of experience offered.

Though we had concerns about the applicability and usefulness of some of the other questions, wholesale change was undesirable due to the commonality required for comparing responses from other project partners.

Once the platform is operating properly and reliably, we intend to have a detailed demonstration event with MAN Group and others to gather more feedback and opinions.

3.5.1 Identify Requirements / Objectives

Within the LL in this industry domain, which is dominated by engineering SMEs, companies usually work on a project-basis, forming alliances as required by the project. In response to a business opportunity, e.g. a tender, they assess the capability that will be required. If they feel that they have a sufficient value contribution, they will look to form a partnership with other SMEs who have a complimentary capability. These projects tend to be short-term projects rather than long ones. The products that they produce are more for prototyping and short production runs rather than traditional large batch manufacturing. Consequently, they would prefer to work with trusted partners, but are more open to new partnerships than larger businesses would be.

In the Engineering sector demonstration, Functionality, Usability, Reliability, and Interoperability are the most important factors. These are prioritized as follows:

1. Functionality;
2. Interoperability;
3. Reliability;
4. Usability.

Within these categories, functionality, effectiveness and interoperability sub-categories are the "Critical" evaluation factors.

Within this sector the fulfillment factors for an effective system are ones that address the characteristics of the SME Engineering businesses that dominate the LL. These are:

1. They do not have advanced factory management systems (in fact many of the business are run by spread sheets). Thus the IMAGINE platform must have interoperability with a wide range of factory systems.
2. They have a shortage of skills in the IT area: thus easy configuration and usability are important.
3. They must add value in co-ordination, IMAGINE can achieve this through providing Visibility across the whole of the supply chain, and "push" based execution system, more suitable to short term projects rather than a KANBAN style "pull" system, more suitable for stable production runs. These factors help build trust, and functionality that builds trust will be core to the success of IMAGINE. This defines the valued functionality required.
4. Since the projects the LL members work on tend to be quick, agile short term, design, development and prototyping projects they need a reliable and stable system.

3.5.2 Investigated Systems

In the Engineering sector demonstration, Functionality, Usability, and Interoperability are the most important factors and that would be the basis to evaluate the different components. Described below are the attributes in the investigated systems that are important to the LL. The evaluation results presented further on, are for the standard comparative process designed for all of the LLs. The evaluation from customized LL testing will be described in other documents.

Blueprint Repository

The investigation focused on how easy and efficient it was to upload, edit and delete Participant Blueprints. This has now been achieved using the interfaces written by UoW and IPA. The UoW interfaces are designed for bulk upload of data where the IPA is designed primarily for editing data once it has been uploaded. The UoW and IPA interfaces are thus complementary. However, UoW did not find these interfaces easy to write, the bulk upload does not appear to have the ability to ignore whitespace in the bulk-upload file and it seems that ImagineID generator is capable of creating ImagineIDs that are later not acceptable to the Blueprint repository. However these are just the teething troubles that might be expected in the development of any complex system.

Production Requirements Composer

The data-structures as well as the user-interfaces were investigated. Within the different LLs the requirements on the production scheduler will vary considerably. The UoW living lab production requirements focus on Capability of partners in configuring schedules, and less on the existing products that they make. This introduces a lot more uncertainty regarding capacity, and in some cases capacity might not be important at all. It is thus unfortunate that average capacity rate is a required field for partner definitions.

Partner Search

The evaluation investigated both long-listing and short-listing, as well as skill, process & capacity search. Its operation was compared with the UoW existing process for partner search and team formation. In particular partner search tends to have two phases, absolute criteria to be met, and desirable criteria. The former is fairly straightforward with good data, the latter is very difficult. It usually involves bringing together companies that have a similar culture. This can arise from many factors, such as common quality standards, size, location, end customers and market experience. Currently the partner search does not seem to be as reliable as the WMCCM partner search and the user needs to have more user control over which attributes form part of the search and which do not. Insistence on using attributes such as average capacity rate is not always relevant to the context in which the UoW supplier base makes its searches, e.g. when a supplier wishes to find a partner with a specific capability such as design of tooling, products, fixtures etc.

DMN Design Toolset & Dashboard

These have proved impossible to evaluate with partner companies.

IPA Partner Management Portlet

The UoW team also evaluated IPA's Partner Management Portlet, giving feedback on functionality, deployment and teething issues. Essentially the interface was found to work well.

4 Evaluation Results, Analysis & Discussion

In the technical evaluation of the IMAGINE platform, a total of 70 assessments were conducted during evaluation meetings by all the Living Labs. From these 43% were internal, meaning from within the same company or organization but from another department and hence having previous to the training sessions no expert knowledge about IMAGINE (cf. Figure 4-1 a). When considering the affiliation of the participants the largest group of participants is affiliated to the Academic Partners, Universities, or research institutes (53%). The 2nd largest group of assessors is the group of Living Labs, Manufacturing Companies, or End-Users which have a percentage of 27%, followed on the 3d place by the Technical Partners, IT Companies, and System Integrators (cf. Figure 4-1 b).

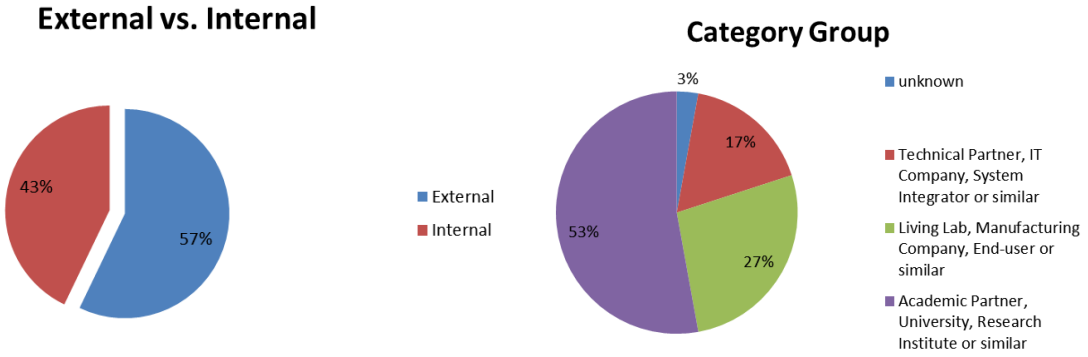


Figure 4-1: a) External vs. Internal Evaluators, b) Distribution of affiliations

When looking at on the sector of people joining the evaluation Figure 4-2 a) lists the background of the evaluators and their current employment. 20% of the participants have a background in the car manufacturing industry, 17% in Ecommerce, 10% in Aerospace and Defence. It is worth to notify, that the largest portion namely 42% of the participants in the evaluation did provide "not applicable" as answer to this question.

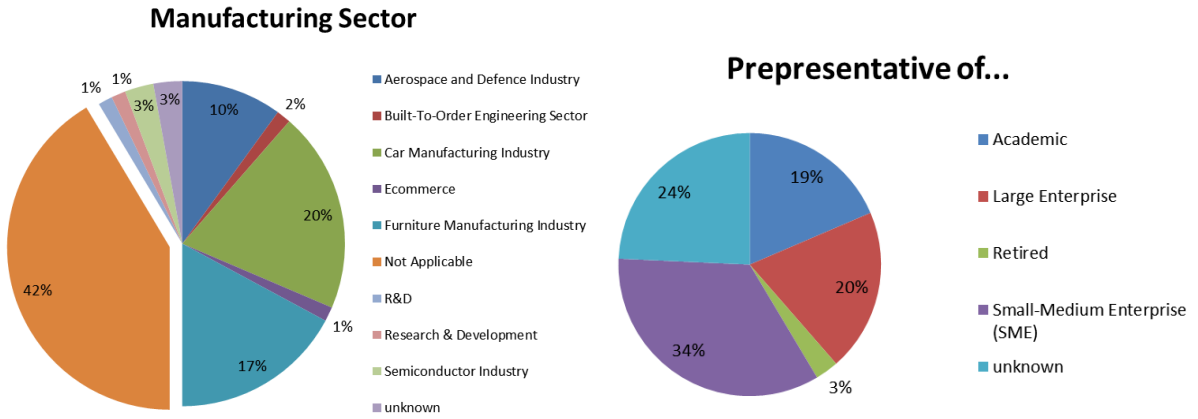


Figure 4-2: Results grouped by a) Manufacturing Sector and b) Representative of

Evaluators have been asked about the domain which they represent (cf. Figure 4-2 b). 34% of the participants are representatives from SMEs, 20% from Large Enterprises, and 24% from academia. 24% didn't provide an answer to this question.

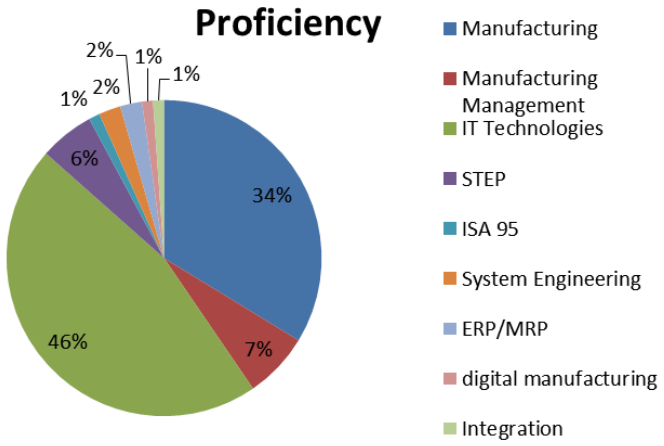


Figure 4-3: Proficiency in IMAGINE related standards (multiple selections are admissible)

When evaluators were asked about their proficiency in IMAGINE related industry standards, the results are as follows (cf. Figure 4-3) were we allow multiple answers per evaluator:

46% of the participants have knowledge in IT Technologies, 34% in Manufacturing, and 7% in Manufacturing Management. Only a minority of the participants has knowledge in standards like STEP, ISA'95, integration, etc. which is less than 10 % each.

When analyzing the evaluation results it turns out, that they have a strong variation with different respects. When considering one domain-specific evaluation it turns out that for some evaluations the group of evaluators assessed the platform in a similar way, obtaining a low variance. On the other hand it is the case that evaluations results show a large diversity which can be explained due to the varying backgrounds of the evaluators as some living labs have heterogeneous evaluation teams with people from different industry domains outside their living lab. This eventually leads also to a higher variation in the results.

In addition – when comparing evaluation results from all IMAGINE partners – there are partly large variations as the evaluation criteria when comparing different IMAGINE Living Labs. This is the case as the IMAGINE platform is perceived differently due to the difference in the demonstration, trainings, documentations, etc. Evaluation results depends solely on the evaluators perception and its expectation obtained through previous discussions with the IMAGINE teams and documentation manuals. As shown in the Figure below some assessments have a considerably high variance in the obtained evaluation scores that should be considered when drawing conclusion as they can bias the results.

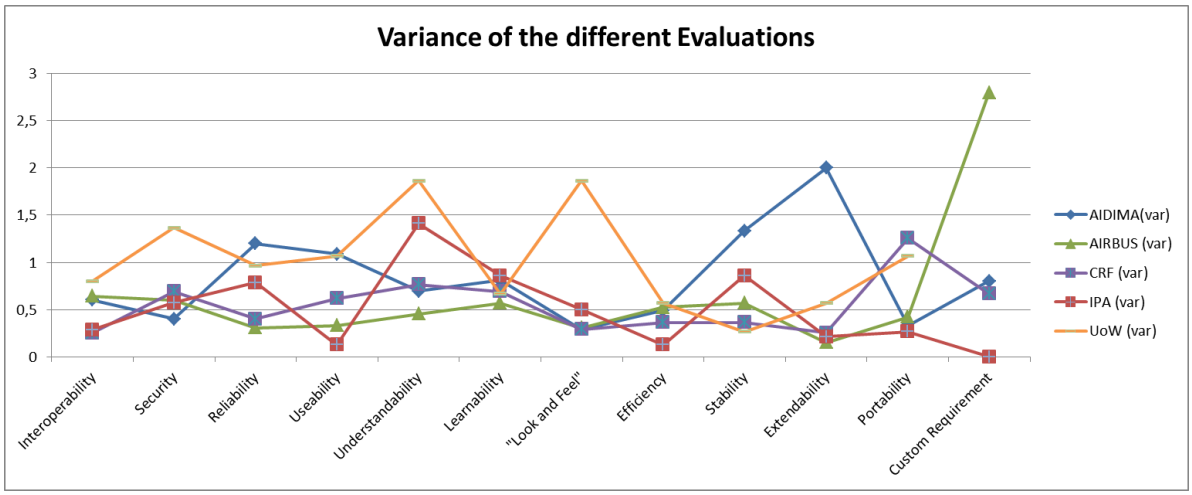


Figure 4-4: Variance within the scores assessed by different industry domains

As the assessments have been conducted by heterogeneous groups of experts with different technical backgrounds and expectations, it is not surprising that there are also high variances in their expectations. For most considered criteria the variance of the expert's expectation is below 1 although there have also spikes beyond 2.

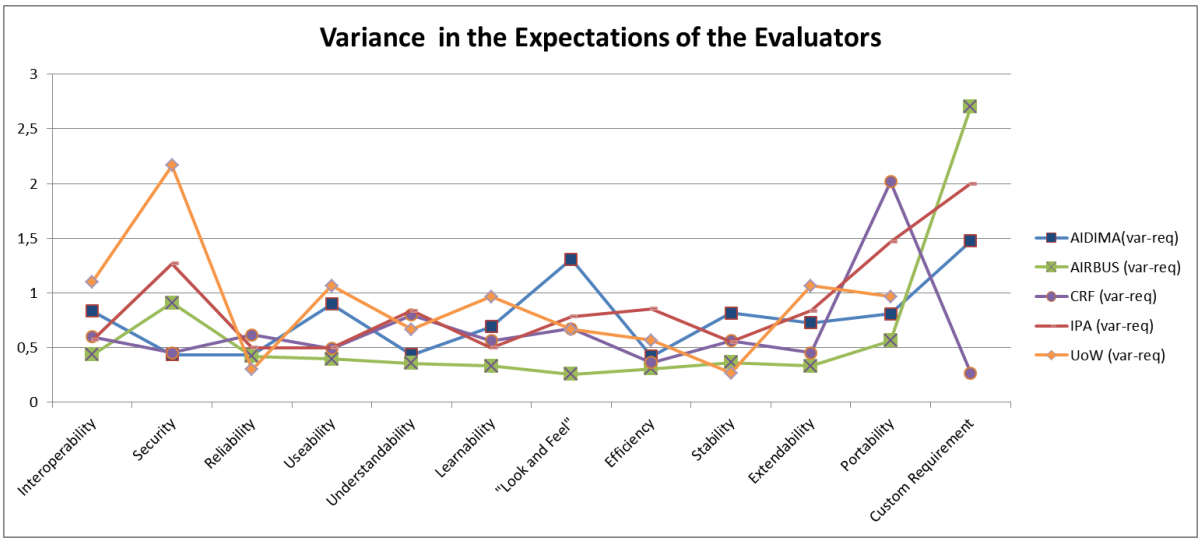


Figure 4-5: Variance in the assessors' expectations to the technical criteria

The following sections will analyze and discuss the individual evaluation results in detail.

4.1 Industry Agnostic

The results from the industry agnostic Living Lab evaluation, which have been created under the basic conditions described in the previous chapter, will be shortly discussed in this section.

The following figure displays the summarized results by criterion, creating an overview of the range of ratings and values chosen by the assessors. The average value has been calculated for each criterion

result set respectively the stated threshold values. The position of the average value indicates the overall importance of each criterion. While each single value is of course a subjective value for each individual, the average value in relation to the range allows to eliminate the subjective character to a degree and to assess the overall significance of each criterion.

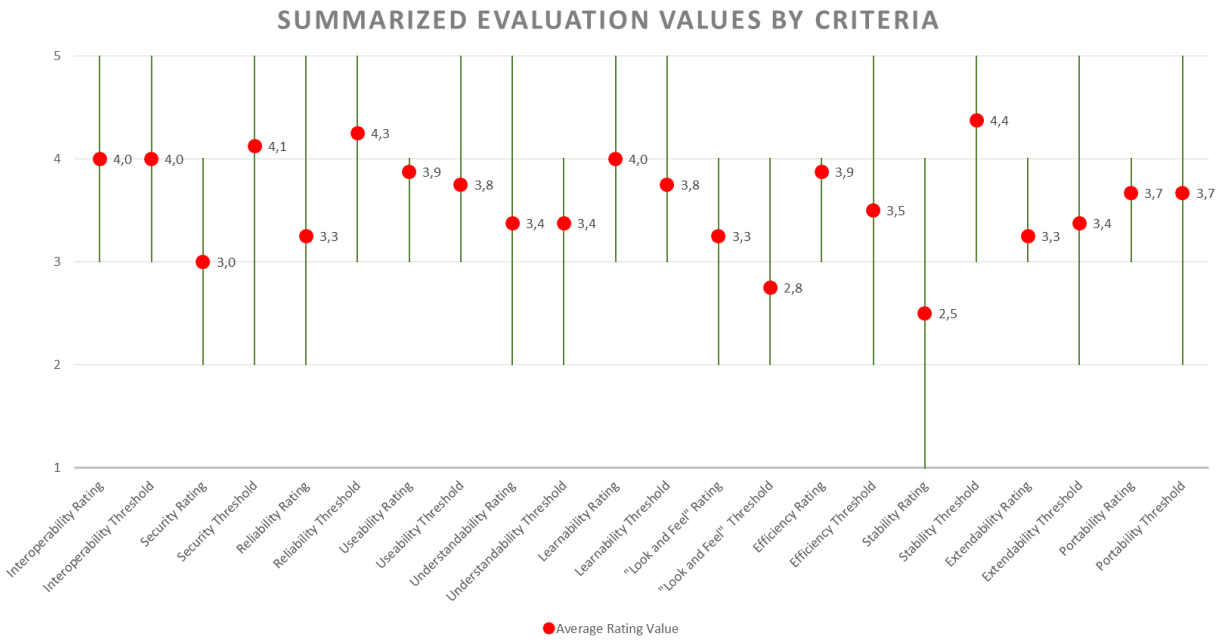


Figure 4-6: Overview of summarized Evaluation Results

Interoperability has been rated meeting or succeeding the critical threshold of a live production system by 75% of the assessors. Especially the open nature of the system with interfaces which allow the creation of additional adapters for external systems, as demonstrated by our custom SAP adapter and interface has been rated as an important feature.

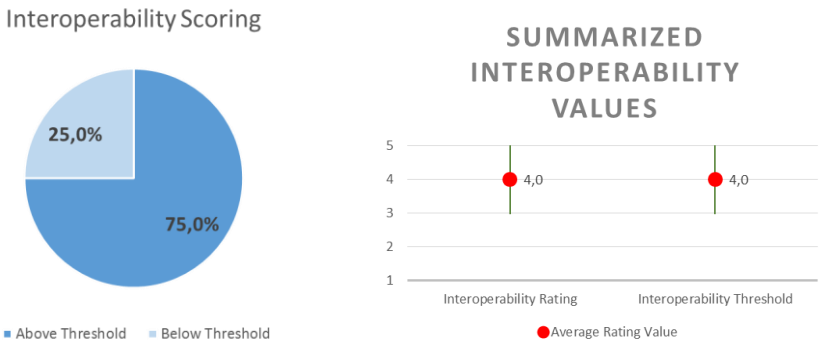


Figure 4-7: Interoperability threshold attainment

Security has been rated below the respective threshold value by 75% of the assessors. As explained before, this rating is referred to a scenario where the platform is already operating in live production mode. Additionally to the security features of the generic IMAGINE platform the IPA LL has the ability to be hosted inside a secure network which can only be reached via VPN tunneling and users who have authorized themselves by digital certificates provided by us. However his security feature is not

practical in a prototype demonstrator which is not fully developed. By assessing the security criterion stricter than required we have identified the additional features which need to be implemented to reach the required security level of a live production system.

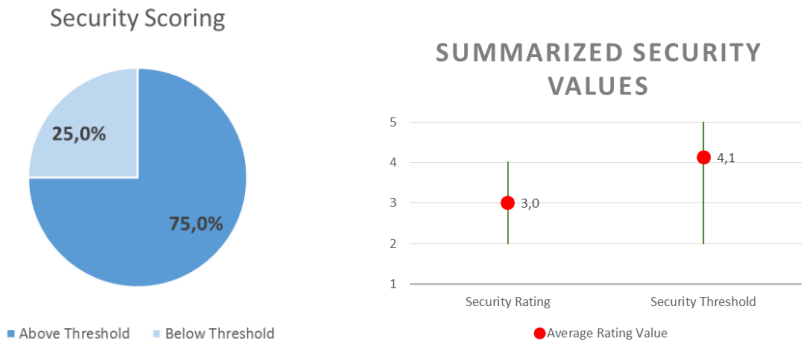


Figure 4-8: Security threshold attainment

Reliability has met the required threshold only in 12.5% of the cases. Just like security, the thresholds for this criterion have been chosen in a strict way and are referring to a comparable system in live production. This way we were able to identify the weaknesses and gaps in specific components which we will need further improvement, to exceed the requirements of a prototype demonstrator.

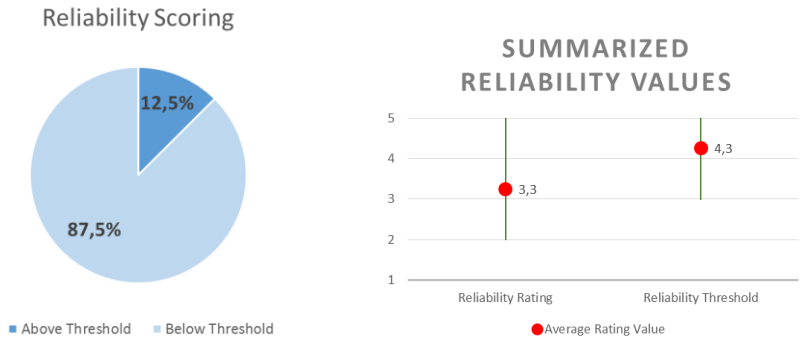


Figure 4-9: Reliability threshold attainment

Usability has been rated by 75% of the assessors above their threshold values. Most assessors remarked that usability doesn't need to be at the level of a consumer-product, since a system like this is expected to be used by trained expert personnel that knows about the content of the system and which processes are necessary. It is quite obvious that such a complex system with a huge number of functionalities has to be trained to the persons that will use it.

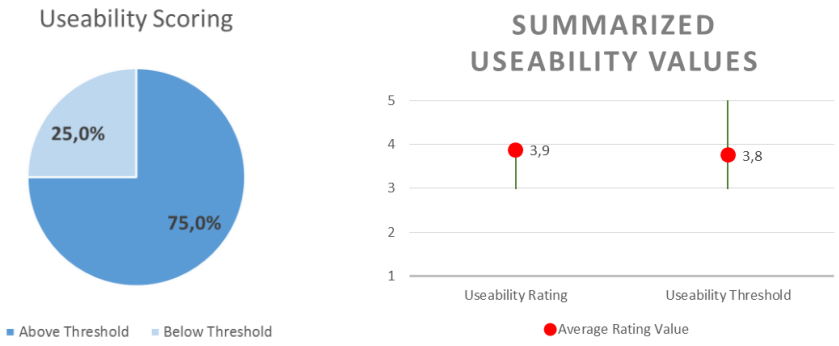


Figure 4-10: Usability threshold attainment

Understandability has also reached a positive rating of 75%. One assessor noted that the user interface reflects what a user can expect from a web application in terms of understandability of the user interface, but a dedicated help system would be very useful.

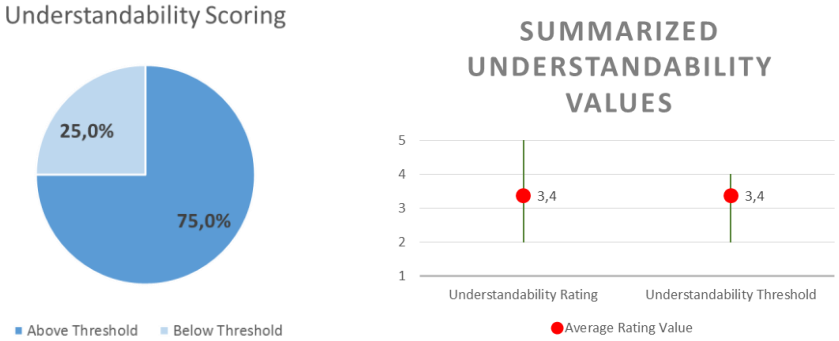


Figure 4-11: Understandability threshold attainment

Learnability has reached the threshold values in 87.5% of the cases, but it has been indicated that there is still room for improvements. Especially the available training portal has been noted a being a useful addition. Similar to the understandability criterion this system has to be trained to the personnel.

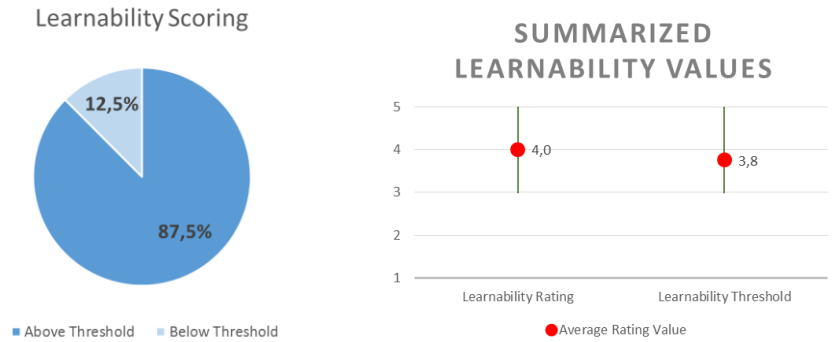


Figure 4-12: Learnability threshold attainment

The look and feel has been rated "very good" by 75% of the assessors. Only minor remarks have been made to some functional design decisions, but these can be addressed to the fact, that the assessors have not been working with the platform for an extended period.

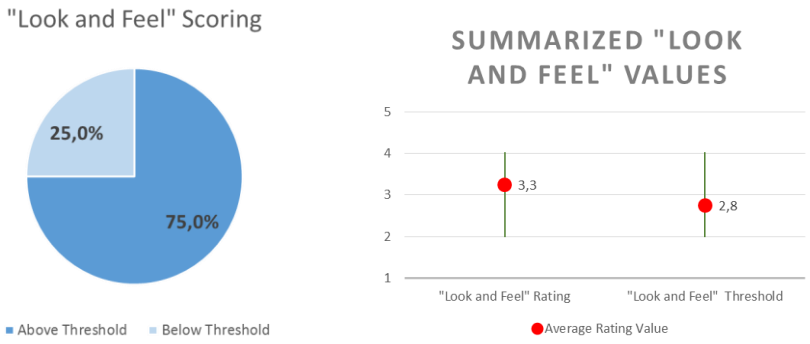


Figure 4-13: Look and Feel threshold attainment

Efficiency also achieved a very high rating with 87.5% of the assessors exceeding their threshold value. This very good rating is directly related to the high extensibility rating, which allows interfacing of external systems with the platform, which we were able to successfully demonstrate with the SAP ERP integration with our IPA IMAGINE LL platform instance.

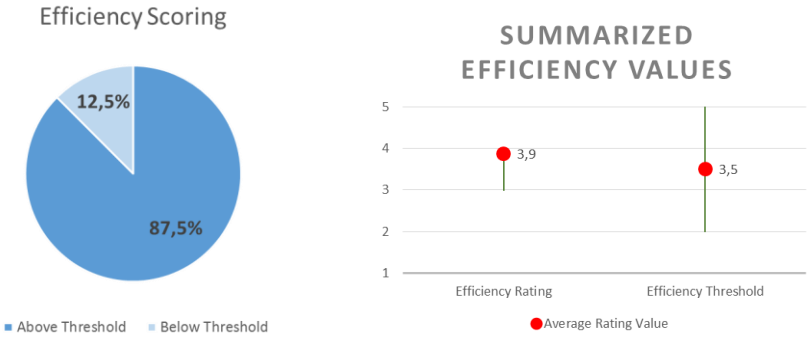


Figure 4-14: Efficiency threshold attainment

Stability has just as reliability only met in 12.5% cases the threshold values. As explained before stability and reliability are closely related and needed to be assessed more strictly.

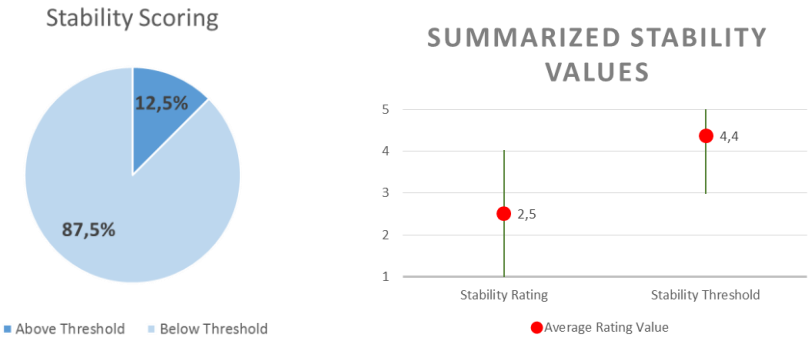


Figure 4-15: Stability threshold attainment

Extendibility reached 63% of the threshold values. Most assessors, who are experienced with software integration and implementation, gave a higher rating, since they are familiar with the technical foundation and back-end technology of a web-technology based platform like the i_Platform.

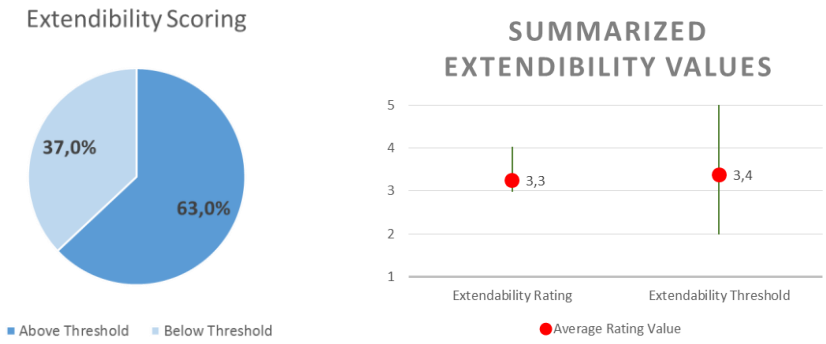


Figure 4-16: Extendibility threshold attainment

Portability has been rated above the respective threshold by 66% of the assessors. 33% of the assessors picked the highest possible value for their threshold, but still giving this criterion the second best rating.

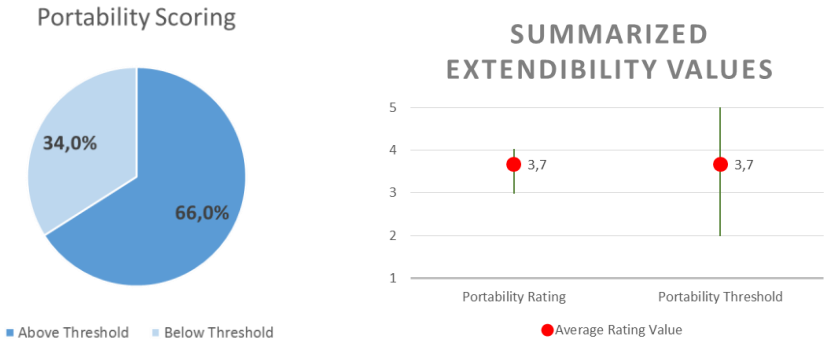


Figure 4-17: Portability threshold attainment

The first evaluation has been performed on the second release (R2) of the IMAGINE platform, while this evaluation took place on the third (R3), respectively the R4 release of the platform which also encloses the complex event processing building block, which adds additional functionality. The following figure shows the congruence between the thresholds and the rated values. As expected our reliability, stability and security show gaps, since we asked our evaluators to rate these criteria more strictly because they have been chosen as our top priority criteria from a developer's point of view.

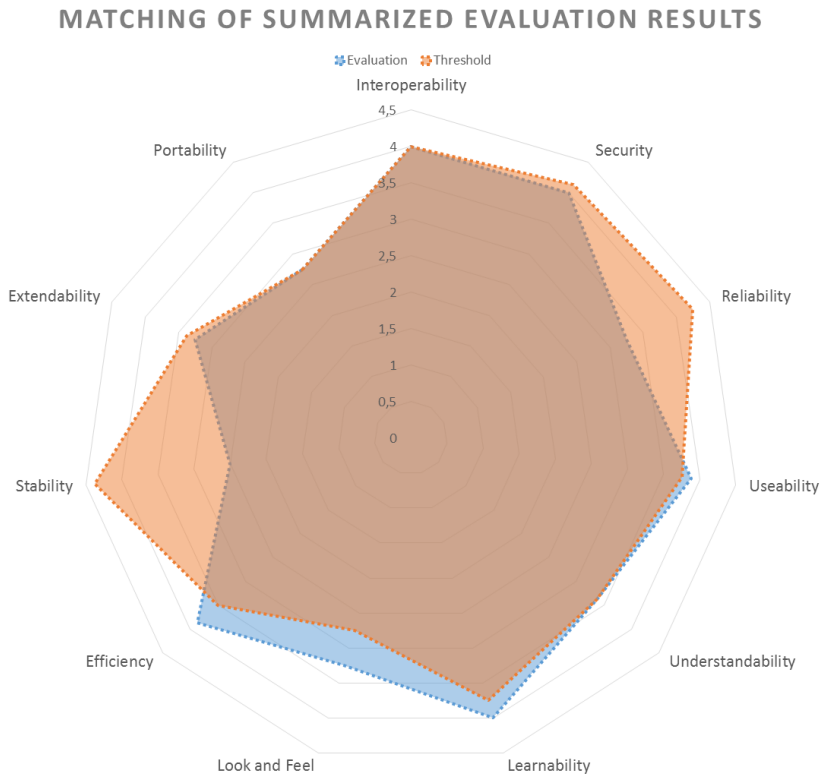
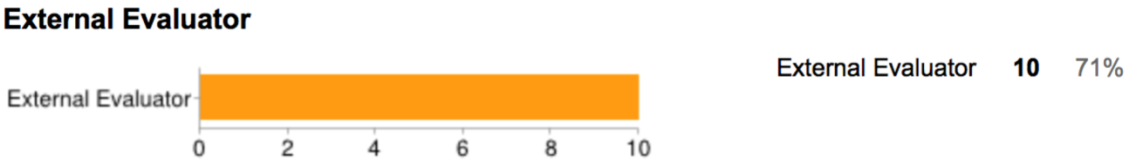


Figure 4-18: Congruence between threshold and evaluation values

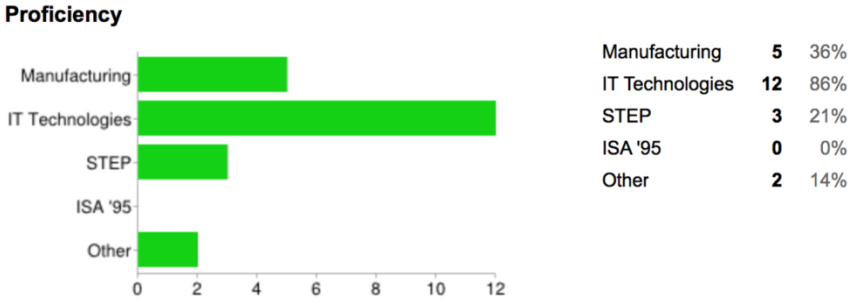
R3 has added a lot of improvements over R2, which have been further enhanced by the customizations of the IPA IMAGINE LL instance. Security and reliability are the two most crucial features which we chose to be rated particularly strict. As expected these are the criteria on which we need to improve and which need to be our priority.

4.2 Aerospace and Defense Industry

The evaluation of the Aerospace and Defense living lab was carried out by a set of experts including more than 70% of external evaluators.



The evaluators were selected in order to represent as much as possible the diverse categories and groups and level of expertise required to guarantee an acceptable evaluation.



The following graphs illustrate the evaluation results including the scores as well as the considered as critical values for the several functionalities and properties provided by the Aerospace and Defense Living lab.

- Functionality Interoperability:

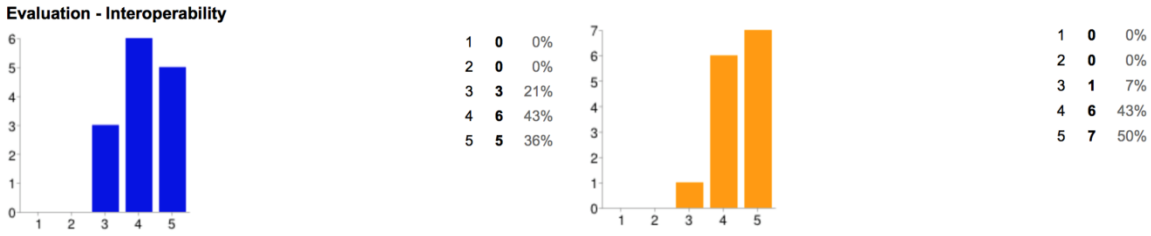


Figure 4-19: Functionality - Interoperability a) Score, b) Critical Value

- Functionality Security:

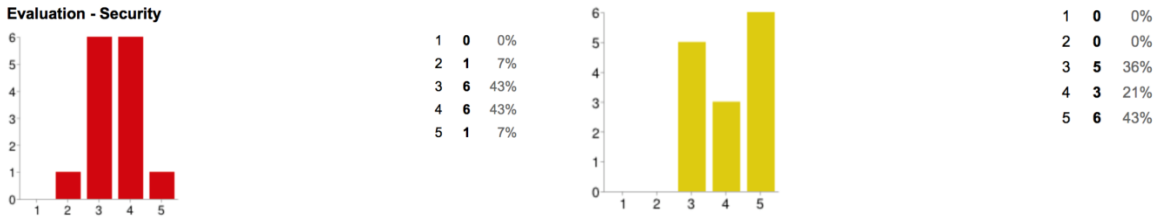


Figure 4-20: Functionality - Security a) Score, b) Critical Value

- Reliability:

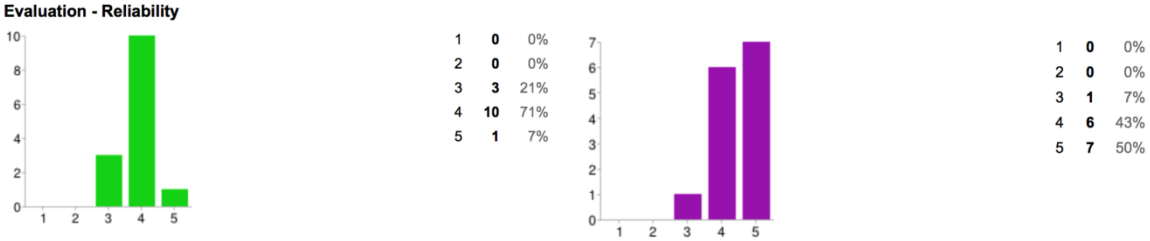


Figure 4-21 Reliability a) Score, b) Critical Value

- Usability:

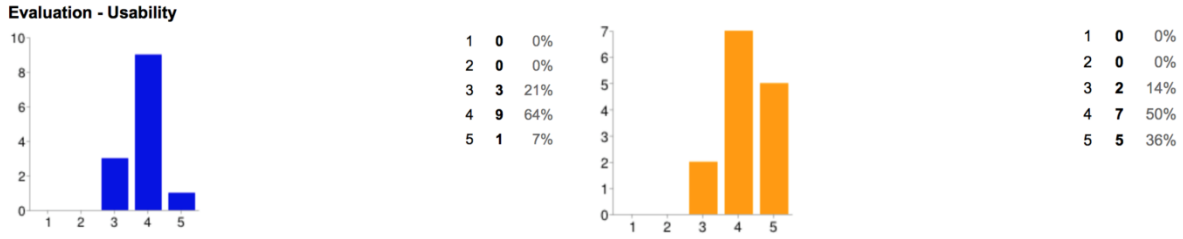


Figure 4-22 Usability a) Score, b) Critical Value

- Understandability

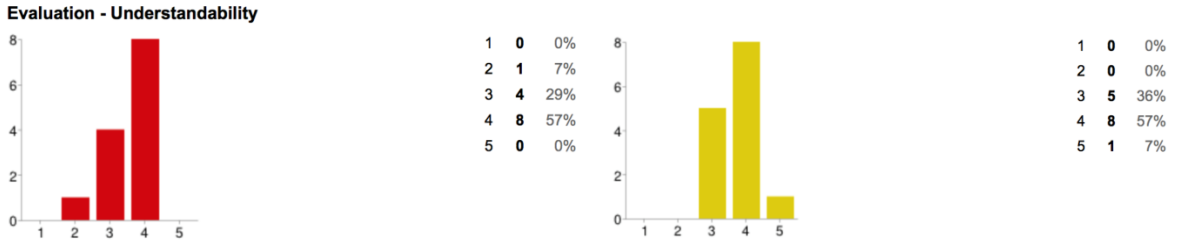


Figure 4-23 Understandability a) Score, b) Critical Value

- Learnability

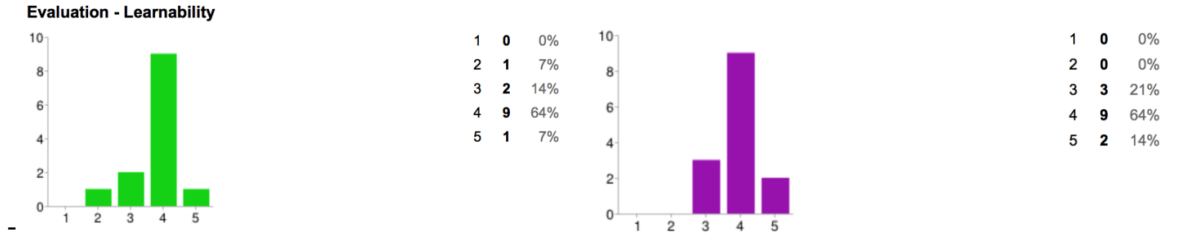


Figure 4-24 Learnability a) Score, b) Critical Value

- Look and Feel

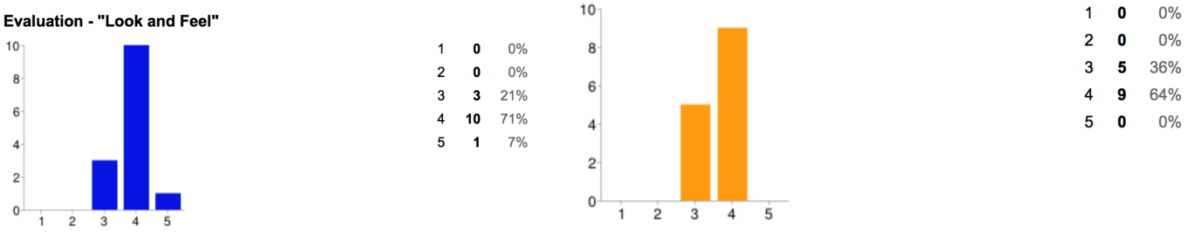
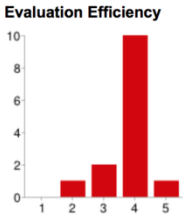
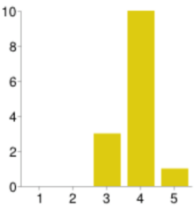


Figure 4-25 Look and Feel a) Score, b) Critical Value

- Efficiency



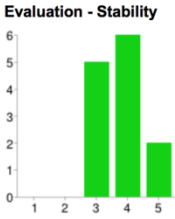
1	0	0%
2	1	7%
3	2	14%
4	10	71%
5	1	7%



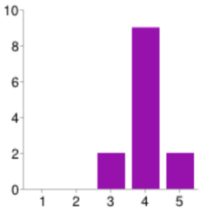
1	0	0%
2	0	0%
3	3	21%
4	10	71%
5	1	7%

Figure 4-26 Efficiency a) Score, b) Critical Value

- Stability



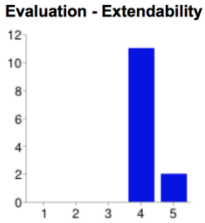
1	0	0%
2	0	0%
3	5	36%
4	6	43%
5	2	14%



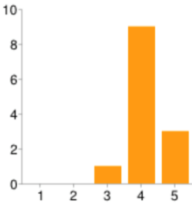
1	0	0%
2	0	0%
3	2	14%
4	9	64%
5	2	14%

Figure 4-27 Stability a) Score, b) Critical Value

- Extendability



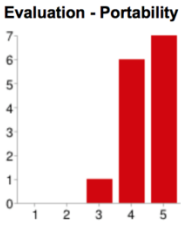
1	0	0%
2	0	0%
3	0	0%
4	11	79%
5	2	14%



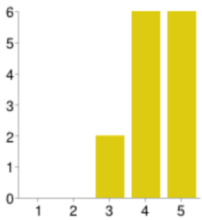
1	0	0%
2	0	0%
3	1	7%
4	9	64%
5	3	21%

Figure 4-28 Extendability a) Score, b) Critical Value

- Portability



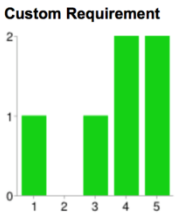
1	0	0%
2	0	0%
3	1	7%
4	6	43%
5	7	50%



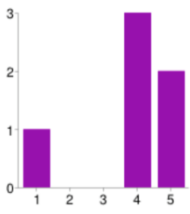
1	0	0%
2	0	0%
3	2	14%
4	6	43%
5	6	43%

Figure 4-29 Portability a) Score, b) Critical Value

- Custom requirement



1	1	7%
2	0	0%
3	1	7%
4	2	14%
5	2	14%



1	1	7%
2	0	0%
3	0	0%
4	3	21%
5	2	14%

Figure 4-30 Custom requirements a) Score, b) Critical Value

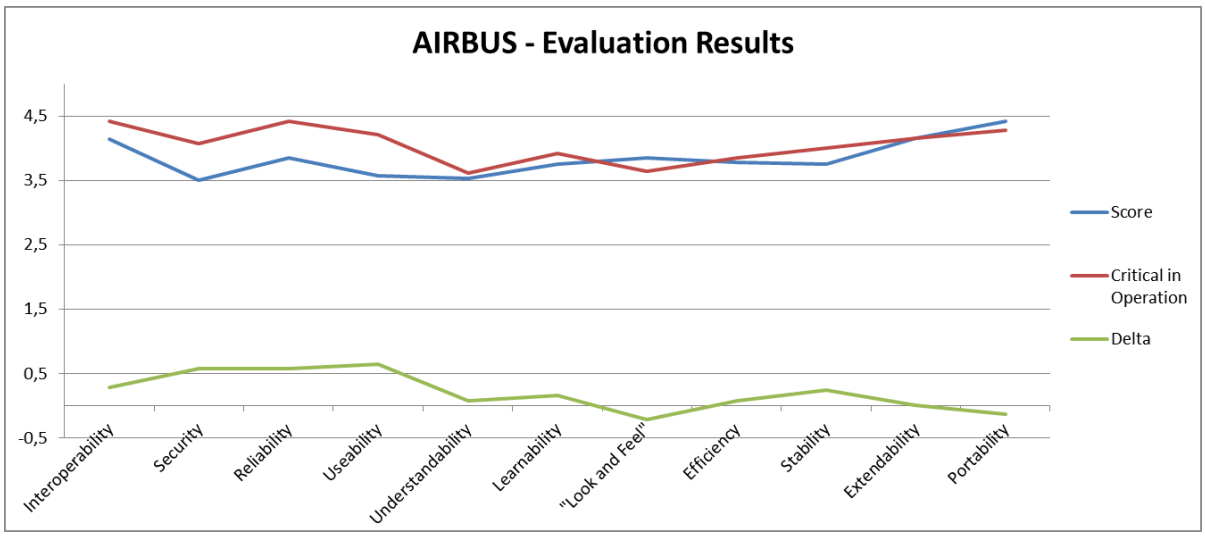


Figure 4-31: Comparison of Evaluation Scores, Critical Operations, and Deltas

Looking at the results, the delta is always less than one 1 (maximum delta =0.64). So it means that by default, the cPlaform dedicated to experimentation is close to what is expected for applications in operation for all the expected qualities. For some qualities like look and feel or portability, cPlatform reach the same level of expectation than for applications supporting operational processes. So the results are quite goods considering that cPlatform was developed and integrated only by Airbus Group Innovations with the resources made available by the IMAGINE project.

The following table provide analysis each delta, and describe how it is addressed in the current exploitation of IMAGINE results within the SIP project.

Table 4-1: GAP Analysis of the Aerospace and Defence LL

Sub Category	Delta	Analysis	SIP project extensions
Interoperability	0.28	Availability of generic adapters for facilitating the integration of existing systems. Some existing functionalities are considered as missing for covering completely the needs, in particular creation of test scenarios and data.	Motivation for launching the SIP project, for exploiting and extending the results of IMAGINE. cPlatform will be the infrastructure of a test bed for manufacturing standards
Security	0.57	First it was identified missing encryption capabilities for information (files) put on the portal. Such encryption capability was not provided, as considering that trust should exist between partners experimenting together the standards,	Such issues were captured in the SIP project, but the priority is currently not high at the current stage of the project. SIP could extend it according requirements of partners who would like to include such

		and that no confidential data should be put on the experimental platform. Extension of the portal capability is nevertheless possible, by providing encryption capabilities based on TSCP standard, with management of keys and usage of certificates. If possible to make such extension, it will go against usability and will slow the performance due to all the encryption operation to perform. Potential need for usage of trusted certificate was identified in some cases, without making it a stopper for experimentation. Need for potential usage of SAML when trust is established was also identified. Current platform doesn't provide this capability. It was identified that some companies worked on connecting SAML components to the Liferay portal, so it is possible, but not freely available. Finally, a feedback concerned the lack of protection against some attacks for the current instantiation of the cPlatform.	security on their assessment scenarios for secured PLM collaboration.
Reliability	0.57	Analyzing feedback from survey, it seems that this quality was difficult to assess for interviewed people, as such quality implies continuous operational usage in order to collect data.	
Usability	0.64	For this quality, availability of more documentation and training material was identified as a need for some aspects of the platform. The fact that Liferay is easy to use, and availability over the web were provided as good point for the usability	Cookbooks and training material will be improved and extended during the SIP project, applying the approach defined by SIP for active knowledge sharing (YPBL).

Understandability	0.08	Potential of improvement for making usage of the cPlatform clearer for different categories of users. Not a stopper	SIP will contribute to provide improvement of the documentation and of documents of reference for the different categories of partners.
Learnability	0.16	If approach based on cookbooks is considered as a very good point, the cPlatform is complex and the learning curve may be high.	SIP will continuously improve and extend the learning material. Agreement is being established with universities and AIP-PRIMECA for making some results training material that can be used for teaching, being instances of the cPlatform or training material.
Look and feel	-0.21	Default look and feel appreciated, as simple and uniform. Some feedback stated that look and feel was not OK, and should be improved in order to respond to graphical chart of an enterprise. In fact, Liferay provides a sophisticated mechanism for defining and manage look and feel per community or organization, based on set of dedicated style sheets. But it requires having a webmaster (skill) if willing to define it. So more a problem of resources than a technical problem.	No very prior for the SIP project.
Efficiency	0.07	As reliability, difficult for interviewed people to assess. Consequently difficult to analyze the provided score and to make decision.	
Stability	0.24	Efficiency .Similar	
Extensibility	0	Satisfactory, after reviewed people having access to the description of the architecture and usage of standards. But such quality will have to be demonstrated over the time as it is not always demonstrated that used standards and their implementation	SIP aims at providing evidence through usage of the extensibility and of the accuracy of standards.

		support easily extensibility. More a problem of standards than a problem of the cPlatform	
Portability	-0.14	Good feedback here. The score is very high, probably because the requirement for being able to port the platform on other infrastructure is related to requirement of a Living Lab, not of an industrial platform in operation which is quite stable on one and a single one environment.	SIP will promote this aspect for facilitating experimentation within university or for experimentation on a private network when required for security.

The collected feedback was good for the cPlatform, and allowed to identify the potential of the cPlatform. But more important, the fact that several partners agreed to base a project related to manufacturing PLM interoperability test bed on the cPlatform demonstrated that they were convinced about interest of such a platform for experimentation purpose.

4.3 Automotive Industry

The major requirements of the Automotive LL are displayed in Figure 4-32 and Figure 4-33 below. Overall all requirements are ranked high (3 and above, on a [1.5] scale).

The interviewees have ranked high the aspects related to an improvement of the actual processes (monitoring, operational improvement) and the ability to interoperate with existing systems. In the meanwhile they have taken into account the level of maturity of the system and indicated the important areas which are relevant and should be improved (security, reliability above all), but have a correct evaluation at this point of development (3 and above on the [1.5] scale).

Other aspects are more marginal, such as "look and feel", "portability, "extendibility", indicating that the technical approach chosen is appropriate.

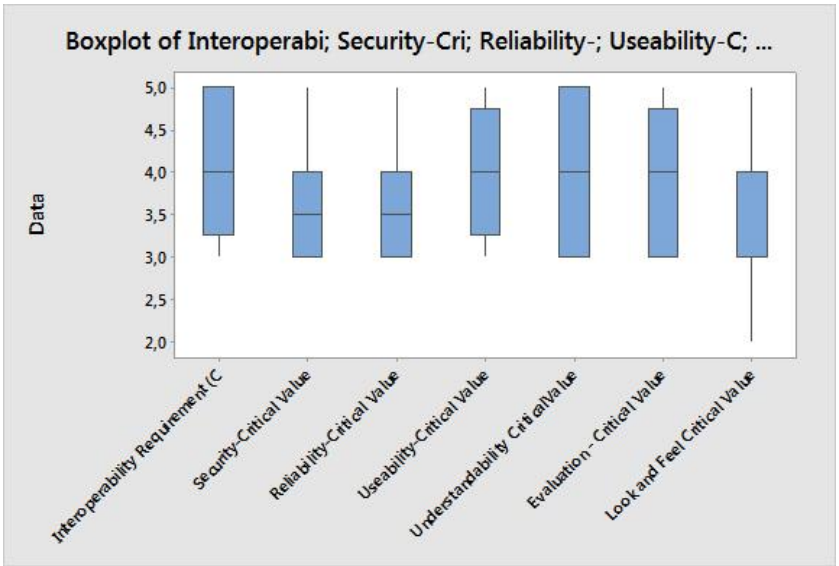


Figure 4-32: Requirements for the AutoLL (part1)

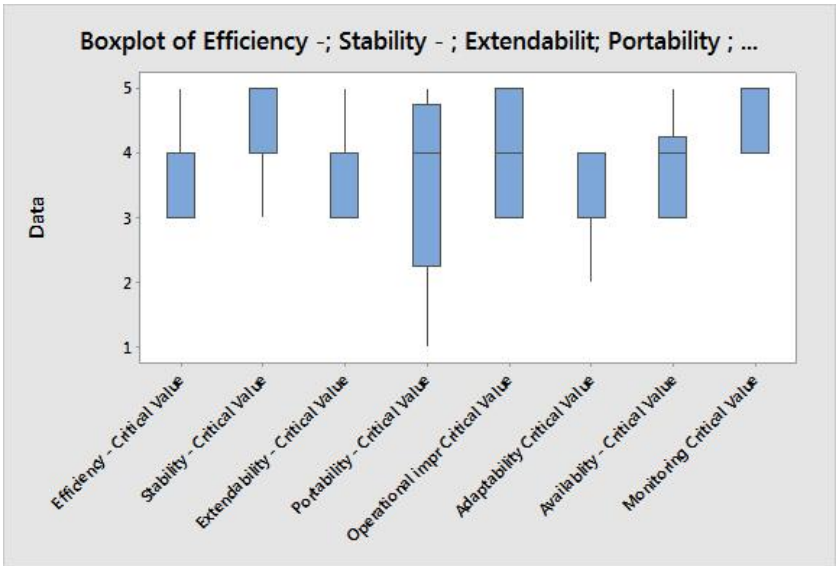


Figure 4-33: Requirements for the AutoLL (part2)

In summary the most relevant aspects were, as indicated in Figure 4-34, and in descending order of importance:

- **Monitoring**
- **Stability**
- **Interoperability**
- **Understandability**
- **Usability**
- **Operational improvement**
- Availability
- Efficiency

- Extensibility
- Reliability
- Security
- Look and Feel
- Portability
- Adaptability

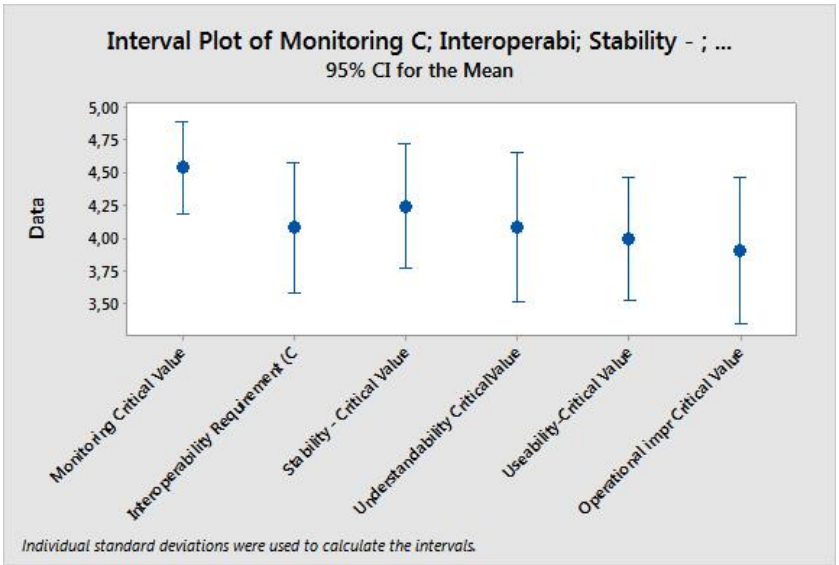


Figure 4-34: Main requirements for the AutoLL

The following section analyses in details the evaluation of the 6 most relevant aspects (highlighted above). The evaluation of these main aspects is reported in Figure 4-35 below.

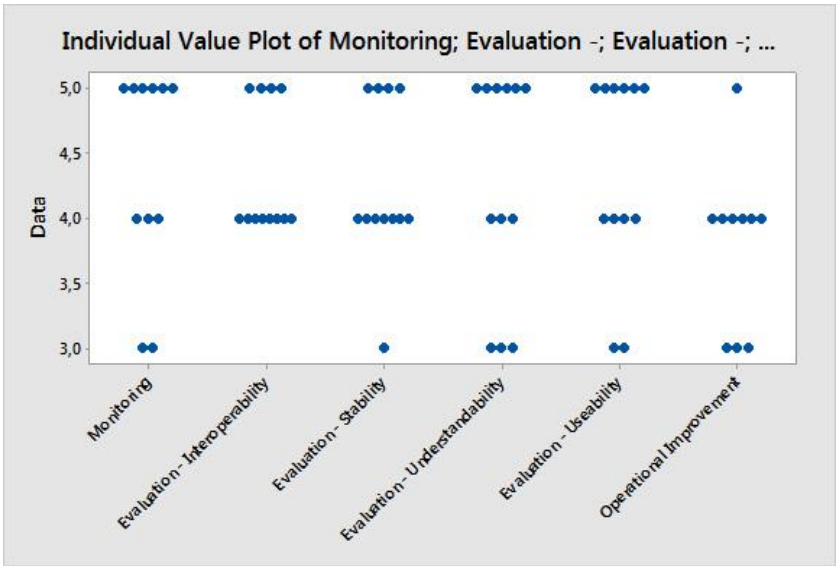


Figure 4-35: Evaluation of main aspects

As in Figure 4-36, the main aspects are ranked in the same order (except for the usability, which has been seen as exceeding even more the expectations than the others).The level of appreciation is in general high (more than 4 on a [1,5] scale). As expected, the top ranking aspects are:

- Monitoring
- Interoperability
- Usability
- Stability
- Understandability
- Operational improvement

Usability is now ranked 3rd, expressing the satisfaction of the interviewees on the specific aspect. The fact that 25% of them had not been exposed to the system before, and therefore had to use the system for the first time, increases the overall evaluation.

In Figure 4-36, the discrepancies with respect to expectations are reported. Each dot represents on evaluation. 0 means: no deviation w.r.t expectations. Positive values mean exceeding the expectations.

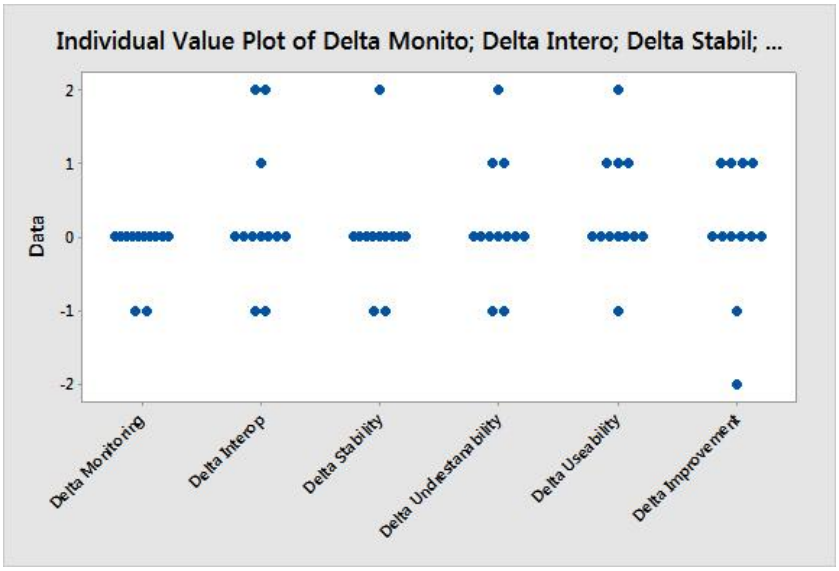


Figure 4-36: Evaluation of main aspects (delta w.r.t. requirements)

It is interesting to note, by comparing Figure 4-34 and Figure 4-35, that the already high expectations have been met or exceeded for all requirements cases in more than 80% of the cases.

Interesting also is to understand the motivation of not meeting the requirements: in these cases, the interviewees:

- Asked for further tests (e.g. "Seems to be the case - but needs to be tested...")
- Looked unable to assess correctly the functionality (e.g. "Another must, which seems correctly addressed.", but with a negative delta…).

In these cases, the negative delta can be seen more as a result of the impossibility to assess the characteristics than a negative evaluation of it.

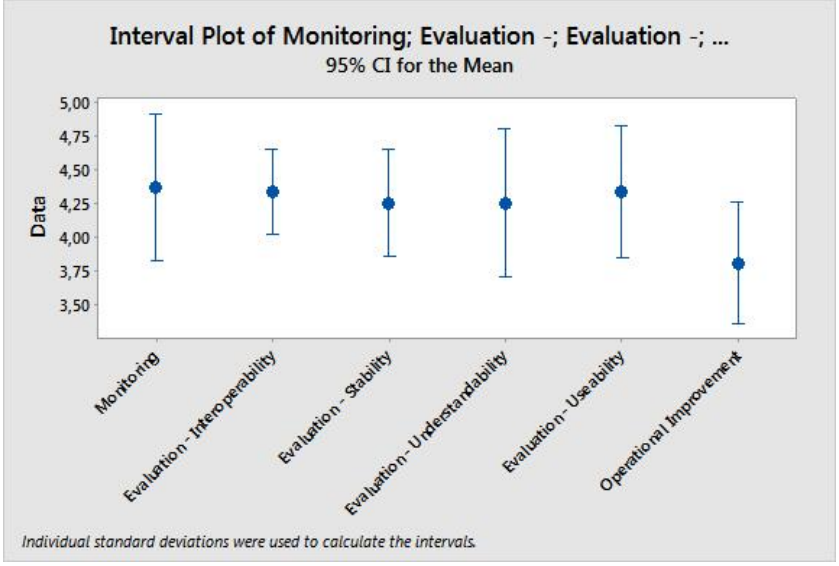


Figure 4-37: Evaluation of main aspects (mean and variation)

In conclusion, Figure 4-37 above reports the overall evaluation of the main technical aspects of the LL platform:

- Monitoring
- Interoperability
- Stability
- Understandability
- Usability and
- Operational Improvement

All aspects rank 4 or above, indicating a high level of trust of the interviewees in the proposed solutions to solve industrial issues. The tool is proving to be useable from a technical point of view for all technical aspects. The lowest ranking aspect (but still around 3.75) is the operational improvement, which will need to be further developed and assessed again.

Finally, this study has focused on the assessment from a technical point of view: the assessment of the impact on the business processes is evaluated in the IMAGINE Deliverable D5.2.2.

4.4 Furniture Industry

Since during evaluation workshop only 9 enterprises data with a short number of resources has been taken for the Furniture Living Lab pilot and experimentation comparing to the expected number that one enterprise will have inserted in a regular use of the platform, thus, it was considered as a possible issue the big duration of the platform processing hundreds of products data. The usability characteristic should take in consideration the required duration for each resource categorization (mapping) accordingly to the reference categories/concepts used in the IMAGINE platform.

Additionally, the main technical concern is about the capability of the system managing thousands of products from hundreds of furniture manufacturers in the searching and simulation procedures executed by the IMAGINE platform. Thus, the platform must be able to give a proper and efficient answer, which is expected that doesn't take so much time.

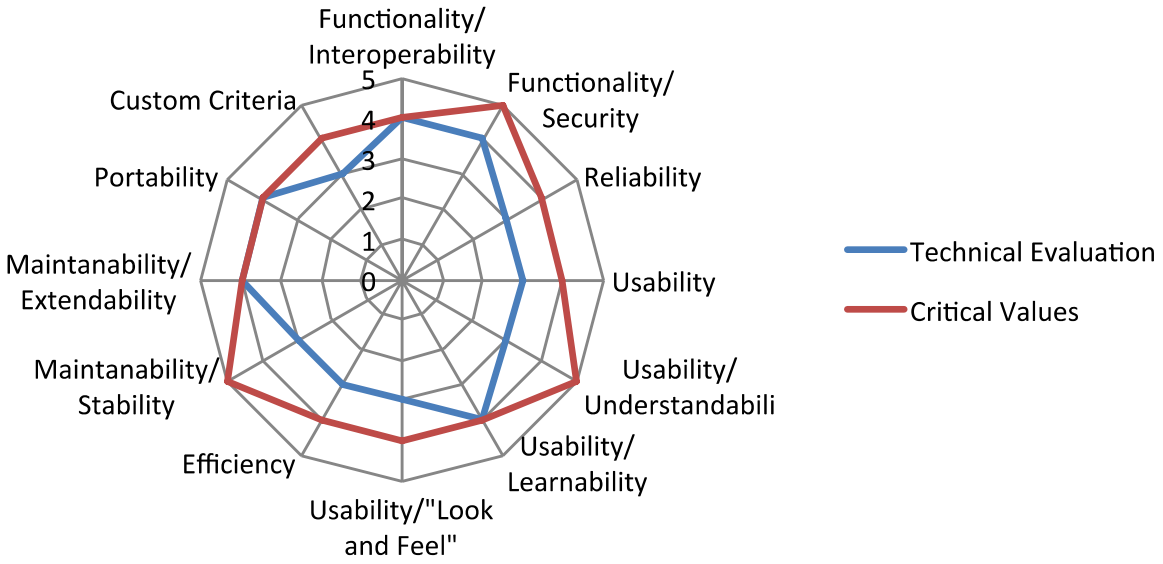


Figure 4-38: Technical Evaluation and Critical Results

These stated remarks are in line to the overall feedback received from the evaluation questionnaire (Figure 4-38). The critical values defined, which intends to point out the importance level of the platform technical characteristics were in some points higher than the score received (technical evaluation). These identified differences represent the gap of the evaluation of the current version of the platform at the time of the workshop, to what the participants expect to be considered as necessary to the platform be in shape to be considered as a "product". This means that the platform still needs further improvements to be successfully launched into the exploitation phase. These identified gaps highlight the characteristics that should be carefully addressed and improved in further implementations/validations, which relate to: reliability, understandability, efficiency, and maintainability. This represents a certain sceptic opinion that could be demystified in further demonstrations workshops by using a bigger amount of data. Due to these conclusions, more workshops with furniture SMEs should be executed before of the IMAGINE platform launch into

exploitation of the IMAGINE platform to obtain a better acceptance potential by the furniture business stakeholders.

From the questionnaires feedback (comments) descriptions were extracted that illustrates the acceptance values for such technical characteristics. Additionally the threshold for a light positive feedback is "3", a good and excellent result are "4" and "5" respectively. The received scores from the questionnaire it is presented in Figure 4-38.

Functionality

In relation to functionality it was received an average of scores equal to four, which represents that users understood the platform objective and think that its functionality level is good. However, users highlighted the importance of a good communication between the legacy systems and the IMAGINE Platform, to ensure an optimal grade of integration between both systems. They also emphasized that some problems could be found in the process of adapting the information of the ERP systems to the IMAGINE Platform system. By accomplishing this, the security has considered a very important issue for the users.

Reliability

The reliability criteria received an average value of "3", which represents users are not so confident with the platform. It was the following comment: "The reliability of the information provided by the platform is a key factor for doing useful simulations." This means that reliability would be naturally increased after its real use in its exploitation phase.

Usability

Concerning usability the score it was around "3", which represents the necessity of some improvements, which the following comments clearly presents the why of such score: "Users consider that companies need very user-friendly tools, no much time consuming, flexible and easy to manage. Some users consider that the current interface is not as friendly as they would like. Manual should be given to make some previous training.

Efficiency

The efficiency received "3", which is also in line to the main comment received: "Efficiency should be improved because some of them have the impression that the tool is a bit time consuming."

Maintainability & Portability

Maintainability and Portability didn't receive any comments. Additionally, they received an average score of "4", which is a good result. This is in line with the functionality grade, thus, it could represents that interoperability has been well addressed giving some trust/confidence for the integration of the platform in furniture business.

"Custom"

The "custom" criteria was related to evaluate the customization of the IMAGINE platform into the furniture business needs/requirements. It received a light positive score. This means that a bigger technically effort has to be done to have a higher positive acceptance from the industry. The goal to follow is effectively to answer to the feedback received by accomplishing all the required improvements.

Additionally, from the variations of these technical evaluation results, which is shown in Figure 4-39, it was concluded that reliability, understandability, efficiency, maintainability and usability characteristics received from some of the participants a negative feedback. Thus, in additional it was also verified that all the usability sub categories received negative scores. This last concluding remark remembered evaluators about the most mentioned comment among the participants, which indicates that the i_Platform must be also available in Spanish to effectively get an overall "usability" acceptance of it from Spain users/enterprises. This is the most important requirement, which demands for more developments. This means that despite the fact that DMN implementation was recognised as an added value to the furniture business, which means that even the i_platform could be in a first phase launched in English, it should, as soon as possible, "translated to Spanish" to be widely accepted/exploited.

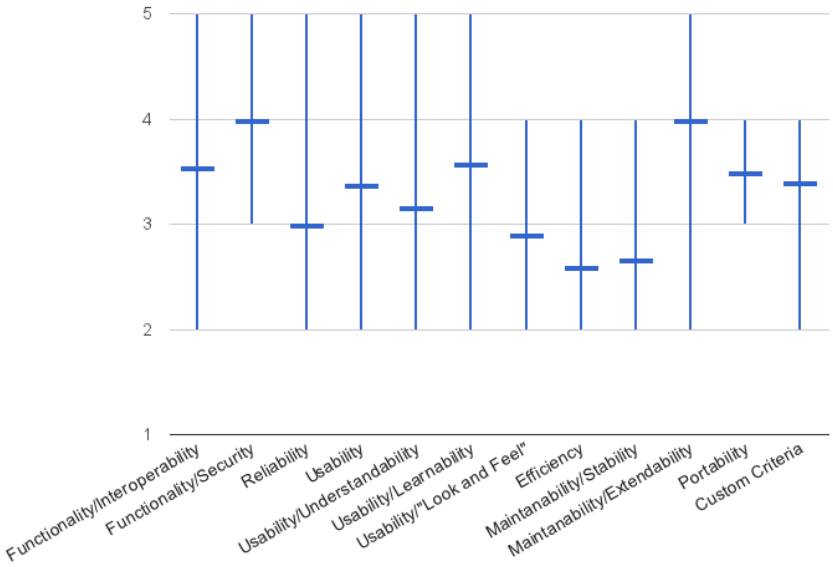


Figure 4-39: Variations of the Technical Evaluation Results

4.5 Engineering Sector

At the time of writing, UoW had 17 respondents to the combined methodology and technical implementation questionnaire. The respondents declared their proficiency and knowledge as follows:

- 35% Manufacturing Management
- 53% IT Technologies
- 24% ERP/MRP

Unsurprisingly the car manufacturing industry was the most represented manufacturing sector. Also unsurprisingly, given the limitation imposed on the assessment exercise, most respondents were academics (76%), with SMEs (12%) and retired industrialists (12%). Given the nature of WMG, the academics will have significant industry backgrounds. Our assessors had a combined experience of 139 years in manufacturing industry, equivalent to an average of 10 years for those who provided a number.

As previously described, our joint assessments were structured to firstly present the DMN methodology and then present the platform. Our assessors were given the option of whether to

complete the questions related to the technical implementation of the IMAGINE Platform as we realized not all respondents would feel able to express an opinion on technical aspects of the Platform. 35% of our respondents chose to answer the technical implementation questions and their detailed responses in matching pairs of evaluation and critical values were as follows.

1. Functionality

a. Interoperability

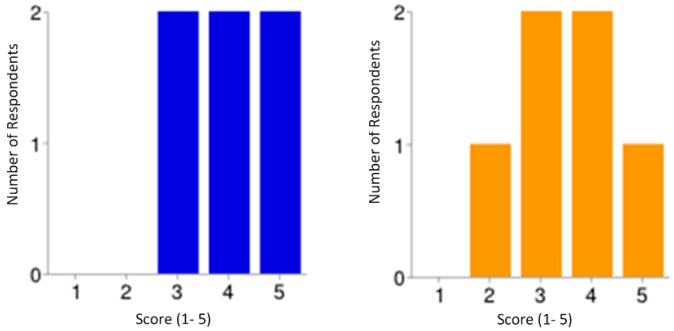


Figure 4-40: UoW Functionality -Interoperability a) Score, b) Critical Value

With a mean of 3.5 for the criticality value and a mean evaluation score of 4 there is a consensus that the platform has sufficient interoperability at the moment. This is pleasing as the system was designed to be open and interoperable from the ground up. In the UoW context of a collaboration network between thousands of SMEs, trust and legal and complexity issues may make it unrealistic to dynamically connect the manufacturing control systems of each SME into the IMAGINE platform. Comment was made in the methodology assessment about it being too risky to connect manufacturing information to a platform also used by SMEs who may sometimes be collaborators and sometimes competitors. Because of supplier concerns in this area it has not been possible for UoW to attempt the creation of an adapter between the IMAGINE platform and a manufacturing information system so no information could be provided to evaluators about how easy or otherwise this might be.

b. Security

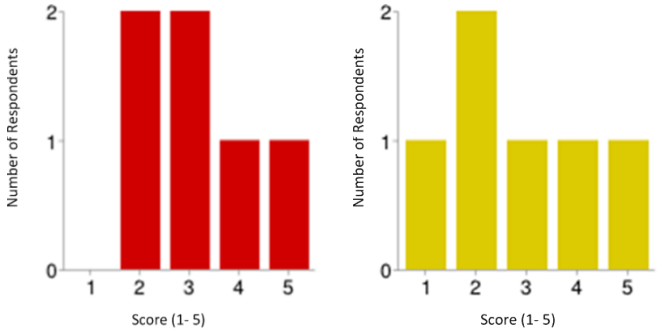


Figure 4-41: UoW Functionality:-Security a) Score, b) Critical Value

Given the sometimes competitor, sometimes partner nature of the relationships between companies in the UoW collaborative network it is perhaps surprising that at a value of 2.83 the mean criticality

score for security is the lowest of all the criticality scores. It should be noted that for this parameter there is a very wide spread of opinion! It could surely be argued that this whole approach would rapidly be seen as unviable if confidential partner data end up being passed to or hacked by competitors. The mean evaluation score of 3.16 perhaps suggests that at this stage in the development of the platform there was perceived to be sufficient security. However it should also be pointed out that there were no security experts in the reviewer group.

2. Reliability

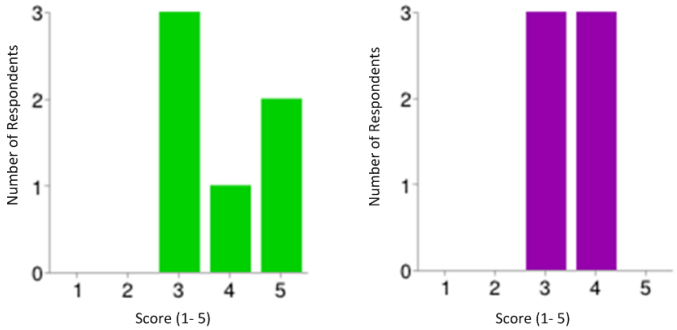


Figure 4-42: UoW Reliability:-Reliability a) Score, b) Critical Value

With a criticality mean of 3.5 and evaluation mean of 3.83 there was general satisfaction with this area although again it should be pointed out that reviewers did not have the opportunity to use the system over an extended period of time and hence find out for themselves how reliable or otherwise the system really was. Again perhaps this was felt to be satisfactory for the current technology readiness level but any sign of unreliability in production use would very rapidly cause companies to revert to traditional ways of doing business. Once lost, it would then be very difficult to win partners back so at the point of first production use it may be anticipated that higher values of reliability would be needed.

3. Usability

a. Usability

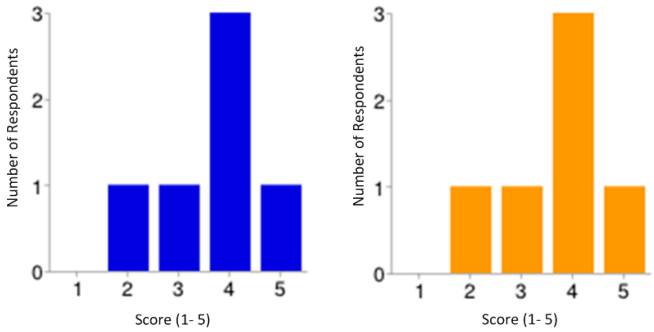


Figure 4-43: UoW Usability-Usability a) Score, b) Critical Value

Half of the respondents rate criticality and performance values as 4 although the spread of opinion results in a mean criticality and evaluation of 3.63. Any software developer is aware that if the system

does not have an 'easy to use' user interface the adoption of the system by users will be at best slow. The reviewers only saw the user interface in the context of a presentation which showed the system in the hands of an expert user. In this context the system is clearly usable although the look and feel is akin to many basic user interfaces. However, to ease users over the learning curve period during adoption, more would need to be done in terms of more informative tool tips, an online help guide and better indication of the workflow from module to module.

b. Understandability

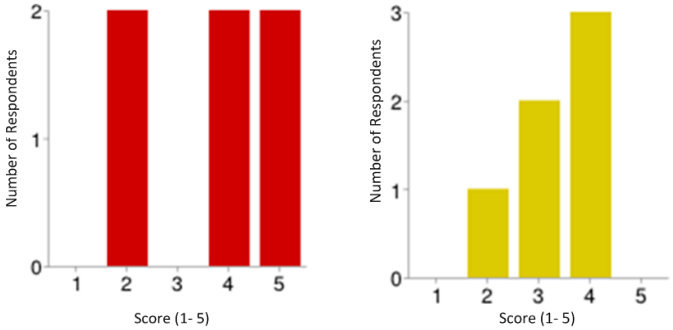


Figure 4-44: UoW Usability-Understandability a) Score, b) Critical Value

With a criticality mean of 3.33 and an evaluation mean of 3.67 it appears that the reviewers are happy with this attribute. Interestingly, however there appears to be a split between those who clearly felt the system was understandable and those who apparently did not understand. This is a little worrying given that it could be argued that all the reviewers were people of higher academic ability than the majority of potential users in the West Midlands SME base. It would be interesting to pursue this to determine whether the issue for those who did not understand was with the presentation, the methodology or the platform.

c. Learnability

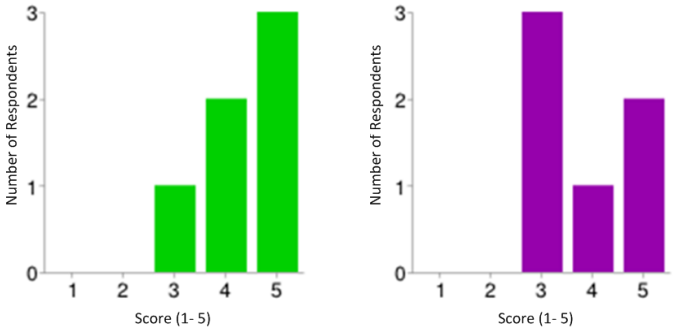


Figure 4-45: UoW Usability - Learnability a) Score, b) Critical Value

Along with stability, this was the joint highest evaluation mean at 4.33 and clearly exceeds the criticality mean of 3.83 by a reasonable margin. Given that most of the reviewers have first-hand experience of learning complex CAD/CAM or ERP packages and making use of Office software with its

plethora of features, commands and options it is perhaps not surprising that the relatively small number of commands needed to drive the Platform leads to strong consensus that the platform is easy to learn. As with all software, as additional features are added, the software becomes more difficult to learn, simply because there is more to remember and it may be anticipated that as the IMAGINE Platform moves into production use this will be the case. However for the moment, even for occasional users this parameter is satisfactory. As already mentioned, online help with videos, how-to guides and so on would greatly assist users trying to learn the system.

d. "Look and Feel"

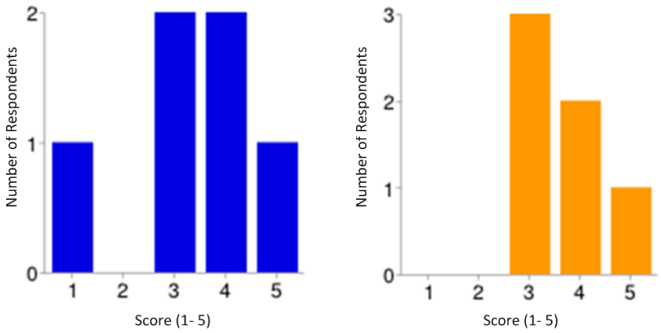


Figure 4-46: UoW Usability - Look and Feel a) Score, b) Critical Value

This is perhaps one of the most subjective judgments required in the evaluation of the platform and the wide spread of results has perhaps as much to do with the spread of ages of the reviewers as anything else. Those old enough to remember command line interfaces doubtless regard the current look and feel as more than satisfactory. Those used to the sophisticated and visually appealing user interfaces provided in virtual world games would perhaps regard it as dull. However overall it seems that for an industrial system the reviewers judge the look and feel to be satisfactory.

4. Efficiency

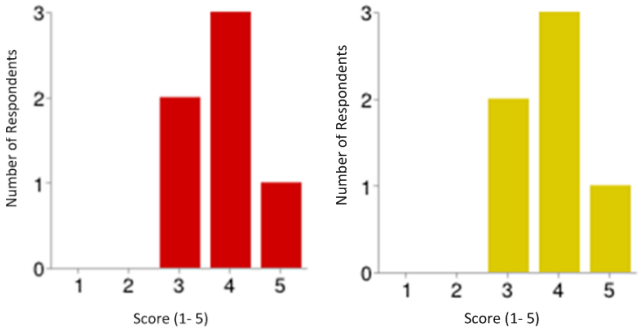


Figure 4-47: UoW Efficiency a) Score, b) Critical Value

Efficiency was defined in the review meeting as being the contribution of the platform to forming partnerships more effectively and in a shorter time than would be possible with traditional approaches to partnering. With both criticality and performance evaluations averaging 3.83 the reviewers

obviously feel the system has the potential to deliver significant time savings in production use. Even though system delays while searches are executed will vary with the complexity of the search and the number of partners on the platform, it can be readily seen that the approach will still be more efficient than the alternative of 'googling' possible partners and then trying to phone them. Even so it may be that in production use search speed issues will need to be addressed by faster hardware than was available for the review.

5. Maintainability

a. Stability

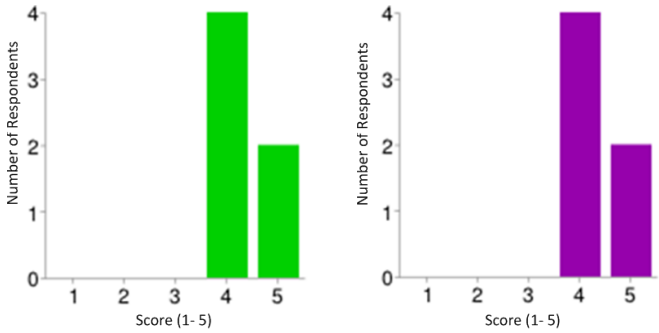


Figure 4-48: UoW Maintainability - Stability a) Score, b) Critical Value

Whilst it was found to be difficult to explain the difference between reliability and stability to the reviewers, there was almost complete unanimity that this was very important. At a mean score of 4.33 this was the highest criticality assessment. The performance assessment (mean 4.33) is based on what the reviewers saw over a relatively short period of time. Ideally, stability needs to be assessed over a much longer period of heavy usage by a wide range of partners. Such an assessment is impossible at the current state of deployment. So for the present all that can really be said is that at the current state of development this measure is satisfactory but that before the system goes into production a longer term stress test would be advisable to determine whether stability in real use is as good as in demonstration situations.

b. Extendibility

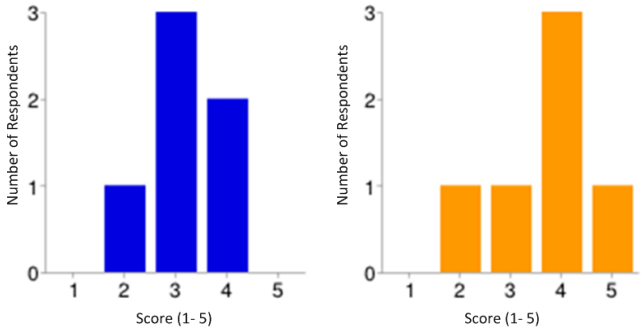


Figure 4-49 UoW Maintainability - Extendibility –a) Score, b) Critical Value

This is an area where it is very hard for reviewers over the short period of a demonstration to not only assess what the platform currently does but to also form a view of where the functionality of the platform may need to be extended in the future. Perhaps this difficulty is reflected in the wide spread of views apparent in both the criticality and performance scores. The means of 3.67 and 3.17 respectively disguise the spread of opinion. It is perhaps fair to say that users would only really start to feel the need for something extra after they had used the platform in a production environment for a reasonable period of time. The relative ease with which this can be done has been illustrated by the creation by both IPA and UoW of user interfaces for the partner blueprint. However the review meeting gave little opportunity to get this point across.

6. Portability

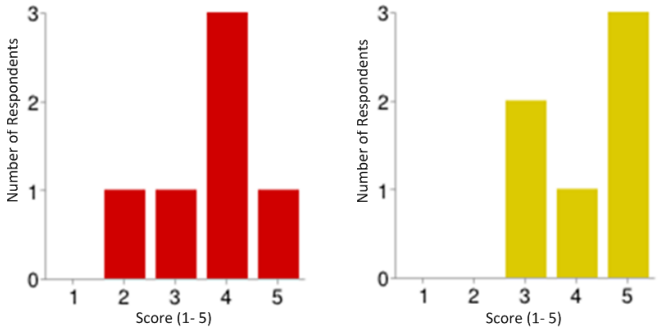


Figure 4-50 UoW Portability a) Score, b) Critical Value

Portability, taken to mean the ease with which the software can be moved from one platform to another, has been given a remarkably high criticality. Essentially this is an issue which only affects the platform provider and once the platform is installed and running should not even be an issue for them so in the absence of explanatory comments from the reviewers it is hard to diagnose why this attribute achieved the second highest criticality mean at 4.17. Also given that the reviewers had not been involved in setting up the local platform it is hard to see on what basis they made their evaluation of performance (Mean 3.67). However, it is clear to the UoW LL team who have set up the software on a local machine that this is an area which needs significant improvement if the platform is to be made available to a wide range of platform providers. Ideally a setup routine that automates the entire task would be needed and an installation guide would also need to be written.

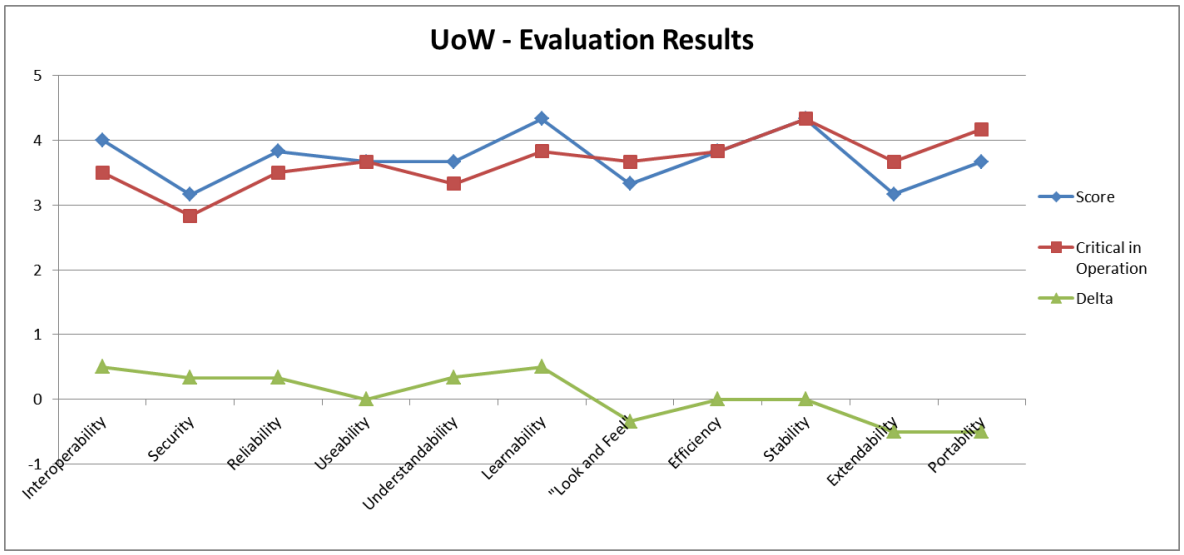


Figure 4-51: Overview of UoW Criticality, performance evaluation means, and deltas

Figure 4-51 shows the overview of the criticality and evaluation mean results and it is clear than from the perspective of the reviewers the evaluation scores are all fairly close to the criticality or target scores.

However, the timing of the review process relative to the national holiday period has made it very difficult to engage with partner companies to build a real industrial demonstrator and to find reviewers able to give up their time to the review process. Further, using videos to present the platform may have inadvertently provided an unrealistic view of the platform. In setting up the demonstration it has become apparent to the UoW LL team that there are some significant issues with the platform in the context in which we are trying to use it.

Gap analysis

The platform has been designed for those who have a requirement to rapidly produce a certain number of piece parts for which a design already exists. In this context the emphasis on capacity is understandable. The UoW network is trying to use networking at an earlier stage in the design to manufacturing life-cycle, namely at the tendering stage. Here the aim is to form a network of partners who collectively have the capability to bid for work, perhaps from large companies or government organizations, that require more skills, capability and perhaps equipment than any single SME possesses. After formation of the network the consortium write a single bid to the potential customer. It is only after the bid has been successful, and perhaps after a length design test cycle that issues of production capacity become relevant. Thus a partner search where requirements are expressed in terms of the equipment and capacity rate to produce a particular product are not entirely appropriate. However this could be easily addressed by greater flexibility in the requirements composer and the search algorithm. Perhaps an options or config file could be provided that allowed the network administrator to tune these areas more to the particular requirements of their network would be a useful addition.

Equally for many of the embryo networks formed in our context the first major piece of work is to prepare a joint bid against a customer Request for Proposal (RFP). Whilst it is possible that if the IMAGINE 'product' was understood to be a 'bid' rather than a piece part the orchestration components could still add some value, they are not ideally tailored to this particular requirement where draft paragraphs, cost information and indeed the whole draft document can be easily shared and worked on in parallel. In this context more sophisticated workflow management/ orchestration might be beneficial.

Again, the requirements composer in its existing form works well for relatively simple assemblies such as chairs with a seat, back and four legs. However, much of the West Midlands SME base is dedicated to the production of white goods, consumer durables, and in particular automotive and aerospace subassemblies. Here the complexity in terms of numbers of parts, number of levels in the product structure tree and so on is much greater. Interfaces that allow product structure trees to be imported from CAD or Product lifecycle management systems would be helpful. Since an XML export based on a PLM/CAD vendor design schema is the normal way that this is done (unless we want to do battle with STEP AP203!) the capability to import data against an IMAGINE XML schema would ease interoperability issues. Tools such as Altova Mapforce make the generation of style sheets (XSLTs) to translate from one XML schema to another relatively easy to create. Equivalent tools do not currently seem to exist for translation of RDF format data.

Business process management systems based on BPMN or other graphical presentations of the workflow/orchestration are now commonplace. Whilst this has been beyond the scope of the resources available for development of the IMAGINE platform it would make management of the orchestration phase of the network much easier and much more intuitive. Equally the ability to manage the orchestration at a more detailed level of granularity would be beneficial in some circumstances. (See comments above about Bid preparation) It is undoubtedly a difficult thing to achieve and may ultimately require either a significant injection of funds to develop or perhaps even further research effort.

In summary the IMAGINE Platform in its existing form has been well received by reviewers and has great potential for future use as part of the West Midlands Collaborative Commerce Network. However, greater user/administrator ability to modify the platform to suit a particular need would be beneficial in our particular context.

5 Conclusion

The 2nd technical evaluation of the customized IMAGINE platform clearly shows the technical value of the developed solution for the different industry sectors. Five different evaluation perspective of the IMAGINE platform are presented, differing in their application domain, evaluation focus, and being conducted in a different context by customers and affiliated partners. Consequently, the obtained results cannot be simply compared as each evaluation reflects the heterogeneity of the different industry domains and the diversity of the developed approaches within the five Living Lab partners. Hence the main results from the previous chapter may only be considered on their own, summarizing some general findings from the technical perspective on the customized IMAGINE platform.

In the evaluators' eyes of the Industry Agnostic and Automotive Living Lab, security aspects and the reliability of the platform in general leave further space for improvements. On the other hand criteria like "look and feel", portability, Extendibility seem to be appropriate in the later one and obtained high scores in the technical assessment.

For the Avionics and Defence domain, the collected feedback demonstrated a high level of technical value and allowed to identify the potential of the platform but focusing also on aspects of improvement like usability, reliability, and security. However, with respect to the usability criteria an improved documentation and more training material have been identified to accomplish this.

The Engineering Living Lab at the University of Warwick obtained a positive feed-back. During their evaluations the requirements composer and the search component were identified as they need more improvement. This would allow the UoW Living Lab to easily address the requirements from their use case, ensuring all the flexibility needed.

Based on the evaluation of the furniture Living Lab it becomes clear that aspects like stability and understandability should be in the focus of further development, as they do currently not to meet an adequate level. With respect to efficiency, the platform must be streamlined and upgraded to generate more proper and faster results as this currently takes too much time according to the evaluators. The most important requirements is however the demand for localization to offer a "Spanish" version of the IMAGINE platform and hereby increase the acceptance of the market and potential customers. Through upcoming workshops with furniture SMEs the awareness of the platform should be improved before launching the exploitation of the IMAGINE platform to obtain a better acceptance of furniture business stakeholders.

For the some of the evaluation results a misalignment between the evaluators' expectation and their perception of the technical platform is noticeable. This leaves space for many interpretations which can consider improvements of the training material, introductory material and information brochures, additionally necessary development – to reach a higher level of customization – and so on. However, these aspects should be carefully considered in the individual exploitation plans as to reflect the customer's and the market expectation when preparing the individual business cases. Thus findings of this evaluation should be reconsidered in future exploitation scenarios in terms of a long-term customization roadmap. On the other hand, platform aspects which obtained a positive evaluator's perception should be used in the following tasks to leverage the IMAGINE Business Cases as these functionality is well suitable to serve the market demand. From these the valuable add-ons and

unique selling points of the IMAGINE platform can be derived to foster the commercialization of the IMAGINE platform in the different industry sectors.

Technical evaluation categories for which this account the most are shown in Figure 5-1. Here, in particular platform aspects like stability, reliability, and security would benefit the most from this improvements whereas interoperability, extensibility or portability are very close to the evaluators expectation.

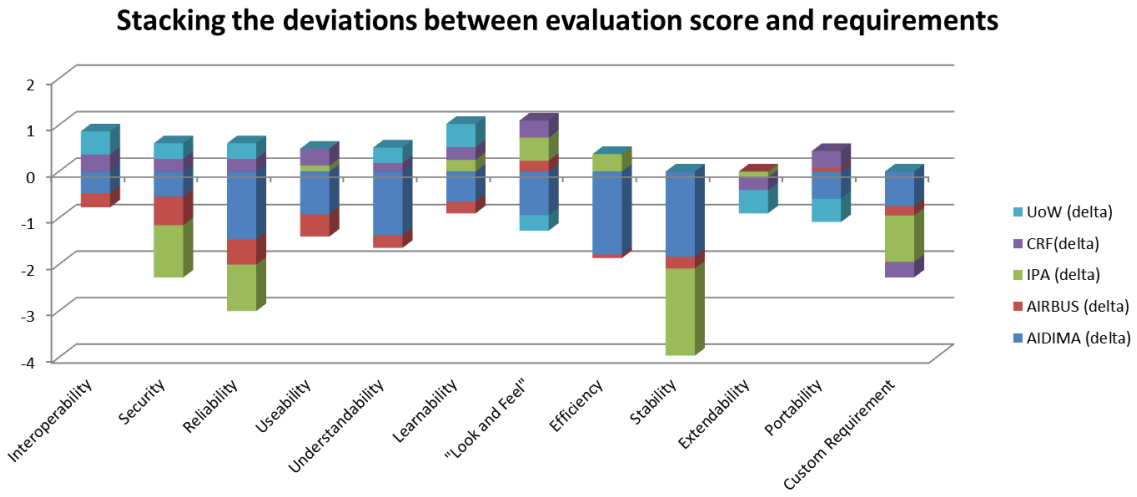


Figure 5-1: Difference between evaluation scores and the evaluator's requirement

Also with respect to the TCO the industry sectors are heavily varying due to significant difference in the implementation, their use of components, and individual business cases. From this perspective IMAGINE platforms are expected to be operated at the cost of 9 000€ in the automotive sector which corresponds to a lean integration with REPLY's cloud instance. As UoW will make use of an existing platform, the hosting and operating costs for a sustainable integration of the IMAGINE platform are expected as high as 7 PM a year. The furniture industry expects the TCO for AIDIMAs business model at approx. 75 000€ p.a. For AIRBUS and the IPA business case the targeted costs are respectively 125 000€ and 520 000 Initial costs plus 164k€ yearly costs. Results are summarized in Figure 5-2 below.

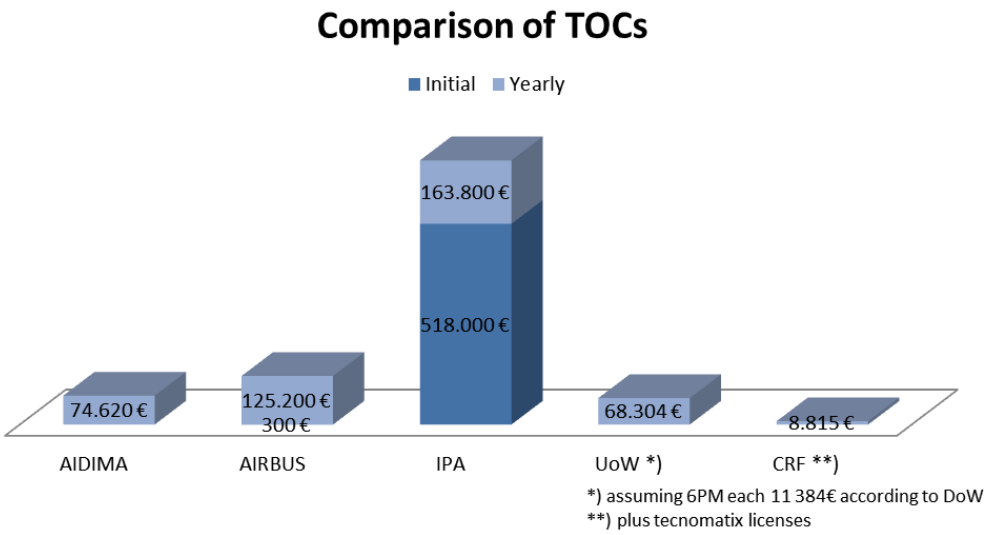


Figure 5-2: Comparison of the IMAGINE TCOs (TCO_1)

To summarize the contribution of this deliverable, it has two major outputs which are the TCO and the technical evaluation of the IMAGINE platform, both with respect to the five individual industry domains of the IMAGINE project. By identifying the costs of "owning" the IMAGINE platform, the upcoming tasks Task 5.3 "IMAGINE Business Cases" will identify the expected benefits and the most pertinent financial indicators from the stakeholders perspective and hereby allow statements on the profitability of IMAGINE.

As the major outcome of this tasks, five different and customized IMAGINE platforms have been evaluated by experts from related industry domains, stressing technical highlights of the technical implementation. This will enable IMAGINE partners to directly leverage from this evaluation by stressing industry relevant platform aspects and push the commercialization with the help the platform's most valuable unique selling points as part of the DMN concept.

Annex A: References

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[2] Muhammad Ali Babar, Liming Zhu, Ross Jeffery, A Framework for Classifying and Comparing Software Architecture Evaluation Methods, National ICT Australia Ltd. and University of New South Wales, Australia, 2004

[3] Rimmi Saini, Sanjay Kumar Dubey, Ajay Rana, Analytical Study of Maintainability Models for Quality Evaluation, Indian Journal of Computer Science and Engineering (IJCSE), 2011

[4] Balzert, H. and Balzert, H. and Koschke, R. and Lämmel, U. and Liggesmeyer, P. and Quante, J., Lehrbuch Der Softwaretechnik, Spektrum Akademischer Verlag, 2009

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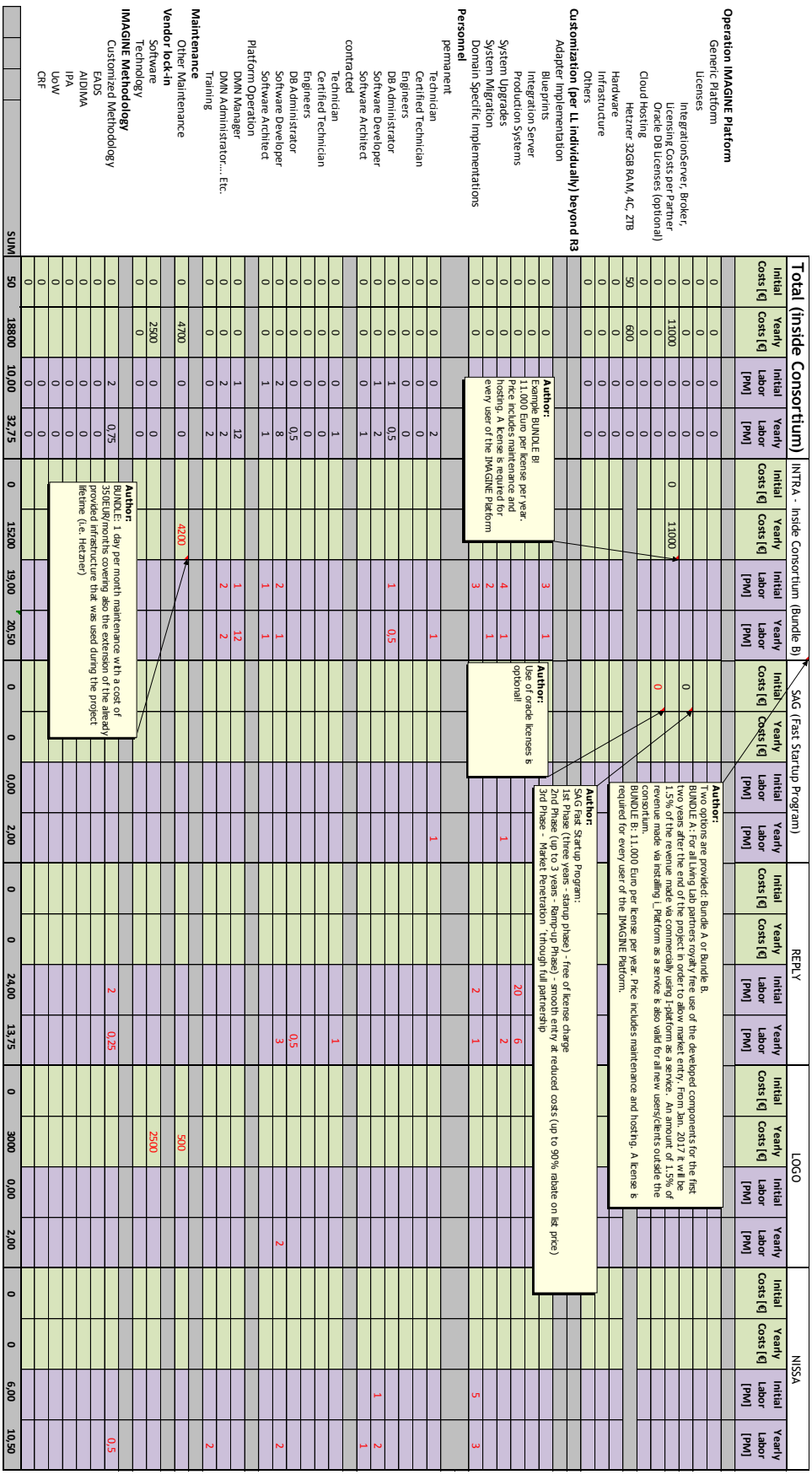
[6] ISO/IEC 25000:2014, Systems and software engineering – Systems and software Quality Requirements and Evaluation (SQuaRE) – Guide to SQuaRE, ISO Committee, 2014

Annex B: Total Cost of Ownership – Developer's Overview



	Total (inside Consortium)		INTRA - Inside Consortium (Bundle B)		SAG (Fast Startup Program)		REPLY		LOGO		NISSA	
	Initial Costs [€]	Yearly Costs [€]	Initial Labor [PM]	Yearly Labor [PM]	Initial Costs [€]	Yearly Costs [€]	Initial Labor [PM]	Yearly Labor [PM]	Initial Costs [€]	Yearly Costs [€]	Initial Labor [PM]	Yearly Labor [PM]	Initial Costs [€]	Yearly Costs [€]	Initial Labor [PM]	Yearly Labor [PM]
Operation IMAGINE Platform																
Generic Platform	0	0	0	0												
Licenses	0	0	0	0												
IntegrationServer, Broker,	0	0	0	0												
LicensingCosts per Partner	0	11000	0	0	0	0										
Oracle DB Licenses (optional)	0	0	0	0												
Cloud Hosting	0	0	0	0												
Hetzner 32GB RAM, 4C, 2TB	50	600	0	0												
Hardware	0	0	0	0												
Infrastructure	0	0	0	0												
Others	0	0	0	0												
Customization (per LL individually) beyond R3																
Adapter Implementation																
Blueprints	0	0	3	1												
Integration Server	0	0														
Production Systems	0	0	4	1				1								
System Upgrades	0	0	2	1												
System Migration	0	0	3													
Domain Specific Implementations	0	0														
Personnel																
permanent																
Technician	0	0	0	2												
Certified Technician	0	0	0	0				1								
Engineers	0	0	0	0												
DB Administrator	0	0	1	0,5			2								5	3
Software Developer	0	1	2													
Software Architect	0	0	1	2											1	2
contracted																1
Technician	0	0	1	0												
Certified Technician	0	0	0	0				1								
Engineers	0	0	0	0												
DB Administrator	0	0	0	0,5			0,5									
Software Developer	0	0	2	1			3									
Software Architect	0	0	1	1											2	2
Platform Operation	0	0	1	12												
DMN Manager	0	0	2	2												
DMN Administrator,... Etc.	0	0	2	2												2
Training																
Maintenance	0	4700	0	4200						500						
Other Maintenance																
Vendor lock-in	0	2500	0	0						2500						
Software	0	0	0	0												
Technology																
IMAGINE Methodology	0		2	0,75			2	0,25								0,5
Customized Methodology			0	0												
EADS	0		0	0												
AIDIMA	0		0	0												
IPA	0		0	0												
UoW	0		0	0												
CRF	0		0	0												
SUM	50	18800	10,00	32,75	0	15200	19,00	20,50	0	0,00	2,00	0	0	24,00	13,75	0	3000	0,00	2,00	0	0	6,00	10,50

Author:
Example BUNDLE B!
11.000 Euro per license per year.
Price includes maintenance and hosting. A license is required for every user of the IMAGINE Platform

Author:
Use of oracle licenses is optional!

Author:
SAG Fast Startup Program:
1st Phase (three years - startup phase) - free of license charge
2nd Phase (up to 3 years - Ramp-up Phase) - smooth entry at reduced costs (up to 90% rabate on list price)
3rd Phase - Market Penetration 'through full partnership

Author:
Two options are provided: Bundle A or Bundle B.
BUNDLE A: For all LWrig Lab partners royalty free use of the developed components for the first two years after the end of the project in order to allow market entry. From Jan. 2017 it will be 1.5% of the revenue made via commercially using I-platform as a service. An amount of 1.5% of revenue made via installing I_Platform as a service is also valid for all new users/clients outside the consortium.
BUNDLE B: 11.000 Euro per license per year. Price includes maintenance and hosting. A license is required for every user of the IMAGINE Platform.

Author:
BUNDLE: 1 day per month maintenance with a cost of 350EUR/months covering also the extension of the already provided infrastructure that was used during the project lifetime (i.e. Hetzner)

Annex C: Online Questionnaire

The online questionnaire has been provided using Google Forms and the master template – the basis for all the evaluation forms -- is available here:

https://docs.google.com/forms/d/1F-DLxpjh7hwVKss1ZBgFanCIU2Sb7CBbvL0HzWVD-Pc/formResponse

The Content of the Questionnaire for the technical platform evaluation is displayed below:

This questionnaire aims to evaluate the IMAGINE DMN Methodology and its underlying implementation as the CUSTOMIZED IMAGINE Platform (Platform R3 + Customization). Attention: In order to count your evaluation the last page contains a "completed" check box which indicates, that you completed the questionnaire and submit your answers. Note that without checking this box, your input will not be considered for the evaluation!

In some questions, there is also a field asking about "Preferred/Critical Values" which reflect the user requirement. This field aims to identify the values that you would like to be achieved by the proposed by the IMAGINE solution. For example, when asked about Portability, you may evaluate the IMAGINE solution with 5, but give a preferred value of 2. This would mean that you consider the solution very good (value of 5) in terms of portability, but in your case even less portability (value of 2) would be fine.

This section contains general questions. The questionnaire consists of a total of 4 parts and requires approx. 1 h to be answered.

* Required

Partner Name

Please select your affiliation. If you are an external evaluator, you may leave this field empty and just click the tick-box in the next question.

Mark only one oval.

- ☐ INTRASOFT
- ☐ SAG

- ☐ REPLY
- ☐ LOGO
- ☐ IPA
- ☐ NTUA
- ☐ UoW
- ☐ ServTech
- ☐ LMS/UoP
- ☐ CNRS
- ☐ UNINOVA
- ☐ EADS
- ☐ AIDIMA
- ☐ CRF
- ☐ NISSATECH

External Evaluator

Are you an external valuator?

Check all that apply.

- ☐ External Evaluator

Category/Group

From the groups below, please select the one closer to your activities.

Mark only one oval.

- ○ Living Lab, Manufacturing Company, End-user or similar
- ○ Technical Partner, IT Company, System Integrator or similar
- ○ Academic Partner, University, Research Institute or similar

Manufacturing Sector

Mark only one oval.

- Aerospace and Defence Industry
- Semiconductor Industry
- Furniture Manufacturing Industry
- Car Manufacturing Industry
- Built-To-Order Engineering Sector
- Not Applicable
- Other:

Proficiency

Check all that apply.

- Manufacturing
- IT Technologies
- STEP
- ISA '95
- Other:

(Optional) Representative of...

Mark only one oval.

- Large Enterprise
- Small-Medium Enterprise (SME)

(Optional) Evaluators Name

Please provide your name here

1. Functionality

Covers the capability of the software product to provide functions which meet stated and implied needs when the software is used under specified conditions. It hereby states that the

specification of the requirements are properly met in terms of the delivered "product" and all functional aspects as previously defined and agreed on.

Evaluation - Interoperability

Interoperability is the ability of making systems and organizations to work together.

Mark only one oval.

	1	2	3	4	5	
Not Interoperable	○	○	○	○	○	Fully Interoperable

Interoperability Requirement (Critical Value)

Mark only one oval.

	1	2	3	4	5	
Not Interoperable	○	○	○	○	○	Fully Interoperable

Comment

Evaluation - Security

Security includes all the processes and mechanisms by which computer-based equipment, information and services are protected from unintended or unauthorized access, change or destruction. Are security standards implemented and does the system apply to state of the art implementations?

Mark only one oval.

	1	2	3	4	5	
Not Secure	○	○	○	○	○	Secure

Security Requirement (Critical Value)

Mark only one oval.

	1	2	3	4	5	
Not Secure	○	○	○	○	○	Secure

Comment

2. Reliability

The term reliability of a technical system indicates the ability of a system to perform its required function under stated conditions for a specific period of time. It is hence a measure of how often a program works and produces the expected answers. Reliability can be further detailed into Availability, Quality of Service, and Service Dependability which are explained below.

Evaluation - Reliability

Mark only one oval.

	1	2	3	4	5	
not reliable	◯	◯	◯	◯	◯	very reliable

Reliability Requirement (Critical Value)

Mark only one oval.

	1	2	3	4	5	
not reliable	◯	◯	◯	◯	◯	very reliable

Comment

3. Usability

In general terms the usability of a system covers the ease of use and learn-ability of the i_Platform. It also covers the elegance and clarity with which interaction is accomplished. Since this aspect is considered as important in particular for inexperienced users, it is further broken down into the following evaluation targets:

Evaluation - Usability

A set of attributes that bear on the effort needed for use, and on the individual assessment of such use, by a stated or implied set of users.

Mark only one oval.

1 2 3 4 5

not usable						highly usable

Usability Requirement (Critical Value)

Mark only one oval.

	1	2	3	4	5	
not usable						highly usable

Comment

Evaluation - Understandability

Are intuitive interfaces used, is the use of the UI easy to understand?

Mark only one oval.

	1	2	3	4	5	
not intuitive						very intuitive

Understandability Requirement (Critical Value)

Mark only one oval.

	1	2	3	4	5	
not intuitive						very intuitive

Comment

Evaluation - Learnability

The capability of a software product to enable the user to learn how to use it.

Mark only one oval.

	1	2	3	4	5	
not understandable						easy to learn

Learnability Requirement (Critical Value)

Mark only one oval.

	1	2	3	4	5	
not understandable	○	○	○	○	○	easy to learn

Comment

Evaluation - "Look and Feel"

How attractive is the use of the platform, how appealing it the use of design elements and interfaces provided?

Mark only one oval.

	1	2	3	4	5	
not attractive	○	○	○	○	○	very attractive

"Look & Feel" Requirement (Critical Value)

Mark only one oval.

	1	2	3	4	5	
not attractive	○	○	○	○	○	very attractive

Comment

4. Efficiency

A set of attributes that bear on the relationship between the level of performance of the software and the amount of resources used, under stated conditions.

Evaluation Efficiency

How much time is needed between interactions, how efficiently are resources utilized?

Mark only one oval.

1 2 3 4 5

inefficient	○	○	○	○	○	efficient

Efficiency Requirement (Critical Value)

Mark only one oval.

	1	2	3	4	5	
inefficient	○	○	○	○	○	efficient

Comment

5. Maintainability

A set of attributes that bear on the effort needed to make specified modifications.

Evaluation - Stability

How stable is the platform? Did you frequently experience crashed or similar behaviour?

Mark only one oval.

	1	2	3	4	5	
unstable	○	○	○	○	○	stable

Stability Requirement (Critical Value)

Mark only one oval.

	1	2	3	4	5	
unstable	○	○	○	○	○	stable

Comment

Evaluation - Extendability

Is sufficient documentation for available for extending the IT architecture and the platform?

Mark only one oval.

	1	2	3	4	5	
not extendable	○	○	○	○	○	very extendable

Extendability Requirement (Critical Value)

Mark only one oval.

	1	2	3	4	5	
not extendable	○	○	○	○	○	very extendable

Comment

6. Portability

A set of attributes that bear on the ability of software to be transferred from one environment to another.

Evaluation - Portability

How flexible can the platform be ported to other infrastructures and are there limiting factors. Also consider installing and running the platform on your own systems.

Mark only one oval.

	1	2	3	4	5	
not portable	○	○	○	○	○	portable

Portability Requirement (Critical Value)

Mark only one oval.

	1	2	3	4	5	
not portable	○	○	○	○	○	portable

Comment

7. Custom Criteria

A custom evaluation criteria which is important to consider in your industry sector. Please add a custom requirement if needed for your assessment and describe it.

Custom Requirement

Mark only one oval.

1	2	3	4	5
○	○	○	○	○

Critical Values - Custom Requirement

Mark only one oval.

1	2	3	4	5
○	○	○	○	○

Comment

8. A few last questions

Suitability of this online assessment

Please indicate whether this online questionnaire is a good mean for the considered evaluation or not

Mark only one oval.

	1	2	3	4	5	
not suitable	○	○	○	○	○	well suited

Submit Assessment *

Please indicate whether your assessment should be counted for the final evaluation. If the Check-box is not clicked, your input will be lost!

Mark only one oval.

- ○ completed (Your evaluation will be counted)
- ○ please discard my evaluation