



*D2.5 –
FITMAN V&V Assessment Summary
M18 issue*

Document Owner:	Kim Jansson, Iris Karvonen Outi Kettunen - VTT
Contributors:	Giacomo Tavola , Stefano Perini – POLIMI , Guy Doumeingts - IVLAB, Dimitris Panopoulos, Fenareti Lampathaki - NTUA
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0.2	13.6.2014	TEXT ADDED CHAPTER 1
0.3	25.6.2014	CHAPTER 3.1 AND 5.1 AND 5.3 ADDED
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0.8	13.10.2014	CATEGORIZATION OF BUSINESS INDICATORS REVIESED (IVLAB) PEER REVIEW COMMENTS TAKEN INT ACCOUNT
1.0	14.10.2014	FINAL

DELIVERABLE PEER REVIEW SUMMARY

ID	Comments	Addressed (✓) Answered (A)
1	Owing to the complexity of the matter, we should put more effort in the Executive Summary to include only and just the major achievements. The Executive Summary is very extensive and not focused on the contribution of the deliverable.	✓ Executive Summary revised
2	A short methodological handbook would be also helpful.	A: Can be produced as a separate independent document
3	Comments and remarks in the text.	✓ Have been taken into account. Figure 1.2: updated. Trial Journal presented as the fourth V&V scopes.
4	In Section 5, the results are presented, but a critical analysis is missing.	A: The results of the cross-trial assessment of Business and Technical Indicators, and consolidation and comparison of self-certification results will be reported in D8.1 FITMAN use case comparative evaluation, due at M21.

5	<p>The general impression is very good indeed.</p> <p>I found the document very well structured and the contents responding to what is expected in the Deliverable.</p>	✓
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Executive Summary

The overall objective of WP2 is to develop a method for the evaluation and assessment of the SF-DF-VF solutions experimented in the FITMAN Use Case Trials. As a whole WP2 provides assessment and data definition methods, a collection platform and process support. WP2 has delivered a holistic FITMAN Verification & Validation Method accompanied by a V&V Assessment Package, and it has now been instantiated for each FITMAN Use Case Trial. The current Task T2.5 “*Continuous adaptation and support of the V&V package in the trials*”, is the final task in WP2. The results of the task are reported in this deliverable “D2.5 – FITMAN V&V Assessment Summary”.

In T2.5 the *V&V methodology has been updated* in order to meet the requirements of the trials better and in order to increase versatility of the method for the use outside FITMAN. The main aims were to simplify the method further and to offer optimal support for the trials. Target values have been included for the Business Indicators, and an iterative process has been defined for the definition of the Business Indicators. The number of Technical Indicators has been reduced down to eight, which are obligatory and common for all trials, in order to facilitate the use of the method and to enable reliable cross-trial assessment. Self-certification has been made easier and product specific verification tests are done only for Release Verification and Product Validation. The V&V data acquisition tool in Survey Monkey has been updated, and a Trial Journal has been included in the tool in order to collect also non-structured information. The updated V&V methodology has been described in detail in Chapter 2 of D2.5.

T2.5 has offered *support for the use of the FITMAN V&V methodology* in the trials. T2.5 partners organized training events and online training meetings for the trials. In addition to this, V&V Technical Support has been provided to FITMAN Specific Enablers developers. Survey Monkey platform for V&V data collection has been taken into use and instantiated to fit each trial. The support process and activities are described in Chapter 3, and instantiation of the V&V Assessment Package into survey forms in Chapter 4.

Methodology for *Cross-trial assessment* of Business Performance Indicators, Technical Indicators and SE development has been developed in T2.5, and versatility of GEs has been assessed from the FITMAN viewpoint. The FITMAN trials represent various industrial domains and scopes, and this has been taken into account in the cross-trial assessment methodology of the Business Performance Indicators. The BPI's have been classified into four categories, quality, time, cost and productivity. Comments on significant elements have been formulated concerning each category and on each FITMAN domain in order to enable high quality cross-trial assessment of the BPI's. The cross-trial assessment as a whole is described in detail in Chapter 5 of D2.5.

T2.5 has collected *feedback* from the trials in several ways concerning the use of the FITMAN V&V method in order to refine the method. The feedback has been obtained by close interaction with the trials along the instantiation process and with a questionnaire. This deliverable reports the ways of obtaining the feedback as well as the feedback itself in Chapter 6.

The V&V method developed in FITMAN WP2 offers sustainable high value assets that can be exploited in parallel FI-PPP projects, as well as in a broader context. In order to facilitate the use of the V&V method outside FITMAN, a compact *V&V handbook* has been created in T2.5 and is included as an appendix in D2.5.

1. Introduction

1.1. WP2 Overview

The Work Package 2: FITMAN Verification & Validation Method has as an overall purpose to develop a method for the evaluation and assessment of the FITMAN Trials, through:

- The identification and integration of existing V&V methods
- The description of functional and non-functional technical indicators for evaluating openness and versatility of FI-WARE in FITMAN trials
- The description of business indicators for evaluating the business benefits in the trial after the adoption of FI-WARE Generic Enablers (GEs)
- The integration of technical and business indicators in a generic V&V assessment package for FI-WARE evaluation in manufacturing smart-digital-virtual factories of the future
- The instantiation of the generic V&V package into the chosen Use Case Trials and application domains.
- Continuous adaptation and support of the V&V package in the trials.

(FITMAN DoW)

WP2 has advanced through the four previous partly parallel Tasks in WP2:

Task T2.1 FITMAN V&V Generic Method and Criteria Identification

Task T2.2 FITMAN V&V Business and Technical Indicators Definition

Task T2.3 FITMAN V&V Generic Assessment Package

Task T2.4 Instantiation of V&V Assessment Package Instantiation per Use Case Trial

This Deliverable **D2.5 FITMAN V&V Assessment Summary** is a result of the last task **T2.5 Continuous adaptation and support of the V&V package in the trials** in WP2. It reports the activities and the results of Task T2.5.

Task T2.5 has been in charge of the continuous update and refinement of the FITMAN Verification & Validation Method, Assessment Package and the indicators. The task gives ongoing support and practical guidance to the use case trials. Training events have been arranged to support the trials.

The Task has also delivered the necessary V&V methodology support to FITMAN Specific Enablers verification.

The task summarises the experience and lessons learnt from adopting the FITMAN V&V methodology in the Trials.

1.2. Background and previous work in FITMAN

The following sections will briefly recap the achievements in the WP2 tasks during Months M1 – M6.

1.2.1. Task 2.1; FITMAN V&V Assessment Method - summary

In short, Deliverable D2.1 "FITMAN Verification & Validation Method and Criteria" [1] describes:

- the 7-step FITMAN V&V Methodology. An all-inclusive framework for verifying, validating and evaluating FIWARE and FITMAN products and trial solutions.
- Business and IT evaluation criteria
- A common WP2 Glossary.

As D2.1 states, the goal is to provide FITMAN with the appropriate methodology in order to verify that the FI-WARE generic and FITMAN specific enablers (as well as Trial Specific Components) satisfy the technological platform and architectural integration requirements imposed; validate that the FI-WARE generic and FITMAN specific enablers (as well as Trial Specific Components) satisfy the requirements of Smart-Digital-Virtual Use Case Trials; and identify the evaluation and assessment criteria to be used in all Use Case Trials. The FITMAN V&V methodology introduces a new and innovative way of performing V&V activities in various ways.

The developed V&V method is essentially divided into two perspectives:

- The trial specific perspective which assesses whether the IT and business requirements and domain's needs are met, and
- The product-specific perspective which describes how to verify and validate the product (i.e. the Generic Enabler (GE), the Specific Enabler (SE) or the Trial Solution Component (TSC)) during its development.

In particular, the FITMAN V&V method is elaborated step-by-step, providing the potential techniques to be employed, the stakeholders to be engaged, and the potential crowd engagement methods to be applied.

1..2.2. Task 2.2; FITMAN V&V Business and Technical Indicators Definition - summary

In short Deliverable D2.2 “FITMAN Business and Technical Indicators Definition” [2] describes Business indicators for business benefits and sustainability assessment, in particular:

- Trial specific business performance indicators based on the usage of ECOGRAI simplified method
- Technical indicators for assessing openness and versatility
- Quantitative as well as qualitative indicators to measure conformance with evaluation criteria

The goal of the deliverable D 2.2 “FITMAN Business and Technical Indicators Definition” is to identify and define a selection of Business Performance Indicators and Technical Indicators for the “FITMAN Verification & Validation Method”.

The Task 2.2 evaluates two kinds of performance:

- The performance of a “Business System”: the Trials. This System has a different behavior and the criteria of evaluation are different. It is necessary to combine Economic, Social and Human behavior with Technics. This evaluation is based on Business Performance Indicators (BPI).
- The performance of Generic Enablers (GE), Specific Enablers (SE), Trial Specific Components (TSC), and also the various platforms developed in FITMAN project based on GEs and SEs. The nature of the systems is “Technologic”; the criteria of evaluation are more oriented on the technical performance.

1..2.3. Task 2.3; FITMAN generic V&V Assessment package - summary

The Deliverable D2.3 “FITMAN Verification & Validation generic Assessment Package” [3] is the consolidation of the developed V&V Generic Method, assessment criteria, technical and business performance indicators into a generic package. The Deliverable D2.3 also constitutes the input for the subsequent Deliverable D2.4 (FITMAN V&V Assessment Package instantiations per Trial). It constitutes the generic integrated reference model for the practical achievement of the three following objectives:

- the Verification of the Specific Enablers (SEs) and Trial Specific Components (TSCs) under development during the FITMAN project;
- the Validation of the complete solution which developed for each Use Case Trial in the framework of the FITMAN project.

1..2.4. Task 2.4; FITMAN V&V Assessment Package Instantiations per Trial - summary

In FITMAN instantiation means specifying and adapting the Generic FITMAN Assessment Package for each FITMAN trial..

“The Use Case Trial scope and specific requirements and environment conditions will affect each instantiation of the package. In addition to the necessary indicators relevant to all the optional indicators are reviewed and selected. The Instantiation of Package will be provided to the Use Case Trial to support and document the assessment.” (FITMAN DoW)

As the result of instantiation, each trial has defined the scope of V&V assessment according to FITMAN V&V methodology, following the guidelines for mandatory and optional V&V elements:

- selected the SEs for self-certification (optional)
- identified the GEs, SEs and TSCs for product validation
- defined the technical indicators for Trial solution
- selected the people to be involved in the assessment in different phases (stakeholders)
- identified the source of data for the indicators

As a whole the instantiation is a preparation task started in T2.4 and completed for the trial in WP4-5-6 where final selections of business indicators are done to support evaluation and assessment. The collection of values for technical and business indicators as well as the community-based assessment or self-certification are not part of the instantiation; they are performed as part of T7.1.

1.3. Links to other work packages

Figure 1.1 illustrates the main links of Task T2.5 to other FITMAN WPs. The previous WP2 tasks, as described above, were completed already in Period 1. The tasks T4.4, T5.4 and T6.4 contain the coordination and actual detailed definition of suitable metrics that will be used during trial experimentation. WP2 has created the solid foundation for T7.1 *Synthesis of Use Case Trials Experiences and Consolidation* of results, and T8.1 *FITMAN Use Case Trials comparative evaluation and future Phase III extensions*. Thus V&V WP2, WP7 (T7.1) and WP8(T8.1) have a strong connections. WP2 provides all assessment and data definition methods, collection platform and process support. T7.1 owns data gathering from Use Case Trials (WP 4, 5 and 6) i.e. technical and business indicators’ values as well as synthesis of use case trials and lessons learnt.

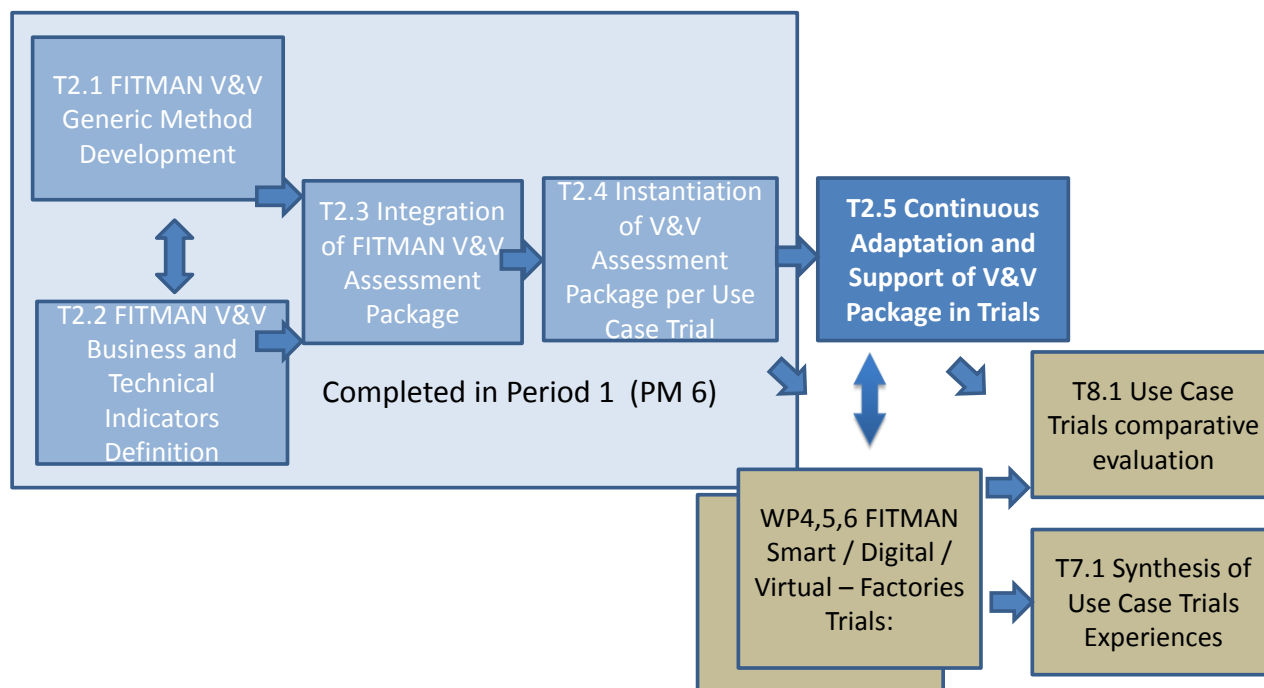


Figure 1.1. Task T2.5 main links to other WPs and Tasks

1.4. Progress during M7 – M18

After the definition of the V&V assessment package framework and instantiation of the package, each trial has defined the final objectives of V&V assessment, selected the business performance indicators to be evaluated, selected the people to be involved in the assessment, and identified the proper sources of data for the indicators.

As a result the FITMAN V&V assessment package can be presented as composed of four different scopes, Figure 1.2:

- **Business Performance Indicator** system, specific to each trial, assessed by the end users, through “as-is”, “to-be” and target values.
- **Technical Indicator** system, made of two groups of indicators, i.e. three indicators for the software components (i.e. generic enablers (GEs) and specific enablers (SEs)), implemented as evaluation through a scale of different values, and five indicators for the whole trial solution, implemented as community-based collection of users’ opinions
- **Trial Journal** for collection of unstructured information for each Trial, addressing both Technical and Business aspects.
- **SEs Verification and Self-certification** system, a set of tests aiming at improving the quality of the SEs. After the development phase, each SE is certified by the software development partner using their own testing methods. The reporting of results is then channelled through a self-certification mechanism.

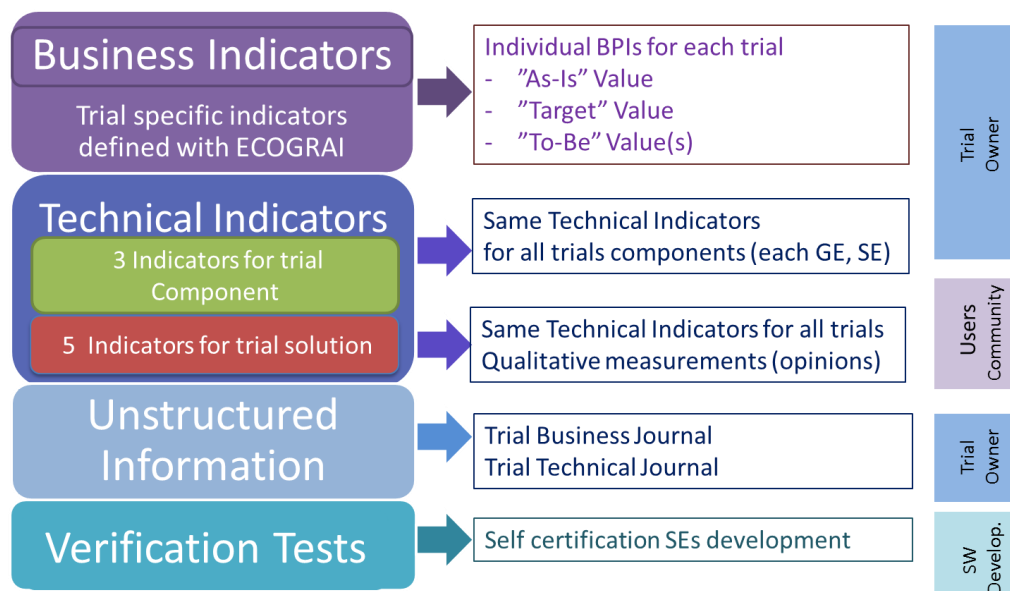


Figure 1.2 FITMAN V&V Assessment Package overview

The following is a summary progress in WP2 / T2.5. The subsequent sections of this deliverable will go into details:

- **Inclusion of target values for Business Indicators** in the V&V methodology. As recommended by the FITMAN project reviewers, indication of objective, measurable targets and a clear definition of success have been included in the V&V Methodology. For each business performance indicator a target value has been defined.
- **Number of technical indicators reduced.** Identical indicators for all trials are used, for software components (3) and trial solutions (5).
- **Self certification.** Product specific Verification tests are in practice done only for Release Verification and Product Validation
- **Trial Journal.** Implementation of the Trial Journal to collect information also in a non-structured way
- **Data acquisition tool.** For the collection of all data the SurveyMonkey platform is used.
- **Training sessions.** Regional interactive training sessions have been organised.
- **Cross trial assessment methodology.** Also as response to review recommendations, cross-trial assessment methodologies have been defined in this deliverable.
- **Collection of V&V experience.** Feedback and experience from adopting the FITMAN V&V method has been collected.

1.5. Structure of the Document

The introduction in Chapter 1 gives an overview of WP2, background and a summary of previous work in WP2. The links to other work packages are highlighted. Additionally the Chapter summaries progress in WP2 during the M7 – M18. Chapter 2 reports on V&V Methodology updates regarding Business Indicators, Technical Indicators and Software Self-Certification and Unstructured Information collection. Chapter 3 reports on the ongoing support to FITMAN V&V methodology application and usage. Chapter 4 explains the instantiation process and usage of SurveyMonkey forms. Chapter 5 introduces and defines an approach for Cross-trial assessment, as response to review #1 recommendation. Chapter 6 delivers experiences of using the FITMAN V&V methodology. Conclusions and Next steps are given in Chapter 7.

The Appendixes contains the following;

Appendix 1: Summary of defined business indicators per each trial

Appendix 2: Data Collection Forms

Appendix 3: Results of the versatility assessment

Appendix 4: V&V methodology usage questionnaires

Appendix 5: V&V Handbook

1.6. Contribution by beneficiaries

The following is a brief description of FITMAN partners' main contribution to Task T2.5. VTT is the owner of this report. NTUA has contributed to the update of the V&V methodological approach and assumed responsibility for the ongoing support to the V&V activities of the Specific Enablers as well as for organizing the training event in Spain. The main contribution of IVLAB is in the area of ECOGRAI Methodology and Business Indicator definition and categorisation and in organizing the training event in France. Polimi is responsible for the Instantiation of V&V Assessment Package, data acquisition tool implementation and unstructured information collection, as well as for the training event in Italy. VTT has coordinated and arranged the training events and has delivered the methodologies for cross-trial assessment of technical indicators.

2. FITMAN V&V Methodology update

2.1. Business Indicators

Business Performance Indicators have been identified for each trial through the Simplified ECOGRAI Method [3], in the frame of the trials objectives and according the identified Decision variables. For each Business Performance Indicator, the trials are required to report the current value (AS-IS), the target value they want to achieve (Target) and the values after the solution implementation (TO-BE). The objective of a Performance Indicators system is to see what happens in the controlled system in order to make the right decisions at the right time.

The simplified ECOGRAI method uses only three phases among the six which consist the logical structured approach of the complete ECOGRAI method.

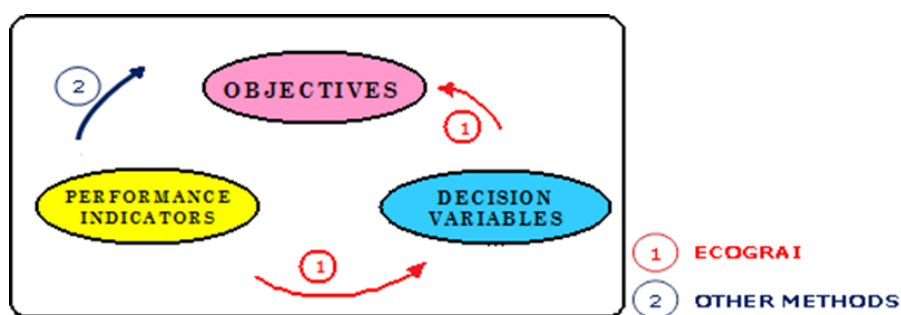


Figure 2-The ECOGRAI original approach

The main originality of ECOGRAI method is the search of a limited number of Performances Indicators by an original approach (Figure 2). The simplified ECOGRAI method has been created for a better understanding, and to facilitate the application of the method. This method allows having correct results, but the control structure is less developed.

For the trials inside the FITMAN project, this simplified method is proposed in order to avoid some confusion for the trials. It seeks to find a number of customized and limited indicators in agreement with the objectives of decision makers

- First Phase: Description of the system in which the performance indicators will be defined by using the System Modeling to determine:
 - the elements which compose the system and the relation between these elements
 - the objectives assigned to the system,.
 - the functions which allow to reach the objectives
 - the processes which support the dynamic transformations
 - the boundary which delimits the elements which don't belong to the system. It could be interesting to evaluate the influence of these external elements on the running of system. We recommend to list only the elements outside of the system
 - the dynamic of evolution of the system particularly in the case of the evolution from AS IS to TO BE. In fact a system is always evolving, the speed of evolution could be low or rapid
- Second phase: Determination of potential actions called Decision Variables (DV) or Action Variables (AV) by the owner of the system to reach the objectives assigned to the system. In

FITMAN it is the implementation of the platform developed with GE and SE. In this phase the followings are to be defined:

- the constraints, which represent the limits of the DV/AV.
- the criteria, in order to choose the DV/AV (Quality, Time and Cost)

Third phase: Determination of Performance Indicators (PIs) which indicate or characterize the reaching of the objectives by using the DV/AV.

During the deployment of the Simplified ECOGRAI methodology, the following important aspects have been analysed to ensure significance of the collected data:

- Significance of data: the observed values need to be significant in the period of observation.
- Frequency: need to collect the data multiple times and compare them in different phases of the implementation.
- “Background noise”: an appropriate evaluation of the direct connection of the observed values change with the adoption of the FITMAN Trial platform, in order to exclude possible effects coming from other causes.
- Confidentiality issues: some trials do not want to disclose absolute values of specific indicators, in particular in relation to the current value, as following better described.

According to the nature of the indicator and the expectations of the trials, it has to specify when and how many times TO-BE value has to be reported. Furthermore, the trial has to identify the TARGET value of each indicator, which represents the expected value coming from the implementation of the solution.

Due to the confidentiality issue previously anticipated, trials can decide to not provide the value because are not allowed to share internal confidential data. For that reason, in some cases AS-IS value is a theoretical value. After the implementation, the trial has to measure what are the effects on the business processes; in doing this, it has to identify how many times and when the measurement and reporting of the indicator is planned to be performed.

Actions of I-VLab during the definition of BPIs by Trials

In the followings, the most frequent and obvious interventions relating to three elements contained in the Simplified ECOGRAI method (objectives, BPIs and DV/AV variables) are mentioned:

- **Objectives assigned to the system:** The first most frequent intervention relates to the objectives. Many comments have been formulated by I-VLab on the definition and formulation of the objectives.
- **Definition of an Objective:** Objectives allow defining the performance(s) that the global company, or a part of the company (trials), expects to reach. In fact for a company a set of objectives will be defined according to the functions, the processes or the services of the organization. In such case, it is very important to check the coherence of the various objectives in order that the global performance will be improved. Each objective must contribute to the achievement of the global objectives.
- **Characteristics of an objective:** An objective should:
 - be clear, concise, (it means :” what the firm is trying to achieve”)

- include a dimension of performance (cost, time etc.) associated with a variation (increase, decrease, etc.)
- be quantitatively or descriptively measurable being able to check whether the target is achieved
- be reachable (achievable)
- define the time period after which they will be achieved

- **I-VLab comments on the objectives:** The most commonly comments which often repeat on the objectives formulation are:

1) The objective is not well formulated: the objective is not clear.

Example: “Effective and consistent prevention strategy “

2) The objective doesn’t show what the Trial is trying to achieve. It doesn’t includes a generic dimension of performance (cost, time etc.).

Example: “Better exploitation of internal and external production capacity “

3) The objective is not quantitatively or descriptively measurable being able to check whether the target is achieved.

Example:” Improving readability of the concreting zones with the combination of visual and textual information.”

4) The objective contains several dimensions corresponding to BPIs. A decomposition of the objective corresponding to the number of BPIs is required to understand the various objectives.

Example: “To improve the communication effectiveness along the help chain organization”

Example: “Make the search of data easier and faster”

5) The objective is formulated as an action/decision variable

6) The objective looks like rather a finality (purpose) than an objective

Example: “Facilitate the detection and initial analysis of home trends for further product design and development”

Due to these misunderstanding, I-VLab suggest to decompose or to formulate the objectives in a different manner.

- **Decision/Action Variables (DV/AV):** The second intervention concerns the role and the use of the DV/AV:
- **A Decision Variable (DV)** is a decision taken by a decision maker in order that the system he controls reaches its objective.
- **An Action Variable (AV)** is an action taken by the owner of a system in order that the system reaches its objectives.
-

In fact, the 2 variables represent similar concepts but the difference is on the human decision. From the beginning of the application of Simplified ECOGRAI method by the Trial and even later, the use of the ratio “after on before the DV and AV implementation” was missing. What it does not allow to measure the degree of the objective achievement by means of the DV/AV

- **Business Performance Indicators (BPIs):** The third intervention relates to the Business Performance Indicators (BPIs). Besides the BPIs' definitions, I-VLab has added their essential characteristics.
- **Definition of a Business Performance Indicator (BPI):** A BPI (Business Performance Indicator) is a quantified data which measures the efficiency of action variables or decision variables, in the frame of the achievement of an objectives defined for this system. The BPI can measure directly the achievement of the objective (result BPI) or the trend/progress in the achievement of the objective (progress BPI) and in this case the efficiency of the decisions.
- **Characteristics of a Business Performance Indicator (BPI):**
 - easy to be interpreted, to put in work, to use or to exploit
 - easily measurable, quantifiable
 - representative of the objective of which it measures the reaching
 - available at any time when one needs it
 - renewed or changed, even disappear according to the circumstances
- **I-VLab comments on the BPIs:** The most common comments formulated by I-VLab on the definition of the Business Performance Indicators (BPIs) are:
 - 1) The BPIs are defined as an objective: the terms “improve, increase and decrease” are present in the formulation.
 Example: “Improved the tools tracking management”: *“Reduction of times spent in FOD prevention”*
 - 2) The BPIs are neither measurable nor quantifiable: It requires the recourse to other dimensions of performance to quantify it.
 Example: The level of the customer satisfaction: Improve customer satisfaction
 - 3) The BPIs are not very precise. The BPIs is not representative of the objective of which it measures the reaching
 Example: Identification of weak signals time cycle: *The process will go automatic so a dramatic reduction of the time cycle is expected*

Each time these inconsistencies occur, I-VLab suggested to reformulate the BPIs. Any time, when the BPIs were not defined according to the Simplified ECOGRAI method, I-VLab transformed and reformulated them to be in conformity with the method concept.

Conclusion

This work was profitable to the trials. In the last formulation of BPI by the trials we have not found the type of errors mentioned previously.

2.2. Technical Indicators

The FITMAN V&V methodology, initially presented in D2.1, is a complete Verification and Validation Methodology able to cover a broad aspect of software development cases. However, like every method which has such generic characteristics that could be (fully or partially) applied in almost any software development process, its application requires extra effort from the development teams in order to fully understand and apply accurately all required steps.

Additionally the FITMAN V&V methodology in D2.1 is complemented by a large number of technical indicators in D2.2 in order to cover any type of business software and to be applicable for every individual software component. Given these, as well as the fact that in FITMAN project there is a large number of software development teams and individual developers involved in developing and integrating FITMAN components as well as building complete solutions ready to be installed in real environments, the development of a simplified version of the V&V approach has been considered. The simplified V&V approach has the same characteristics with the presented V&V methodology, however has less steps and a reduced number of technical indicators to be examined. This way it is expected to receive results of higher quality since the development teams will adopt more easily the V&V approach and will avoid possible mistakes due to misunderstandings or lack of time.

Specifically:

- As far as it concerns the product specific part of the methodology (referring to the V&V of the Specific Enablers, the Generic Enablers and the Trial Specific Components) the simplified approach focuses on the Release Verification and the Product Validation steps, for which specific **self-assessment** forms have been introduced in order all teams to report results in a common way. The reason for selecting these two steps and for skipping the initial Verification steps is that in FITMAN almost no components are built from scratch – they are built by configuring, customising and integrating already available software components. Performing the initial verification steps for such ready components - although possible - is not expected to have great added value in FITMAN case in comparison to the significant effort required for completing the required tests. Based on this, out of the 5 steps presented in the full V&V methodology and presented in the following figure, only steps P-4 and P-5 are considered part of the simplified approach.

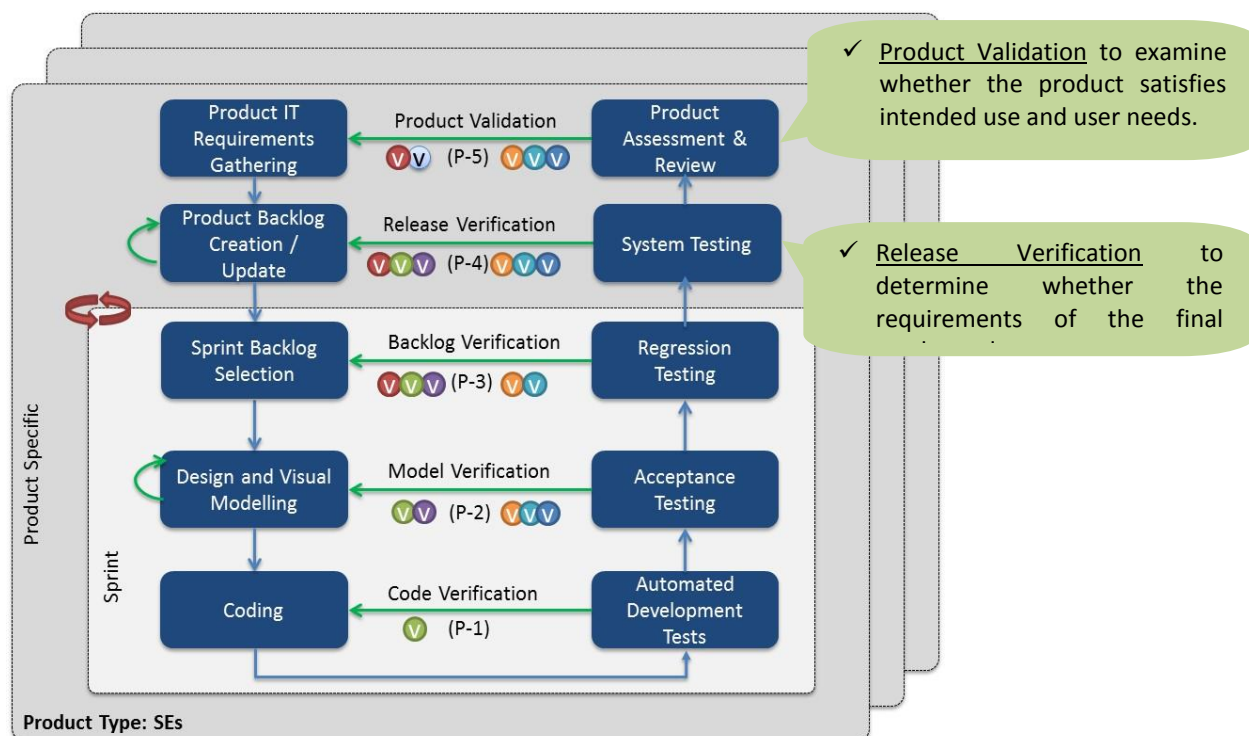


Figure 2.1 Only V&V steps P-4 and P-5 are considered part of the simplified approach.

- As far as it concerns the validation of the complete solutions which are built and installed to the trials, the simplified method includes the application of the Trial Solution Validation step (see figure below). Each trial solution is being validated, from a technical and functional point of view, by following the techniques described in the complete FITMAN V&V methodology. On the other hand, the business validation of the solutions is being performed by applying the simplified version of the ECOGRAI methodology.

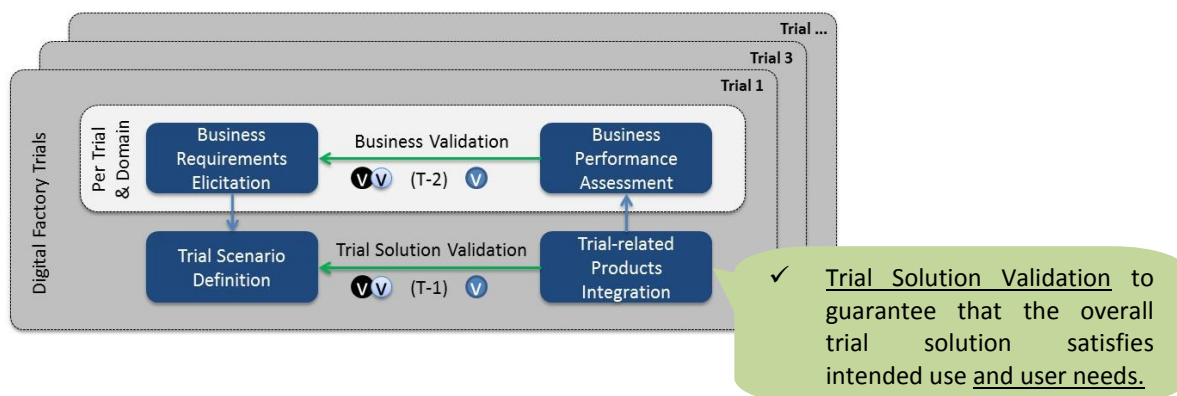


Figure 2.2 The simplified method includes the application of the Trial Solution Validation step.

On the way to the development of the simplified V&V approach to be in practise applied in all FITMAN components and trial solutions, the next step is the definition of a smaller set of technical indicators. This set must be considered complete in terms of examining the most important V&V aspects and at the same time shall be easily understandable and acceptable by all development teams in order to be adopted for every component under examination.

After gathering FITMAN development teams' opinions on the application of the V&V method, it has been considered that two subsets of technical indicators shall be selected which for simplicity

reasons have to be common among all the FITMAN components and all the FITMAN trial solutions respectively.

Towards this direction, two subsets of indicators have been selected: the trial components indicators subset and the trial solutions subset, the first one consisting of 3 indicators, common for all Specific Enablers, Generic Enablers and Trial Specific Components and the second one consisting of 5 indicators, common for all Trials.

The following table presents the selected Trial Components Indicators of the simplified V&V approach, which are to be used in the Product Validation step (P-5) for all components:

Technical Indicators for GEs/SEs/TSCs	Levels per Indicator
Openness	<ul style="list-style-type: none"> • Level 0: Open specifications –Developers can view & study the requirements posed and implement them as they wish • Level 1: Enablers as a Service – Developers can utilize software provided as a service through open interfaces • Level 2: Releasing code as open source - Developers can inspect, download, run and improve the open source code according to their needs. • Level 3: Consulting with the use cases about their needs and collaboratively contributing to the source repository, design documents, and bug reports
Interoperability maturity	<ul style="list-style-type: none"> • Level 0: Isolated Approach (No API exposing the GE / SE functionalities) • Level 1: Baseline Unified Approach (International Standard exists) • Level 2: Open Unified Approach (No International Standard exists) • Level 3: Standardized Integrated Approach
Ease of application	<ul style="list-style-type: none"> • Level 0: No applicability in our environment without extra applying actions or means • Level 1: Applicable with significant amount of work • Level 2: Applicable with some amount of work • Level 3: Easily applicable in our environment

Finally, concerning the Technical Validation of the complete Trial Solutions (step T-1 of the V&V methodology) the following Indicators have been selected to be used by all trials. It has to be noted that these indicators, due to the nature of the solutions, are based on qualitative measurements and on the opinions of the users' communities.

Trial Solutions' Technical Indicators	Statement to be examined / evaluated based on users' perspectives
Fulfilment of requirements	<i>The solution fulfils all the Trial requirements</i>

Trial Solutions' Technical Indicators	Statement to be examined / evaluated based on users' perspectives
Learnability	<i>It is easy to start to use the solution and learn functionalities</i>
Understandability	<i>The solution is easy and self-clear to understand and the concepts and terminology are understandable</i>
User's attraction level	<i>The solution is attractive to the user. I feel satisfied and comfortable when using it</i>
Efficiency	<i>The time and resources required to achieve the objectives of the solution are reasonable, the solution is fast enough and does not require too many steps</i>

For all the aforementioned Technical Indicators, detailed descriptions can be found in Deliverable D2.2 which includes the full set of the indicators as defined in the complete FITMAN V&V methodology. It has to be noted that any trial or development team is allowed to use in practice any indicator which is included in the methodology and not to limit the V&V application to the selected indicators specified in the simplified approach. However these selected indicators have to be used in all cases, so they can be considered as the minimum set of indicators to be applied in order the application of the V&V approach to be complete in the framework of the project.

At the time the present deliverable is being composed, the technical V&V activities are ongoing, yet they already signify their contribution to “building the right software in a correct way” for the Specific Enablers. The initial outcomes of the application of the V&V approach are very positive. By testing all software features in relation to the requirements, Release Verification has already helped to detect and correct malfunctions and bugs. In addition, as far as it concerns the Product Validation which is ongoing, it acts as a direct online feedback mechanism with the trials IT support teams and eventually, in the near future with the Phase III WE / SMEs.

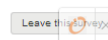
2.3. Self-Certification of Specific Enablers

Given the fact that in FITMAN project there are several development teams working at the same time in order to develop, adopt and customize specific components or software solutions, the coordination of all the teams in order to use exactly the same methods and techniques for software testing is not only difficult but also out of scope since the same step can be often performed by using more than one approach. In such cases, the culture and the experience of the development team on the one hand and the nature of the component under testing on the other hand are the main axes for selecting the most appropriate technique. This is the way in FITMAN V&V methodology, although there are some recommended techniques per step, there is increased flexibility in selecting any other technique considered more appropriate for a case. What is important for FITMAN is to assure that all the required V&V steps have been implemented for each of the components developed, customized or used. This is why a set of Self-Certification forms has been developed through which the different Development Teams will be able to certify, driven by specific procedures, the application of the V&V steps. The self-certification forms shall be filled at least for all the Specific Enablers developed during the project, allowing a rapid and efficient comparison among the different outcomes of the involved software development teams.

The structure of the self-certification forms has been presented in Deliverable D2.3 in detail. However before distributing the forms for all the Specific Enablers developed it has been decided to perform two pilot applications of the self-certification process by applying it to two SEs developed by NTUA, in order to be used as examples for the rest of the SEs:

- the Unstructured and Social Data Analytics SE and
- the Metadata and Ontologies Semantic Matching SE

Using the SurveyMonkey platform, the Self-certification forms for the SEs have been created, as presented in the following figures and sent to the respective development teams.



Unstructured and Social Data Analytics SE - Self-certification Form

Unstructured and Social Data Analytics SE - Self-certification Form

Please indicate the adopted Verification Technique (Recommended or Alternative) and the result of the related test.

RECOMMENDED VERIFICATION TECHNIQUE: WHITE BOX TESTING: UNIT TESTING

SHORT DESCRIPTION: Unit testing is a software verification process in which the smallest testable parts of an application, called units, are individually and independently scrutinized for proper operation. Each unit is tested separately before integrating them into modules to test the interfaces between modules.

V&V SUCCESS CONDITIONS:

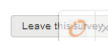
- The development team has written tests for all the code and believes there are no

00042001 - STEP P1

☐ White Box Testing: Unit Testing - Positive Result
☐ White Box Testing: Unit Testing - Negative Result
☐ White Box Testing: Unit Testing - NA
☐ Alternative Verification Technique - Positive Result
☐ Alternative Verification Technique - Negative Result
☐ Alternative Verification Technique - NA

Comments (if any):

Figure 2.3 Self-certification forms for the Unstructured and Social Data Analytics SE



Metadata and Ontologies Semantic Matching SE - Self-certification Form

Metadata and Ontologies Semantic Matching SE - Self-certification Form

Please indicate the adopted Verification Technique (Recommended or Alternative) and the result of the related test.

RECOMMENDED VERIFICATION TECHNIQUE: WHITE BOX TESTING: UNIT TESTING

SHORT DESCRIPTION: Unit testing is a software verification process in which the smallest testable parts of an application, called units, are individually and independently scrutinized for proper operation. Each unit is tested separately before integrating them into modules to test the interfaces between modules.

V&V SUCCESS CONDITIONS:

- The development team has written tests for all the code and believes there are no

00045001 - STEP P1

☐ White Box Testing: Unit Testing - Positive Result
☐ White Box Testing: Unit Testing - Negative Result
☐ White Box Testing: Unit Testing - NA
☐ Alternative Verification Technique - Positive Result
☐ Alternative Verification Technique - Negative Result
☐ Alternative Verification Technique - NA

Comments (if any):

Figure 2.4 Self-certification forms for the Metadata and Ontologies Semantic Matching SE

As obvious, the self-certification forms include all the steps of the FITMAN V&V methodology and not only those considered as mandatory according to the simplified V&V approach. However the development teams that have decided to follow only the steps of the simplified approach are allowed to leave the steps that have not been performed unanswered and to proceed directly to the steps which have been implemented in practice.

As proven by the pilot applications of the self-certification approach, the development teams face no difficulties in filling the forms while at the same time the existence of the forms and the fact that there is a common platform for sharing the V&V results are two facts that have enhanced the interest of the developers for studying and applying the FITMAN V&V method.

The self-certification forms do not provide detailed information – they are just being used for reporting if each V&V step has been applied for a Specific Enabler and which techniques have been selected and applied. The reporting of the testing results shall take place by using specific excel forms developed - and distributed to the development teams - in which all test cases and the results of the iterations performed during testing are kept. Such an indicative form, which refers to Step P4 of the V&V applied during the development of the Unstructured and Social Data Analytics SE is presented in the following figure.

Figure 2.5 Example of MS Excel form developed in which all test cases and the results of the iterations performed during testing are kept.

In this specific case, the technique chosen by the development team for performing the Release Verification step (P-4) is Alpha Testing. The test cases have been developed by the development team in order to reflect all the under testing aspects of the component.

2.4. Unstructured Information (Trial Journal)

Also unstructured information for each Trial is collected according to the FITMAN V&V Methodology. In particular, the Trial Journal supports this collection. The Trial Journal is a page of the General Form available for each Trial. It collects unstructured feedbacks from each Trial, addressing both Technical and Business aspects. It is updated with the most important information each time that there are remarkable events to point out. In particular:

Technical Journal:

- Registration of the implementation issues encountered in the implementation of the Trial system
- Registration of the operational resilience of the Trial (e.g. major bugs, blocking errors, etc.)

Business Journal:

- Collection and analysis of the most important operational issues faced in the implementation of the system in the Trial, e.g. organizational and business difficulties, degradation of the business system.

Furthermore, the present information is reiterated directly in the page of the Trial Journal itself on SurveyMonkey, in order to drive the Trial Owner in the provision of the correct inputs, Figure 2.6.

Trial Journal	
<p>Technical Journal - Please insert in this page (at open format):</p> <ul style="list-style-type: none">- the implementation issues encountered in the implementation of the Trial system;- the operational resilience of the Trial (e.g. major bugs, blocking errors, etc)	<p>Business Journal - Please insert in this page (at open format):</p> <ul style="list-style-type: none">- The collection and analysis of the most important operational issues faced in the implementation of the system in the Trials, e.g. organizational and business difficulties, degradation of the business system.
<p>06 - Technical Journal</p> <div></div>	<p>06 - Business Journal</p> <div></div>
<div>Back Next</div>	

Figure 2.6 – Template of the Trial Journal

3. Ongoing Support to FITMAN trials

3.1. Training events for trial partners

3.1.1. The training events

An essential part of successful instantiation of the FITMAN V&V method has been communicating it to the trials in a way that they would all have a uniform understanding of the method, and in a way that would make the method as easy as possible for the trials to use. Appropriate communication of the method ensures that we are able to obtain high quality and reliable data from the trials. An essential and efficient way, among other communication means, was found to be to organize *training events* for the trials. The target groups for the training were the *trial support organizations* and the *industrial partners*. The support partners are research institutes or technology providers involved in the trials, and managing the instantiation activity in each trial was their responsibility. They also take part in the verification of the V&V method, as well as validation of trial components. It was also important that the industrial partners took part of the training because they use the V&V method concerning validation of trial solutions as well as take part in using the simplified ECOGRAI method for business indicators. The goal was that after the training both the technical and industrial partners would know what is expected from them in order to perform the V&V, and the technical partners would have the knowledge to run the V&V methodology instantiation in the trials.

The training events were organized by WP2 task leaders involved in the V&V methodology development, i.e. VTT, Polimi, NTUA and IVLab. Each WP2 task leader organization run one event, and other task leaders participated in each event according to the need and to availability. The training events were held according to geographical areas, collecting together partners near each other. The events were held during M10-12 of FITMAN according to the table below. Each training event took one full day and one of the support partners kindly took the responsibility of hosting the event and taking care of the practical arrangements.

Table 3.1. The training events held for the trials.

Training session	Date 2014	Organizer	Host	Trial company	Tech.partner	Participants
Berlin	Jan 22th	VTT	Fraunhofer IPK	TR1 Volkswagen TR9 COMPlus	Fraunhofer	1 Volkswagen 3 Fraunhofer 3 VTT 2 Polimi
Italy	Feb 19th	Polimi	Agusta Westland	AgustaWestland	TXT	2 AgustaWestland 1 TXT 3 Polimi
Italy	Feb 28th	Polimi	Whirlpool	Whirlpool	POLIMI and Engineering	1 Whirlpool + Polimi
Italy	Feb 27th	Polimi	Piacenza	Piacenza	Softeco	2 Piacenza 2 Softeco 2 Polimi
Bilbao	Feb 25th	NTUA	Innovalia	TR2 TRW TR11 Aidima	Innovalia Universitat Politècnica de València	2 TRW 1 Aidima 1 UPV 2 Innovalia 2 NTUA
Lyon	March 13th	IVLab	University of Lyon2	TR6 Applications Plastiques du Rhône (APR) TR7 Consulgal TR8 TANet	University of Lyon 2 Uninova Coventry University	2 APR 1 Consulgal 2 TANet 4 Lyon2 4 IVLab 1 UBX1 1 VTT 2 Polimi

The objectives of the day were twofold. Firstly, we wanted to give the trials a good overall picture of the V&V method, as well as guidance of how to perform the assessment. In order to perform the assessment efficiently, they needed to know exactly *what* and *when* was expected from them as well as *how* to do the expected activities. Secondly, also the WP2 partners had some expectations of the day. The training event was seen as a valuable occasion to get a good picture of the status of each trial, ask questions related to it as well as to obtain basic information necessary to launch the V&V assessment in the trials. This information included for example naming the responsible person for the V&V process in the trial and the names of the persons that would take part in the assessment. The main objectives of the training are described in the table below.

Table 3.2. The main goals of the training events for the participants.

Trial people should know:	WP2 people should know:
How and when it is expected to do the assessment	A clear picture of the status and a realistic schedule of the trials
How to use Survey Monkey	Responsible person named for the V&V activities of each trial
	Names or positions of persons to be involved in the assessment
Technical and business indicators to be used and the timing of the assessment	
	Enough information in order to create the forms in the Survey Monkey

The training events took one full day. The main subjects for the day were

- the objectives of the day
- overview of the FITMAN V&V method
- business PI methodology (simplified ECOGRAI) and business indicators data collection

- the technical indicators and the TI methodology application
- trial status presented by each trial
- using the V&V Assessment Package for data collection including also the use of Survey Monkey forms, and in some trainings also using the SM forms “hands on”
- questions and answers.

Each trial was given a slide set template for preparing a presentation of the trial. The presentation included e.g. the status of the trial, which is important information for the timing of the V&V.

The events concentrated on the validation part of the V&V methodology. The verification part was communicated more profoundly to the users of the method through e.g. webinars. The reason for this was that the target partners and end users of the method are different in the verification part of the methodology.

The training events were all organized in quite a homogenous way including the aspects mentioned above, but there was some flexibility depending on the need of the participating trials. Below is given an example of the agenda of the training event organized by NTUA in Bilbao.

Table 3.3. An agenda in training event organized by NTUA in Bilbao for four partners.

		AGENDA ITEM	PRESENTER
1.	09:00	Welcome	ALL
2.	09:15	Introduction / Participants' presentation / Practicalities	INNOVALIA
3.	09:25	Training Objectives, Tasks & Schedules Review recommendations	NTUA
4.	09:45	FITMAN V&V objectives and method overview & V&V Certification Forms	NTUA
	10:45	Short Coffee Brake	
5.	11:00	Presentation of technical indicators	NTUA
6.	11:30	Business indicators data collection	NTUA
7.	12:00 (30' / trial)	Trial & Scenario Status -Scenario status -Used GEs, SEs, TSCs and TICs	TRW / INNOVALIA (Trial 2) AIDIMA / UPV (Trial 11)
	13:00	Lunch	
8.	14:15 (30' / trial)	“Hands on” – Business Indicators “Hands on” – Technical Indicators / Self Certification	TRW / INNOVALIA (Trial 2) AIDIMA / UPV (Trial 11) Supported by NTUA
9.	15:15	Q&A Session	ALL
10.	15:45	Wrap Up	NTUA

A very important aspect of the training events was their **interactive nature**. The trials had a chance to ask questions face to face with the WP2 partners. They were also asked to write down expectations of the day in the beginning, and at the wrap up these expectations were gone through to see if they had been met. On the other hand the WP2 partners were able to clarify issues necessary for V&V concerning the trial solutions and the status of the trials. In the agenda there

was left room for these discussions, and it turned out that the discussions were one of the main offerings and results of the day, and were seen very valuable by all partners.

Minutes of each event were taken. All material, including the agenda of each event, are available at FITMAN web pages.

3.1.2. Experiences of the training events

Instantiating a V&V method in a multi-sectorial environment is challenging. With the training events we wanted to tackle some specific challenges of the instantiation process. These challenges included the differences in schedules and progress of the trials; the large variety of trial cases; tight schedule in FITMAN project and hence very tight schedules for the implementation work in the trials, which in turn sets requirements for the efficiency of performing the V&V. We felt that the training events addressed especially the tight schedule issues and the large variety of trial cases. The training enabled efficiency of performing V&V in trials, and it also helped in using the same simplified method in the trials that differ from each other significantly.

At the end of each training event we also wrote down comments from the participants. The events were seen to be an efficient way to inform the trials about the V&V method, and the whole day was seen useful by the trials. Especially the interactive nature of the day was seen valuable by both trial and WP2 partners. The overall comments from each session were:

- Bilbao / NTUA: The session went very well for both trial partners and NTUA. It went mainly according to the agenda. Some constructive feedback was received regarding the methodology.
- Italy / POLIMI: All three sessions went well and had a very positive feedback.
- Lyon / IVLab: The session went well. The time schedule was challenging as there were 3 trials present; more time could have been used for each trial presentation and status.
- Berlin / VTT: The session went well and was useful. There was a lot of discussion, which was very useful.

After the events, the WP2 partners took some further actions concerning the V&V method. The method was slightly further simplified and some indicators were clarified. Some gaps in informing the trials were identified and corrective actions taken. Interaction with the trials concerning instantiation of the simplified ECOGRAI method was increased.

3.2. Ongoing V&V methodology support to FITMAN Specific Enablers verification

The application of FITMAN verification methodology for the Specific Enablers, developed in the framework of the project, required provisioning of support from the partners who have created the methodology to the teams/partners developing the SEs.

The provisioning of V&V methodology support took place in three phases, starting from December 2013 and covering the experimentation and the expansion phases up to August 2014. The following diagram illustrates the phases and the actions taken in the aforementioned period for training and supporting FITMAN partners in the application of the V&V methodology. Probably the most crucial part of the methodology which required extensive support was the Verification of the Specific Enablers, including the self-certification process and the assessment of the SEs via the provided Technical Indicators.

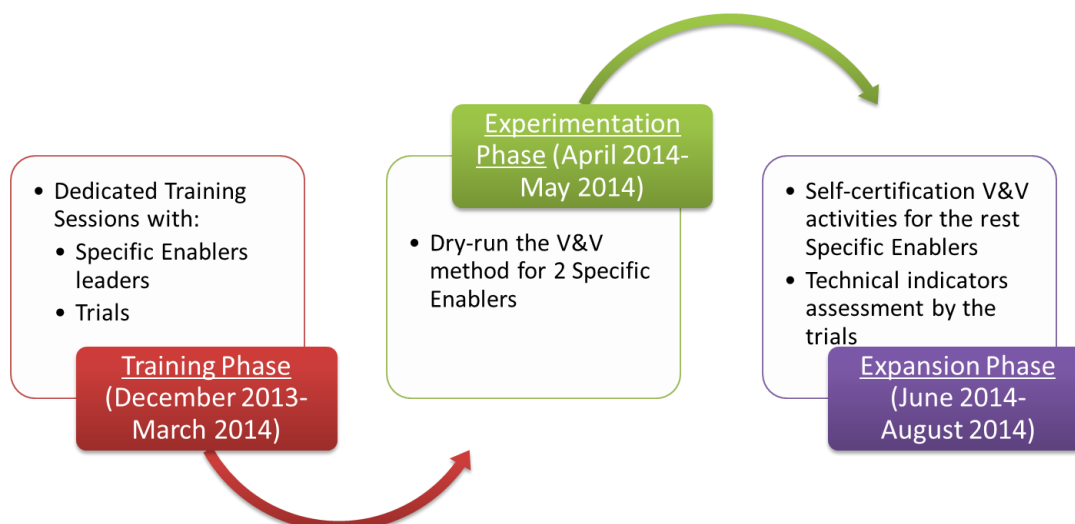


Figure 3.1: V&V Training and Support Process

The **first phase** of the V&V support process included training, of all the involved partners, on the fundamentals of the methodology. Initial training has been provided via a very comprehensive webinar which took place in December 2013, in which the main aspects of the technical V&V methodology were presented. The webinar focused on the application of the methodology during the development of the Specific Enablers including the self-certification processes and the ways to report the results of the SEs' validation. Following the webinar, which was open to all FITMAN partners, dedicated face to face training sessions with the SEs' leaders and the trial partners took place in the framework of the six WP2 training events (see section 3.1.1), in order the participants to fully understand why, how and when they should perform the respective V&V processes (self-certification and technical indicators assessment) on each FITMAN Specific Enabler. During these sessions several clarifications have been provided in order all parties responsible for the creation and/or the application of a Specific Enabler to be fully aware of the V&V processes which shall take place.

Although the training sessions were considered, by the involved partners, as very successful, it has been remarked that before V&V takes place for the different SEs, it would be useful all partners to have access to the V&V results of at least one software component in order to get a better understanding of how the method can be applied in practice. In order to cover this need, the **second phase** of the V&V support process (experimentation phase) included the application of the V&V method for two Specific Enablers (as described in paragraph 2.3) and the distribution of the results, the self-certification forms and the user acceptance questionnaires to the partners involved in the development or application of other SEs. Having these results as points of reference, the responsible partners have been asked to apply the methodology on their own SEs and to report back the results.

The application of V&V in practice has taken place during the **expansion (third) phase** which lasted from June to August 2014 when all SEs' leaders applied the requested V&V processes and provided the respective results in the SurveyMonkey forms prepared for each SE. During this phase (as well as during the second phase in some cases) extensive support was provided by WP2 core partners to all the partners linked to the development of the rest of the SEs, for answering questions, clarifying methodological details and solving specific problems. This support was provided mostly via emails as well as via ad-hoc telcos and/or phone conversations and included

the study of the submitted self-certification forms and – when needed – the provisioning of personalized guidance for their improvement.

In general the V&V processes have been widely and successfully applied on all the Specific Enablers developed in the framework of FITMAN. During their application, the partners responsible for the V&V methodology achieved to successfully respond to all support requests, assuring that common rules have been followed for all the SEs developed in the framework of FITMAN project.

4. Instantiation of V&V Assessment Package into Survey Forms

After the definition of the four components of the FITMAN V&V Assessment Package (i.e. Business Performance Indicators, Technical Indicators, Trial Journal, V&V Tests for SEs), its instantiation has been defined. “Instantiation” has meant specifying and adapting the aforementioned four components to each of the ten trials, starting from the previously mentioned FITMAN V&V methodology and FITMAN V&V measuring system.

As a result of the instantiation, the FITMAN V&V Assessment Package can be presented as composed of four different sections:

- Business Performance Indicators, specific to each Trial, assessed by the end users, through “as-is”, “to-be” and target values. They refer to the Step T2 of the FITMAN V&V methodology.
- Two groups of Technical Indicators, i.e. five indicators for the whole Trial solution, implemented as community-based collection of users’ opinions, and three indicators for the software components (i.e. Generic Enablers (GEs) and Specific Enablers (SEs)), implemented as evaluation through a scale of different values; they refer to the P5-T1 Steps of the FITMAN V&V methodology.
- Unstructured information for each Trial, addressing both Technical and Business aspects; they refer to P5-T2 steps.
- V&V Tests for SEs: after the development of SEs, each of them is tested by the software development partner. It is allowed to use their own methods, reporting results through a self-certification mechanism; they refer to the P1-P5 Steps of the FITMAN V&V methodology.

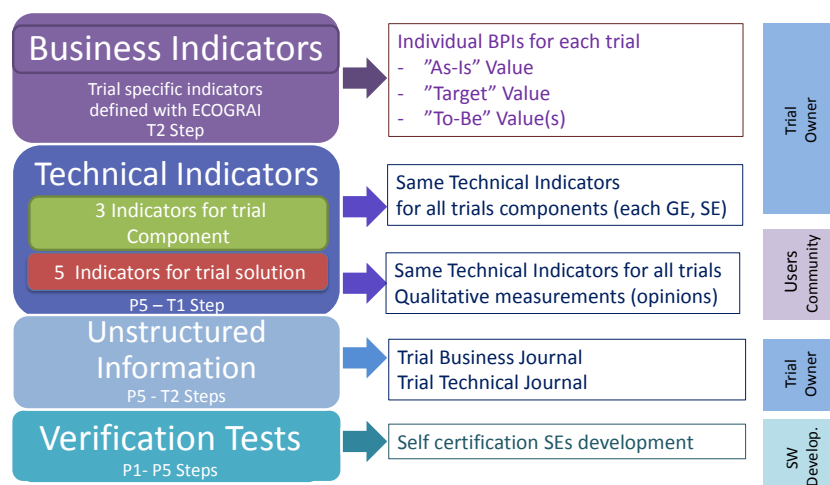


Figure 4.1 – FITMAN V&V Assessment Package overview

The FITMAN V&V Assessment Package presented has been then customized and made available to each Trial by means of a set of different forms implemented and distributed online with SurveyMonkey. The final result obtained is the definition of three categories of forms organized according to whom it is addressed. In particular: General Forms, Community-based Forms and Self-certification Forms:

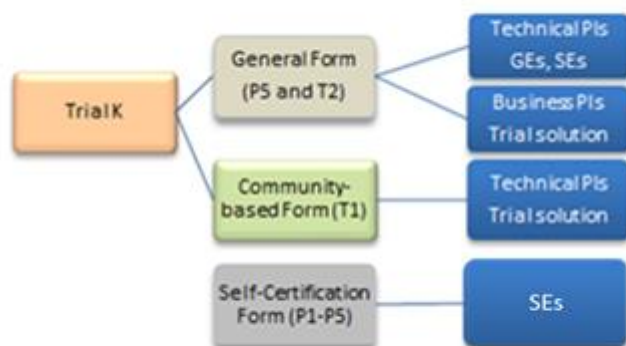


Figure 4.2 – FITMAN V&V Assessment Package – Data Collection Forms

General Form is addressed to the **Trial Owner** who is responsible for completing it. It includes:

- **Technical Indicators forms** (Step P5 of the FITMAN V&V methodology) that are related to each software component (i.e. GEs, SEs), where the indicators are replicated for each form and the value assignment can be carried out within a scale of different levels;
- **Business Performance Indicators forms** (Step T2 of the FITMAN V&V methodology) that are related to the whole Trial solution. Business Performance Indicators are closely linked to the objectives of the trial itself. TO-BE and target values are expressed as the percentage (i.e. ratio) which represents the increment/reduction of the related current value. This choice has been made in order to allow trials to by-pass the confidentiality issues faced during data collection;

Community-based Form (Step T1 of the FITMAN V&V methodology) requires crowd engagement because it aims to collect the “community-based” assessment, e.g. opinions and subjective perceptions in using the solution; therefore, it has to be completed by **all the users** of the Trial team. The unit of analysis is the whole integrated solution and the value is assigned within a scale of four level of agreement according to a given statement;

Self-certification Form (Steps P1-P5 of the FITMAN V&V methodology) is designed for the software component developers, because it aims at assessing the results of the specific V&V Tests applied to each of them during their development. The self-certification process, unlike the previous ones, is specifically designed for each software component (i.e. SEs) independently of the different Trials in which they have subsequently been implemented. Additional forms for Specific Enables Validation (Step P5 of the FITMAN V&V methodology) are also developed in order for any developer who reuses the Specific Enabler to assess its functionalities in more detail.

From an operating point of view, the procedure of instantiation of the Data Collection Forms for each Trial, once the V&V Assessment Package had been defined, has implied:

1. Definition of the list of Software Components (GEs, SEs) for each Trial: The list of GEs and SEs for each Trial has been defined thanks to the information of D3.1 – Trial IT Infrastructure and Platforms and to a further iteration with the Trials for checking and updating.

2. Definition of the Business Scenarios for each Trial: The Business Scenarios of each Trial has been defined according to the findings of D3.2 - FITMAN Trials Business Cases WP3 Design and Development of FITMAN Experimentation Sites. Then iterations with the Trials have been done in order to check and update the information.
3. Definition of the Business Performance Indicators for each Business Scenario: The Business Performance Indicators (related to the single Business Scenarios of each Trial) have been collected as outputs of the D4.4-5.4-6.4 – FITMAN Technical – Business Indicators for Smart/Digital/Virtual Factory, as well as their AS-IS and Target Values.
4. Development of the General Form for each Trial: Thanks to the information previous collected, the General Form for each Trial has been developed, integrating also the Trial Journal for unstructured information. AS-IS and Target Values of Business Performance Indicators have also been inserted in SurveyMonkey administration system. Subsequently, each Trial Owner has been identified and has then received via email the General Form to be filled in with related credentials.
5. Development of the Community-based Form for each Trial: The Community-based Form for each Trial has been developed, including the Technical Indicators referred to Step T1.
6. Identification of the Community Panel for each Trial: Through another iteration with the Trials, the users of each Trial Solution have been identified. The forms have been then disseminated to each user of each Trial as well as the credentials to access them.
7. Development of the Self-certification Form for each SE: The Self-certification Form of each SE has been developed and it has been afterwards sent to each SE Owner for its compilation.
8. Additional forms: Specific Enables Validation Forms (Step P5 of the FITMAN V&V methodology) are also developed in order for any developer who reuses the Specific Enabler to assess its functionalities in more detail.

Some useful experiences and lessons learned have been collected during the instantiation of the FITMAN V&V Assessment Package.

- Need to establish Technical Indicators common to each Trial. Identical Technical Indicators to evaluate each Trial Solution (Step T1 – Community-based Forms) and each Software Component (Step P5 – General Forms) allow comparison and improve the effectiveness of the whole V&V process.
- Need to establish specific Business Performance Indicators for each Trial and for each Business Scenario. Unlike the Technical ones, Business Performance Indicators should be closely related to the specific situation, hence taking into account its needs and features. Anyway, a common approach in developing these indicators has been followed, i.e. Simplified ECOGRAI Methodology.
- Need to identify specific recipients for each of the different kinds of Forms. In particular, for each General Form a single Trial Owner has been identified, while for each Community-based Form the community of users of the Trial Solution has been defined. Furthermore, the Self-certification Forms for the SEs have been submitted to the related SE Owners.
- Definition of a place in the General Form where to collect also unstructured information (i.e. the Trial Journal), in order not to lose important information and lessons learned especially when expanding/modifying the existing solutions.
- Importance of the confidentiality issues. If the Trial have not been able to provide numerical values for the Business Performance Indicators, these values have been provided in percentages

5. Methodology for Cross-trial assessment

5.1. Objectives of comparison

The objective of FITMAN is to assess the usefulness of FI-WARE solutions in manufacturing industry, both from the technical and business viewpoints. To perform the task, FITMAN includes 10 trials in which the FI-WARE solutions are adopted and experimented. The experimentation is also used to assess the trial business benefits and technical performance of the software components and the trial solution. As a whole 26 FI-WARE GEs and 8 FITMAN SEs are adopted and experimented in the trial solutions. (The new 7 FITMAN SEs derived from our open call will be integrated into the Trials at M21).

Each trial will perform its own measurement of business and technical indicators but for further conclusions it is interesting to analyze and compare the results of the assessment. The comparison might reveal strengths and weaknesses, applicability in different situations, successful processes and cases and as a whole confirm the performance as the information is based not only on one trial and assessment. The cross-trial assessment also allows the assessment of the versatility of FI-WARE GEs, which is not possible realistically at the trial level.

However, it is important to distinguish which elements of the assessments are comparable and which are not comparable across the trials. Even if all the trials are coming from manufacturing industry, the objectives they have and the processes supported by the trial solutions are not similar. Thus there is no straightforward way to compare for example the business benefits. The technical comparison is more realistic but even there the context might affect the results.

In the following, the methodology for the cross-trial assessment is presented for the different “modules” of the FITMAN V&V system.

The results of the cross-trial assessment of Business and Technical Indicators, and consolidation and comparison of self-certification results will be reported in D8.1 FITMAN use case comparative evaluation, due at M21.

5.2. Methodology for the consolidation and comparison of self-certification results

According to the FITMAN V&V methodology, a self-certification process has been applied for every Specific Enabler developed in the framework of the project. The reporting of self-certification results has taken place via a set of questionnaires developed for each SE, using the SurveyMonkey platform.


The present section describes, in terms of methodology, the actions required for analyzing and consolidating the V&V results for all the Specific Enablers, a process very useful not only for verifying that the V&V methodology has been applied correctly but also for comparing the V&V/self-certification results among the SEs.

The required actions for performing the analysis are the following:

Action 1: Collection and analysis of the V&V results

For each Specific Enabler developed in the framework of the project the self-certification form filled by the SE leader will be acquired and initially examined as far as it concerns its completeness. In case, for a SE, the forms have not been completed, as supposed, then direct contact will be established with the respective SE leader in order to proceed to the required additions/modifications. This refers mostly to the free-text fields of the forms since in these fields information shall be provided either in case the method used is different from the one recommended or in case the result of a verification/validation step was not positive. In general the (unavoidable) existence of free-text fields requires a non-automated analysis of the responses in order to extract all the information provided by the development teams.

<p>UNIT TESTING</p> <p>SHORT DESCRIPTION: Unit testing is a software verification process in which the smallest testable parts of an application, called units, are individually and independently scrutinized for proper operation. Each unit is tested separately before integrating them into modules to test the interfaces between modules.</p> <p>V&V SUCCESS CONDITIONS:</p> <ul style="list-style-type: none"> - The development team has written tests for all the code and believes there are no other tests to be written for specific functionalities. - All bugs reported during the tests are fixed. 	<p><input type="radio"/> Alternative Verification Technique - Negative Result</p> <p><input type="radio"/> Alternative Verification Technique - NA</p> <p>Comments (if any):</p> <div style="border: 1px solid black; height: 20px; width: 100%;"></div>
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Free text / comments fields for providing information about:

- Alternative techniques used
- and/or
- Failure reasons in case of non-positive results

Action 2: Examination of the testing techniques selected

The second action, which is based on the results of the aforementioned analysis, is the examination of the testing techniques selected by the development teams for each V&V step. Specific emphasis must be given to the cases that any technique other than the recommended one has been selected. The purpose is to extract simple “cross-product statistics” per verification and validation step as far as it concerns the selected techniques and the percentage of the cases in which the recommended technique has indeed been used. Next, an analysis of the results of the tests performed per V&V step will take place in order to extract cumulative stats about the positive/negative results. Especially concerning the negative results the statistical analysis will focus on the reasons that a verification/validation process has failed always in comparison to the “V&V Success Conditions” provided by the methodology for each step.

Please indicate the adopted Verification Technique (Recommended or Alternative) and the result of the related test.

00040001 - STEP P1

☐ White Box Testing: Unit Testing - Positive Result
☐ White Box Testing: Unit Testing - Negative Result
☐ White Box Testing: Unit Testing - NA
☐ Alternative Verification Technique - Positive Result
☐ Alternative Verification Technique - Negative Result
☐ Alternative Verification Technique - NA

Comments (if any):

RECOMMENDED VERIFICATION TECHNIQUE: WHITE BOX TESTING: UNIT TESTING

SHORT DESCRIPTION: Unit testing is a software verification process in which the smallest testable parts of an application, called units, are individually and independently scrutinized for proper operation. Each unit is tested separately before integrating them into modules to test the interfaces between modules.

Recommended Technique for the V&V Step

SHORT DESCRIPTION: Black-box testing is a method of software testing that examines the functionality of an application without peering into its internal structures or workings.

Comments (if any):

V&V SUCCESS CONDITIONS:

- All failures reported are resolved.
- Specification or the implementation has no defects or incompliances
- The release sufficiently provides its intended functionality to the users.
- The Technical Indicators have been assessed.

V&V Success Conditions:

In case of negative V&V result the conditions not met, leading to failure, are provided in the "Comments" field

Action 3: Analysis of the provided documentation

The third action does not focus on the self-certification forms, like the previous two do, but on the supporting documentation provided by the SE leaders. Since this documentation includes a detailed analysis of the tests performed and of the application of the V&V techniques selected, it is possible to extract the required data in order to calculate useful stats. Such stats shall include – among other - the number of test cases which were developed and applied per SE and per V&V step and the success rates of the tests performed.

TEST CASE ID	TC_10	PRODUCT VERSION	0,9
TITLE	Project set up	TESTER	Evmorfia
DESCRIPTION	Test that every parameter of project set up is correctly processed		
COMPONENTS INVOLVED	User Interface, Connection with database, Connection to FI-WARE GE	TYPE	FUNCTIONAL
RELEVANT REQUIREMENTS	ITR_SE12_A01-04, ITR_SE12_U04		
ITERATION ID	TC_10.1	DATE	06-14
TITLE	Keywords are propagated to twitter streaming script		
MANUAL TESTING	YES		
PRIORITY	High		
INPUT/STEPS	ACTUAL OUTPUT	EXPECTED OUTPUT	PASS/FAIL
1. provide keywords in the corresponding field			PASS
2. press save			PASS
3. check that database contains the right keywords			PASS
4. review collected data to ensure they are related to the project keywords			PASS
FAIL NOTES			
ACTION			
ITERATION ID	TC_10.2	DATE	06-14
TITLE	Twitter accounts are propagated to twitter streaming script		
MANUAL TESTING	YES		
PRIORITY	High		
INPUT/STEPS	ACTUAL OUTPUT	EXPECTED OUTPUT	PASS/FAIL
1. provide twitter accounts in the corresponding field			PASS
2. press save			PASS
3. check that database contains the right twitter accounts			PASS
4. review collected data to ensure they come from the specified accounts or are addressed to them			FAIL
FAIL NOTES	twitter accounts are processed as simple keywords		
ACTION	search in the user_screen_name field		FIXED

Indicative SE testing Documentation

Another type of documentation also examined in this action refers to the provided Developer Acceptance Test surveys. For each Specific Enabler, the development team has created a questionnaire in order its potential users to provide their feedback, in the framework of the Product Validation step (P-5) as defined in FITMAN V&V methodology. In this deliverable, what is being presented is the structure of the questionnaires and that they all follow the basic guidelines provided by the V&V methodology.

FITMAN Anlzer

I. I can set up a new anlzer instance from the beginning, following the provided instructions. In case I use the provided VM, I understand how to use the SE and integrate it into the workflow of my program/application.

1 2 3 4 5

Completely disagree ○ ○ ○ ○ ○ Completely agree

II. I understand how to set up a new project and adjust it to my desired domain of interest.

1 2 3 4 5

Completely disagree ○ ○ ○ ○ ○ Completely agree

III. I understand what information needs to be filled in to create a report and how the combination of the defined parameters will affect the retrieved results.

1 2 3 4 5

Completely disagree ○ ○ ○ ○ ○ Completely agree

IV. I understand how to train the system in order to provide meaningful results.

1 2 3 4 5

Completely disagree ○ ○ ○ ○ ○ Completely agree

V. The provided instructions are correct and complete (i.e. I did not need to take any extra or different steps than the ones described).

1 2 3 4 5

Completely disagree ○ ○ ○ ○ ○ Completely agree

Indicative Developer Acceptance Survey Questionnaire

Action 4: Developer acceptance analysis

The last action includes an analysis of the results per Specific Enabler as far as it concerns V&V Step P-5 (Product Validation) which, for the SEs, refers to the application of the user acceptance testing technique, as previously described. After publishing the developer acceptance questionnaires for all Specific Enablers, potential developers or anybody who is interested in testing a Specific Enabler will have the opportunity to access and try out the component just with the obligation to provide responses to a specifically designed (by the development team) developer acceptance questionnaire.

The scope of action 4 is to analyse all the responses provided for each SE and to produce cumulative results representing the acceptance rates of the different Specific Enablers by their potential users. The most important results to be extracted refer to the weaknesses of each Specific Enabler, as identified during this phase. Obviously, in order to extract reliable data, a minimum number of answered questionnaires shall be available, however several single points of weakness can be identified even by examining the responded questionnaires one by one.

In **conclusion**, what has to be noticed is the fact that since the development of **high quality Specific Enablers** is an important target for the project, the whole **self-certification process** that has been designed for each SE is of **great importance** as well. The actions described above are required in order to proceed to a more complete analysis of the self-certification results for each SE.

Additionally, by providing a way for comparing the results of different SEs, the development teams are forced to try to develop software components of the highest possible quality, always given the available timeframe. The self-certification results, when combined with the assessment of each SE by the trials in which it's being incorporated (taking advantage of the provided technical indicators as described in the next section), can be thought as the vehicle for identifying, for each Specific Enabler, which are the strongest and the weakest points and for cross-comparing both the quality as well as the potential utilization of the different SEs.

5.3. Methodology for Cross-trial assessment of technical indicators

As described in chapters 1-2, in FITMAN V&V method, the technical indicators are assessed with two different scopes and also with different technical indicators:

- the level of software component (GE and SE), 3 indicators
- the level of trial solution, 5 indicators.

Additionally, across the trials, versatility of the FI-WARE GEs in the manufacturing domain can be assessed. It is not reasonable to assess versatility at the level of one trial. Based on the trial data, versatility can be assessed for each GE and as a whole for the group of all GEs.

5.3.1. Cross-trial assessment of technical indicators of software components

As described in chapter 2, the software components adopted in FITMAN trials are assessed through 3 technical indicators: openness, interoperability maturity and ease of application. The technical partners of each trial assess the components applied in the trial. The assessment is performed separately for each FI-WARE GE and FITMAN SE adopted. The same scale from 0 to 3 is used for all the three indicators.

In the cross-trial assessment, it is reasonable to consolidate the assessments made for the same GE in different trials. The GEs have been used in 1-5 trials; thus for different GEs the number of the

assessment varies. For each indicator and GE & SE the mean value and the distribution from the assessments can be calculated.

Comments regarding the specific indicators of software components:

Openness aims to assess if the software components may be accessed openly by different users (from open specifications without implementation, enablers as a Service, code as open source or collaborative development). These conditions are the same for different users; thus the openness indicator is clearly comparable across the trials. The cross-trial consolidation can be assumed to give more reliable assessment than a single trial opinion.

Interoperability maturity is used to assess the capability of the software component to interact with other systems. It is possible that a software component is interoperable with one trial but not as interoperable with another trial. Thus, in the cross-trial assessment it is more reasonable to view on the distribution of the interoperability indicators from different trials than the mean value. Both will be calculated.

Ease of application is a measure of the adaptability of the software to be applied in different heterogeneous environments, in terms of amount of work and extra actions or means needed for its adaptation to the new techno-business environment. The trials are guided to assess the ease of application from their own viewpoint and environment. It is clear that the same software component may be easily adopted for one trial, but not as easily for another environment. Thus, also for cross-trial assessment of ease of application, a distribution is needed, even if also the mean value is interesting.

5.3.2. Cross-trial assessment of technical indicators for trial solutions

The trial solution is the combination of existing company software, FI-WARE GEs, FITMAN SEs and TSCs. Thus each trial solution is unique and it is not straightforward to compare them across the trials. Also the objectives and challenges of the trials are different.

The solution experimentation is performed by the trial end users; and the assessment of the trial solution is performed by the end users. The aim is to have different actors and roles (depending on the solution) to run the experiments. Thus the same solution is assessed by several actors. This is implemented through a community based assessment: the opinions of the performance of the same trial solution are collected from a group of users, and the opinions are then combined for each trial. The assessment result is influenced not only by the solution itself, but also by the arrangements for the experimentation and the knowledge and experience of the group of users selected for the assessment. Thus each assessment result should be seen in its context; not as the absolute truth. The V&V tool offers the possibility to give complementary information about the experimentation and assessment using the so called *Trial Journals*.

The technical indicators for the trial solutions include indicators (see chapter 2 above) about *Fulfilment of requirements, Learnability, Understandability, User's attraction level and Efficiency*. Technically the results of the assessment can be combined and assessed across the trials, but because of the very different contexts, objectives and user groups the assessment does not reveal the real quality of the solutions. However, information about the satisfaction of the users can be received at the trial level and this information may be collected together from different trials. Concluding lessons learnt from the consolidated assessment requires the participation of the trials to take into account the context.

The end users assess the trial solution as a whole; they are not interested or even capable of identifying the components (GE, SE, TSC) used for the solution. Also the GEs selected operate

more in the background; they do not necessarily include any user interface components visible to the user. Thus there is no direct link from the assessment of the trial level solution to the FI-WARE components. The role and significance of GEs and SEs in each trial solution is described in WP4, WP5, and WP6 deliverables.

5..3.3. Cross-trial assessment of versatility

Versatility in the context of FI-WARE and FITMAN is defined and discussed in D2.2. There are different definitions of versatility for different contexts and no generic versatility indicators. In some cases the overall versatility indexes use the calculation of geometric means of single elements, sometimes an arithmetic mean is used. The approach depends on the objectives and context.

The main characteristics linked to versatility (see D2.2) are the following:

- capability of doing many things competently,
- having varied uses or serving many functions.

In FITMAN the software quality characteristics (like usability) are not included in versatility but they are handled through separate technical indicators.

It should be noted that in FITMAN the versatility is assessed only from the FITMAN viewpoint; capability of using the GEs in manufacturing industry solutions. The higher level assessment of versatility requires consolidation of different industrial and application fields (for example parallel FI-PPP use case projects).

For the FITMAN context the criteria for versatility was defined in D2.2 at two levels: FI-WARE components (GEs) are versatile if *the collection of FI-WARE GEs as a whole* and *at a GE level* can be used for multiple manufacturing trials.

In D2.2 two versatility indexes were proposed to be used in FITMAN at the level of FI-WARE collection of GEs (versatility for manufacturing industry): GE package usage index and Average GE usage, both compared to the total number of GEs. For simplicity, and as the total number of GEs is not static, for cross-trial assessment the indicators are here modified to assess the versatility index at GE package level with one indicator and it is proposed to assess the multiple uses separately for each GE. Thus two indicators are used:

Versatility_GE package usage index = Proportion of GEs that were used by any (at least one) trial
= number of used GEs/ number of all GEs:

$$\text{Versatility_GEpackage_index} = N_{\text{GEusedforany}} / N_{\text{allGEs}}$$

Versatility_for GE_i = Proportion of trials applying a GE_i:

$$\text{Versatility_for GE}_i = N_{\text{trial_GE}_i \text{ usedfor}} / N_{\text{trials}}$$

The current data (Sept 2014) to assess these indexes is available in Table 5.1 below. The number of all GEs needs to be assessed based on the FITMAN timeframe of being possible to adopt the GEs. That is, the latest releases may be out of the scope.

Table 5.1. The adoption of GEs in FITMAN trials (Sept 2014).

	Smart			Digital				Virtual			Other	Total # of trials
	2	4	5	1	3	7	11	6	8	9	N/A	
FIWARE Ges	TRW	Whirlpool	PIACENZA	VW	AW	Cons	AIDIMA	APR	TANET	COM+	Exploit	
Applications/Services Ecosystem and Delivery Framework Chapter												
GE1 Apps.Repository	✓		✓	✓					✓	✓		5
GE2 Apps.Marketplace			✓	✓					✓	✓		4
GE3 Apps.ApplicationMashup	✓			✓	✓	✓	✓					5
GE4 Apps.LightSemanticComposition								✓	✓	✓		3
GE5 Apps.Mediator	✓		✓		✓			✓	✓			5
GE6 Apps.Registry	✓											1
GE7 Apps.BusinessCalculator											✓	1
GE8 Apps-BusinessModeler											✓	1
Cloud Hosting Chapter												
GE9 Cloud.DCRM - IaaS Data Center Resource Management GE- RI by IBM										✓		1
GE10 Cloud.SM - IaaS Service Management (Claudia by Telefonica)										✓		1
GE11 Cloud.ObjectStorage - Object Storage RI by Intel										✓		1
GE12 Cloud.SelfServiceInterfaces - Cloud Portal RI by UPM										✓		1
GE13 Cloud.SDC										✓		1
GE14 Cloud.PaaS										✓		1
Internet of Things (IoT) Services Enablement Chapter												
GE15 IoT.Gateway.DataHandling - Esper4FastData (Orange)	✓	✓	✓		✓				✓			5
GE16 IoT.Gateway.ProtocolAdapter (Telecom Italia)									✓			1
GE17 IoT.Backend.IoTBroker (NEC)	✓	✓	✓		✓							4
GE18 IoT.Backend.ConfMan (Telefonica I+D)	✓	✓	✓		✓							4
GE19 IoT.Backend.DeviceManagement									✓			1
Data/Context Management Chapter												
GE20 Data.PubSub - CAP Context Broker by Telecom Italia				✓	✓	✓	✓					4
GE21 Data.SemanticApplicationSupport (Atos)								✓		✓		2
GE22 Data.PubSub - Orion Context Broker by TID				✓								1
GE23 Data.UDA							✓		✓	✓		3
GE24 Big Data	✓	✓										2
Security Chapter												
GE25 Security.IdentityManagement										✓		1
GE26 Optional_Security_Enablers.DBAnonymizer												0
TOTAL	8	4	6	5	6	2	3	3	8	12		26
VIRTUAL FACTORY PLATFORM												
DIGITAL FACTORY PLATFORM												
VIRTUAL FACTORY PLATFORM												

Restrictions and interpretation:

The short timeframe of FITMAN has posed some restrictions which also affect the usage of GEs. When interpreting the results of the versatility assessment this should be kept on mind. The indexes received may be considered as *minimum*, not final values for the versatility of the GEs. Having more time and resources would have allowed the usage of additional GEs. Additionally the number of GEs has further increased during FITMAN and from the schedule viewpoint it has not been possible to take over all the latest developments.

The criteria used to select the GEs for FITMAN included, not only the relevance to the manufacturing domain and meeting the trials' requirements, but also the availability of implementation and the terms and conditions.

Also, the coordination of the adoption of GEs inside FITMAN project has had effect on the utilization. To ensure the testing of diverse GEs, coordination between the smart, virtual and digital trials was performed, which has influenced the selection of GEs or which trial is using which GE. Thus, it is possible that a single GE could be used more extensively in FITMAN than what was the case.

Thus, to conclude, the scale of the adoption of FI-WARE GEs in FITMAN may give information about the *minimum versatility*, not the absolute one, based on the assessment from the *manufacturing industry* viewpoint. The technical quality of the GEs used is assessed through technical indicators.

5.4. Categorization of business indicators

The objective of this section is to define a categorization of the Business Performance Indicators (BPIs) using the classification described below:

- By criteria of performance: Quality, Time, Cost and Productivity,
- By domain of trials in FITMAN project: Smart, Digital and Virtual,
- By combination: Domain/Criteria.

Comments: We have also formulated additional comments on various elements of the classification taking into account:

- The production type (service type) to analyse if it can influence the BPIs or not.
- The management levels: strategic, tactical and operational.

BPIs' relations: The BPIs of each trial are also studied for each combined category (for example the BPIs of TRW trial in SMART-Quality) in order to identify their relations. In other words, the objective is to study how the BPIs' values can impact each other or if it is possible to aggregate these values:

- No relation (independent BPIs),
- Independent BPIs but possibility of comparison,
- Dependent values (the value can increase or decrease the other).

It should be mentioned that in case of having only one BPI for a trial in a category (example PIACENZA in SMART-Quality category), the study on the relations is not performed.

Table 5.2: BPIs in Quality Criteria for all the domains

Domain: SMART - Quality			
TRIALS	N°	Objectives & BPIs	Total
TRW	2	Objective: <i>To reduce the number of accidents and incidents in the factory.</i> SQ-BPI 2.1: <i>Ratio: Number of accidents and incidents in the factory after / before the DV/AV implementation during a period*</i>	2
		Objective: <i>To decrease the errors in the prevention (of accidents and incidents) strategy</i> SQ-BPI 2.2: <i>Ratio: Number of human errors in the design of prevention strategy planning after /before the DV/AV implementation during a period*</i>	

WHIRLPOOL	4	<p>Objective: <i>To improve the product quality</i></p> <p>SQ-BPI 4.1: <i>Ratio: Fall Of Rate (FOR)¹ after/before the DV/AV implementation during a period*</i></p> <p>SQ-BPI 4.2: <i>Ratio: Service Incidence Rate (SIR)² after / before the DV/AV implementation during a period*</i></p>	4
		<p>Objective: <i>To improve the effectiveness of equipment preventive maintenance.</i></p> <p>SQ-BPI 4.3: <i>Ratio: Number of breakdown between two planned maintenances after /before the DV/AV implementation during a period*</i></p> <p>SQ-BPI 4.4: <i>Ratio: % of defective parts to rework after /before the DV/AV implementation during a period*</i></p>	
PIACENZA	5	<p>Objective: <i>Improve the monitoring of the production capacity</i></p> <p>SQ-BPI 5.1: <i>Ratio: Percentage of forecast error in delivery after / before the DV/AV implementation during a period*</i></p>	1
Total number of BPIs for SMART - Quality			7
<p>Comments on SMART – Quality BPIs:</p> <ul style="list-style-type: none"> For TRW, the objectives are linked with Human incidents and accidents; therefore the BPIs have the same nature and are based on events at the shop floor level. The production type has no effects on the BPIs. These BPIs are defined at operational level (smart factory) for the first one and at strategic level for the second one. <p>The BPIs' relations: The BPIs can be related if “human errors” in BPI2.2 can cause “accidents and incidents in the factory” in BPI2.1.</p> <ul style="list-style-type: none"> For WHIRLPOOL, the first objective concerns quality of the product, the second effectiveness of preventive maintenance. The BPIs have the same nature and are based on events at the shop floor level. The production type has no effect on the BPIs. These BPIs are defined at operational level (smart factory). <p>The BPIs' relations:</p> <ul style="list-style-type: none"> the relation between BPIs 4.1 and 4.2: The first BPI indicates the defected products detected in the production before the delivery to customer and the second one indicates the defected products undetected in production causing calls from customer service. The sum of the value of theses BPIs indicates the overall defected products as a global indicator of product quality. the relation between BPIs 4.1, 4.2 and 4.4: a part of the defected products, mentioned in BPI 4.1 and 4.2, is related to the problems in maintenance mentioned in BPI 4.4. Therefore, improving the maintenance (the second objective) can also improve partially the product quality (the first objective). 			

¹ Fall Off Rate (FOR): represent the internal defectiveness; is the ratio between the number of defects detected along the production line and the total production volume in a specified period (shift; day; month; YTD). (See: FITMAN D4 4 FITMAN Technical - Business Indicators for Smart Factory v1.2)

² Service Incident Rate (SIR): is the percentage of how many calls received from the Customer Service on the overall production in a time period. (See: D4.6 FITMAN Technical - Business Indicators for Smart Factory v0.2)

- For Piacenza, the objective concerns the monitoring of production, the BPI doesn't have the same nature, it is based on events at the shop floor level "forecast error in delivery" different from the nature of the objective. These BPI is defined at tactical level because it is necessary to observe the process during a certain interval of time. The production type has no effects on the BPI.
- Considering the three trials, for TRW and WHIRLPOOL the objectives are connected with the improvement of the quality by suppressing the defaults in the production. The BPIs are defined by taking in account events at the shop floor. For Piacenza the objective is linked with the monitoring of "production capacity" and the BPIs have not a direct link "percentage of forecast error in delivery". In the three cases there is no link between the production type and the BPIs. The BPIs are defined at various levels of management. Besides these generic relations between the BPIs and objectives of the trials in SMART – Quality category, no further relations can be mentioned between the values of theses BPIs. In fact, these values are dependent of the nature of each trial.

Domain: DIGITAL - Quality

TRIALS	N°	BPIs	Total
VOLKSWAGEN	1	<i>Objective: To improve the Evaluation accuracy</i> <i>DQ-BP 1.1: Ratio: Evaluation accuracy rate³ after / before the DV/AV implementation during a period</i>	1
Total number of BPIs for DIGITAL - Quality			1

Comments on DIGITAL – Quality BPIs:

For VOLKSWAGEN, the objective is to improve the quality of technology implementation process. The BPI has the same nature because it is related to the quality of an evaluation task defining the cost of implementation. Such evaluation makes the BPI to be at tactical level because it is necessary to observe the process during a certain interval of time. It is also observed that the trial is related to a product and the production type does not affect the proposed BPI.

Domain: VIRTUAL -Quality

TRIALS	N°	BPIs	Total
COMPLUS	9	<i>Objective: Improve the performance of document sharing using a platform.</i> <i>VQ-BPI 9.1: Ratio: Number of mistakes and errors⁴ after / before the DV/AV implementation during a period*</i>	1
APR	6	<i>Objective: Decrease the number of product received back due to fault.</i> <i>VQ-BPI 6.1: Ratio: Number of products received back due to faults after / before the DV/AV implementation during a</i>	1

³ Accuracy of the implementation cost (Evaluated implementation cost / real implementation cost) (See: FITMAN D5 4 FITMAN Technical - Business Indicators for Digital Factory V16 Uninova-13.04.2014)

⁴ Mistakes due to versioning and non-consistent documents. (See: FITMAN D5 4 FITMAN Technical - Business Indicators for Digital Factory V16 Uninova-13.04.2014)

	<i>period*</i>	
Total number of BPIs for VIRTUAL – Quality		2
Comments on VIRTUAL – Quality : <ul style="list-style-type: none"> ▪ For COMPLUS, the objective is to provide a platform to improve the quality of document sharing. The nature of proposed BPI is consistent with this objective because it has the same nature. The BPI is related to operational level because the collect of information is at short term. . The production type does not affect the proposed BPI. ▪ For APR, the objective concerns the quality of the delivered products. The BPI has the same nature and is based on the retuned products due to faults. The BPI is at the tactical level because it is necessary to wait the output of the products and the receipt back. The production type has no effect on the definition of this BPI. ▪ Considering both trials, COMPLUS and APR are respectively concerned with the quality of process of document sharing at tactical level and the quality of product at operational level. In both cases, the BPI is directly linked to the objective and the production type does not affect the BPI. Besides these generic relations between the BPIs and objectives of the trials in VIRTUAL – Quality category, no further relations can be mentioned between the value of theses BPIs. In fact, these values are dependent to the nature of each trial. 		

Comments on Quality BPIs for all the domains:

Considering all the trials related to the Quality criterion, the objectives are mainly connected with the improvement of the quality of processes/products. The BPIs have mostly the same nature. In all cases there are no links between the production type and the BPIs. The BPIs are defined at tactical or operational levels of management.

Table 5.3: BPIs in Time Criteria for all the domains

SMART - Time			
TRIALS	N°	BPIs	Total
AGUSTAWESTLAND	3	<p>Objective: To improve the monitoring and management of tools tracking in Final Assembly Line (FAL) and service center.</p> <p>ST-BPI 3.1: Ratio: Average time spent to track the tools management during working operation after/before the DV/AV implementation during a period*</p>	1
PIACENZA	5	<p>Objective: To reduce the production time from order to delivery.</p> <p>ST-BPI 5.1: Ratio: Average production lead time per meter (of fabric) produced from order to delivery after / before the DV/AV implementation during a period*.</p>	1
Total number of BPIs for SMART –Time			2
Comments on SMART - Time : <ul style="list-style-type: none"> For AGUSTAWESTLAND, the objective is to improve the tools tracking in the shop floor. The nature of proposed BPI is consistent with only one aspect of such improvement, the time aspect. The BPI is related to the operational level (smart factory). The production type does not affect the proposed BPI. For PIACENZA, the objective is to reduce the production lead time. The nature of the proposed BPI is completely linked with this objective. The BPI is related to the tactical level because the life cycle of the product is taken in consideration. In fact, the times of the processes at this level (manufacturing and delivery) affect the BPI. The production type (textile) is present in the definition of BPI because the BPI is defined based on produced meter of fabric. Considering both trials, they are concerned with the time aspect of processes performance at the operational and tactical level. In both cases, the BPIs are linked to the objective. For the first trial, contrary to the second one, the production type does not affect the BPI. Besides these generic relations between the BPIs and objectives of the trials in SMART-Time category, no further relations can be mentioned between the values of these BPIs. In fact, these values are dependent to the nature of each trial. 			
DIGITAL - Time			
TRIALS	N°	BPIs	Total
VOLKSWAGEN	1	<p>Objective: To reduce the time for the updating of a production module within MR (Machinery Repository)</p> <p>DT-BPI 1.1: Ratio: Updating a production module time after / before the DV/AV implementation during a period*</p>	3
		<p>Objective: Reduction of time needed for the assessment of product related inquiries</p> <p>DT-BPI 1.2: Ratio: Time needed for the assessment of product related inquiries after / before the DV/AV implementation during a period*</p>	
		<p>Objective: To reduce the lead time to accede to experts knowledge about production equipment</p> <p>DT-BPI 1.3: Ratio: Average lead time to access experts knowledge about production equipment after / before the</p>	

		<i>DV/AV implementation during a period*</i>	
CONSULGAL	7	<p>Objective: To reduce the time to access to information on concreting zone: concrete class and composition.</p> <p>DT-BPI 7.1: Ratio: Average lead time to access the information relating to concrete characteristics and concreting plan after/before the DV/AV implementation during the concrete control process.</p>	4
		<p>Objective: To reduce the time to perform, record and analyze the test result.</p> <p>DT-BPI 7.2: Ratio: Average lead time needed to perform and record the test results after/before the DV/AV implementation during one concrete operation.</p> <p>DT-BPI 7.3: Ratio: Average lead time needed to analyze the test results after/before the DV/AV implementation during one concrete operation.</p>	
		<p>Objective: To reduce the time for exchange of information between stakeholders.</p> <p>DT-BPI 7.4: Ratio: Time for data exchange between stakeholders after/before the DV/AV implementation during the concrete control process.</p>	
AIDIMA	11	<p>Objective: To reduce the searching time process per source to identify and classify the weak signals⁵</p> <p>DT-BPI 11.1: Ratio: Search time process per source after/before the DV/AV implementation during a period*</p>	4
		<p>Objective: To reduce the trends⁶ report delivery time since initial weak signals detection until trends report publication.</p> <p>DT-BPI 11.2: Ratio: Time to market for publishing the Home Trends Report⁷ after/before the DV/AV implementation during a period*</p>	
		<p>Objective: To reduce the complaints resolution time process</p> <p>DT-BPI 11.3: Ratio: Complaints resolution time process after/before the DV/AV implementation during a period*</p>	
		<p>Objective: To reduce the time for the design process in the technical office</p> <p>DT-BPI 11.4: Ratio: Average lead time for the design process after/before the DV/AV implementation during a period*</p>	
AGUSTAWEST LAND	3	<p>Objective: To improve the documentation management by making the search of data easier and faster</p> <p>DT-BPI 3.1: Ratio: Average time to make data available in a</p>	1

⁵ AIDIMA's analysts perform a thorough analysis of industry market variables in order to determine trend signals that are related to the current furniture movements. (See : FITMAN D3 2_FITMAN Trials Business Cases_Final)

⁶ Trend: specific term used for indicating the market tendency.

⁷ Trend signals are related to the current furniture movement. Home trend reports are the reports on trends in market resulting from AIDIMA's analysts working on analysis of industry market variables. (See FITMAN TRIAL HANDBOOK CHAPTER 5 24.09.2013)

		<i>digital format to different business units after/before the DV/AV implementation during a period*</i>	
Total number of BPIs for DIGITAL – Lead Time			12
Comments on DIGITAL – Time:			
<ul style="list-style-type: none">For VOLKSWAGEN, the objectives are to improve the access/update time of product-related information using IT technologies in production chain. This information is about machinery, production equipment and product inquiries. The nature of each proposed BPI is consistent with its corresponding objective but the second BPI does not completely cover the “<i>assessment time of product related inquiries</i>”. It covers only the “<i>Inquiry respond time</i>”. The BPIs are related to the tactical level because it takes a certain time to collect the information and to react. The production type does not affect the BPIs. <p>The BPIs’ relations: The values of all the BPIs are calculated separately for chronological activities which are independent from each other. The sum of these values can be an indicator of the overall time of treating the product related information.</p> <ul style="list-style-type: none">For CONSULGAL, the objectives are to reduce the time of accessing, collecting, recording, analyzing and exchanging the product-related information. The nature of the proposed BPIs is consistent with the objectives. The BPIs are mainly related to the operational level because of the direct link of the targeted processes in trial with the production. It is only the fourth BPI that can be also linked to tactical and strategic levels based on the type of stakeholder exchanging information. The production type does affect all the BPIs. Although, the traces of product (concrete) are found in the BPIs’ definitions, it can be replaced by another type of product. <p>The BPIs’ relation: The processes related to the BPIs 7.1 to 7.3 are interconnected in a chronological way but the BPIs’ values are calculated independently. The sum of these values indicates the overall time of test process. The last BPI, (7.4) is completely independent from the others.</p> <ul style="list-style-type: none">For AIDIMA, the objectives are to reduce the time of different types of processes: searching and assessment of market trends (called “<i>weak signals</i>”), assessment of complaints and design. The nature of the proposed BPIs is consistent with the objectives. The BPIs 11.1 to 11.3 are related to the tactical level because of the supportive role on the targeted processes (market trend analysis and complaints resolution) but the BPI 11.4, addressing the design process, is linked to the operational level. The BPIs can be valid for any production type. <p>The BPIs’ relation: The values of all the BPIs are calculated separately for chronological activities which are independent of each other. The sum of these values can indicate the overall time of the design process from market analysis to achieving a new designed product.</p> <ul style="list-style-type: none">For AGUSTAWESTLAND, the objective is to reduce <i>the data search time and to make it easier</i>. The nature of the proposed BPI is consistent partially with this objective (only the time aspect is mentioned in the BPI). The BPI is related to the tactical and operation levels depending on the type of searched data. The nature of the production doesn’t affect the BPI.Considering the four trials, the objectives are focused on the improvement of the targeted processes by reducing their time. The BPIs are defined also by taking in account the time aspect. In all the cases there is no link with the production type. The BPIs are defined at various levels of management. Besides these generic			

relations between the BPIs and objectives of the trials in DIGITAL – Time category, no further relations can be mentioned between the values of these BPIs. In fact, these values are dependent to the nature of each trial.			
VIRTUAL –Time			
TRIALS	N°	BPIs	Total
COMPLUS	9	Objective: To improve the service that allows a transparent and visual Network ⁸ Configuration VT-BPI 9.1: Ratio: Average lead time for configuration and data entry of LED Network after / before the DV/AV implementation during a period*	2
		Objective: To improve the service that allows more efficient supplier search. VT-BPI 9.2: Ratio: Average lead time for searching a supplier in the LED Network after / before the DV/AV implementation during a period*	
APR	6	Objective: To decrease the lead time to answer to the quote VT-BPI 6.1: Ratio: Lead time for responding of quotes (current/new product) after / before the DV/AV implementation during a period*	5
		Objective: Optimize the lead time for analysis and control of customer recovery ⁹	
		VT-BPI 6.2: Ratio: Lead time for analysis and control of customer recovery after / before the DV/AV implementation during a period*	
		Objective: Reduce customer recovery lead time	
		VT-BPI 6.3: Ratio: Average customer recovery lead time after / before the DV/AV implementation during a period*	
		Objective: Reduce the lead time of the acknowledgement of receipt	
		VT-BPI 6.4: Ratio: Average lead time to confirm the acknowledgement of receipt (with/ without quote) after / before the DV/AV implementation during a period*	
		Objective: Increase the lead time devoted to analysis and control of orders VT-BPI 6.5: Ratio: Lead time for analysis and control of orders after / before the DV/AV implementation during a period*	

⁸ LED development network

⁹ The sales manager can perceive the list of ongoing customer quotes (not-yet validated by them) and they can decide if it's suitable to generate a reminder for the concerned quotes in order to recover the customer. (see: FITMAN TRIAL HANDBOOK CHAPTER 5 24.09.2013)

TANET	8	<p>Objective: To decrease the time taken to enter a new tender^(x) into the system</p> <p>VT-BPI 8.1: Ratio: New tender input time after / before the DV/AV implementation during a period*</p>	1
Total number of BPIs for VIRTUAL - Lead Time			8
<p>Comments on VIRTUAL - Time :</p> <ul style="list-style-type: none"> For COMPLUS, the first objective concerns the time the LED network configuration and the data entry. The second one focuses on the search of the suppliers inside this network. The BPIs are related and are directly linked to the objectives. They are also defined at tactical level. The production type does not affect the BPIs. <p>The BPIs' relation: Here, the objectives are related to the performance of the service configuring the LED Network. In fact, the shorter lead time to configure such network (BPI 9.1) is, the shorter lead time required for searching a supplier in the network (BPI 9.2) could be.</p> <ul style="list-style-type: none"> For APR, all the objectives focus on the time reduction of tasks devoted to the services of the customers: the first objective concerns the reduction of the time to send the quote, the second and the third concern the reduction of the time of customer recovery (with a previous quote). The fourth and the fifth are devoted to reducing the processing of the customers' orders. The BPIs completely respect the nature of objectives and they are defined at tactical level (customer service). The production type does not affect the BPIs. <p>The BPIs' relation: The values of all the BPIs are calculated separately for chronological activities which are independent from each other. But the sum of these values indicates the overall time of interaction with customers.</p> <ul style="list-style-type: none"> For TANET, the objective concerns the introduction of a new business opportunity (tender) in the system. The BPI has the same nature. This BPI is defined at tactical level (business opportunity treatment). The production type does not affect the BPI. Considering the three trials, the objectives are connected with the reduction of time to improve the service rate concerning the customers, the suppliers and the business opportunity management. For all cases, there is no link between the BPIs and the production type. Besides these generic relations between the BPIs and objectives of the trials in VIRTUAL-Time category, no further relations can be mentioned between the values of these BPIs. In fact, these values are dependent to the nature of each trial. 			

Comments on Time BPIs for all the domains:

Considering all the trials related to the Time criterion, the objectives are mainly focused on reducing the time of processes in design, production, delivery, customer service and data processing (search, access, exchange...). The BPIs have mostly the same nature as the objectives. For these trials, BPIs are independent of the production type. The BPIs are defined at two levels of management, tactical and operational levels.

Table 5,4: BPIs in Cost Criteria for all the domains

SMART - Cost			
TRIALS	N°	BPIs	Total
WHIRPOOL	4	<i>Objective: To reduce the production cost</i>	2
		<i>SC-BPI 4.1: Ratio: Production cost per unit after /before the DV/AV implementation during a period*</i>	
		<i>Objective: To reduce the Total Cost of Quality</i>	
		<i>SC-BPI 4.2: Ratio: Total cost of products scrapped after /before the DV/AV implementation during a period*</i>	
PIACENZA	5	<i>Objective: To reduce the fixed costs per machinery</i>	2
		<i>SC-BPI 5.1: Ratio: Machine fixed costs per produced unit after / before the DV/AV implementation during a period*Smart</i>	
		<i>Objective: To reduce the quantity of energy for supporting systems for production</i>	
		<i>SC-BPI 5.2: Ratio: The quantity of energy spent per meter produced after / before the DV/AV implementation during a period*Smart</i>	
Total number of BPIs for SMART - Cost			4
Comments on SMART - Cost:			
<ul style="list-style-type: none">For WHIRLPOOL, the objectives concern respectively the production cost and the Total Cost of Quality (TCQ). The BPIs have the same nature. Meanwhile, these costs can include parameters defined at the tactical or strategic levels, based on the nature of trial, such as workers' salary. The production type has no effect on the BPIs. <p>The BPIs' relation: The first (BPI 4.1) concerns the manufacturing cost indicating only the transformation of raw materials into final products. The second (BPI 4.2) focuses on the cost of quality. The sum of the value of these BPIs can be included in the final production cost per unit.</p> <ul style="list-style-type: none">For PIACENZA, the first objective concerns respectively the fixed cost per machinery and the quantity of energy spent in the production. The first BPI has the same nature of its corresponding objective but in the second BPI, the “quantity of energy spent” is represented by the cost of energy. The production type has no effect on the BPIs. <p>The BPIs' relation: The two BPIs (BPI 5.1 and BPI 5.2) are connected. On one hand, the BPI5.2 concerns the cost of energy in production system and since the machines, mentioned in BPI 5.1, are parts of this system, theses BPIs are connected. On the other hand, the BPI 5.1 concerns the fixed cost of machinery and since it includes the cost of energy, mentioned by BPI 5.2, these BPIs are related. Therefore, these BPIs share a common parameter which is “the cost of energy for machinery”.</p> <ul style="list-style-type: none">Considering the two trials, the objectives are focused on the reduction of production costs. For PIACENZA the second objective focuses on the energy consumption represented as a cost factor. The BPIs are defined at various levels of management. In fact, the final values of costs can be calculated at the operational level (example: cost of products scrapped) but some of the parameters can be defined at the tactical (example: salaries). In both cases there are no links between the production type and the BPIs. Besides these generic relations between the BPIs and objectives of the trials in SMART-Cost category, no further relations can be mentioned between the values of theses BPIs. In fact, these values are dependent to			

the nature of each trial.			
DIGITAL - Cost			
TRIALS	N°	BPIs	Total
VOLKSWAGEN	1	Objective: Reduction of costs spent on the management of the Machinery Repository (MR) DC-BPI 1.1: Ratio: MR cost for a period of time after / before the DV/AV implementation during a period*	2
		Objective: Reduction of costs spent on the assessment of product related inquiries DC-BPI 1.2: Ratio: Cost for the assessment of product related inquiry for a period of time t after / before the DV/AV implementation during a period*	
CONSULGAL	7	Objective: To reduce the cost to perform, record and analyze the test result DC-BPI 7.1: Ratio: Average cost needed to perform, record the test result after/before the DV/AV implementation during a concrete operation. DC-BPI 7.2: Ratio: Average cost needed to analyze the test results after/before the DV/AV implementation during one concrete operation.	2
Total number of BPIs for DIGITAL - Cost			4
Comments on DIGITAL - Cost: <ul style="list-style-type: none"> For VOLKSWAGEN, the objective is to reduce the cost of managing the product-related information using IT technologies in production chain. This information is about Machinery Repository (MR) and product inquiries. The nature of each proposed BPI is consistent with its corresponding objective but the BPIs do not completely cover the cost mentioned in the objective: the “update cost” instead of “management cost” in the first BPI and the “respond cost” instead of “assessment cost” in the second BPI. The BPI is related to the tactical level because of the supportive role of the targeted processes (management of the Machinery Repository and assessment of product related inquiries). The production type does not affect the BPIs. The BPIs’ relations: The second BPI is connected with the first insofar as the assessment of product related inquiry depends on the management of the Machinery Repository (MR). But, the value of each BPI has no effect on each other. For CONSULGAL, the objective is related to reducing the cost of test activities (cost of performing, recording and analyzing). The proposed BPIs are consistent with this objective. The BPIs are mainly related to the operational level because of the direct link of the targeted processes in trial with the production. The production type has no effect on the BPIs. The BPIs’ relations: The two BPIs are connected to one objective concerning the test activities. They are complementary to assess the total cost of test activities. But, the value of each BPI does no effect the each other. Considering both trials, the objectives are connected with the reduction of the cost of targeted processes in each trial. Based on the role of these processes in production, the BPIs of VOLKSWAGEN and CONSULGAL are respectively defined at tactical levels of management. In both cases, the nature of the production does not affect the BPIs. Besides these generic relations between the BPIs and objectives of the trials in DIGITAL-Cost 			

category, no further relations can be mentioned between the values of these BPIs. In fact, these values are dependent to the nature of each trial.

VIRTUAL - Cost			
TRIALS	N°	BPIs	Total
APR	6	<i>Objective: Control the quote cost</i>	4
		<i>VC-BPI 6.1: Ratio: Number of unsuccessful quotes due to high price / Total number of quotes processed after / before the DV/AV implementation during a period*</i>	
		<i>Objective: Decrease of the internal stock out</i>	
		<i>VC-BPI 6.2: Ratio: Internal stock out rate during a period of time after / before the DV/AV implementation during a period*</i>	
		<i>Objective: Decrease of the external stock out</i>	
		<i>VC-BPI 6.3: Ratio: External stock out rate during a period after / before the DV/AV implementation during a period*</i>	
		<i>Objective: Increase the parts of orders¹⁰ realized within a negotiated market</i>	
		<i>VC-BPI 6.4: Ratio: Value of stock at the end of last period after / before the DV/AV implementation during a period*</i>	
Total number of BPIs for VIRTUAL - Cost			4

Comments on VIRTUAL - Cost:

For APR, the first objective concerns the cost of unsuccessful quotes and the BPI has the same nature. This BPI is defined on tactical level because it is necessary to search and analyze the cause of the quote failure. The other three objectives are focused on the costs related to stocks (cost of inventory management and cost of stock itself). The BPIs have the same nature and based on events at the shop floor at operational level. The production type has no effect on the BPIs.

The BPIs' relations:

- The BPI 6.2 and 6.3 are related since the sum of their values indicate the total cost of stock out.
- The BPI 6.1 concerns the unsuccessful quotes due to high price. This BPI which is concerned with the customer can be affected by the other BPIs (6.2 to 6.4) which are related to the suppliers. In fact if the procurement order consultation (related to the suppliers) affects the prices proposed to the customers, the BPIs 6.2 to 6.4 can be related to BPI 6.1. For example, the increase in the stock out rate might increase the prices.

Comments on Cost BPIs for all the domains:

Considering all the trials related to the Cost criterion, the objectives are mainly focused on reducing the cost of processes related to production, customer service and data processing. The BPIs have mostly the same nature as the objectives. In all of the trials, the BPIs are independent of the production type. The BPIs are defined at tactical levels of management.

¹⁰ in procurement order consultation

Table 5.5: BPIs in Productivity Criteria for all the domains

SMART - Productivity			
TRIALS	N°	BPIs	Total
TRW	2	<i>Objective: To increase the standards and regulations in the repository</i> <i>SP-BPI 2.1: Ratio: Number of standards and regulations added in the repository after/before the DV/AV implementation during a period*</i>	6
		<i>Objective: To increase the modeled risks¹¹</i> <i>SP-BPI 2.2: Ratio: Number of modeled risks that has been defined after/before the DV/AV implementation during a period*</i>	
		<i>Objective: To increase the modeled preventive actions¹²</i> <i>SP-BPI 2.3: Ratio: Number of modeled preventive actions using the new system after /before the DV/AV implementation during a period*</i>	
		<i>Objective: To increase the number of safety systems</i> <i>SP-BPI 2.4: Ratio: Number of deployed H&S (Heath & Safety) monitoring system after / before the DV/AV implementation during a period*</i>	
		<i>Objective: To increase the number of risk detections, alarms and warnings</i> <i>SP-BPI 2.5: Ratio: Number of risk detectors, alarms and warnings set up after / before the DV/AV implementation during a period*</i>	
		<i>Objective: To increase the number of training sessions regarding safety</i> <i>SP-BPI 2.6: Ratio: Number of training sessions regarding H&S after/before the DV/AV implementation during a period*</i>	
		<i>Objective: To increase the productivity</i> <i>SP-BPI 4.1: Ratio: Overall Equipment Efficiency (OEE)¹³ after / before the DV/AV implementation during a period*</i>	
		<i>Objective: To improve the monitoring and management of tools tracking linked to training purpose in FAL (Final Assembly Line) and Service Centre</i> <i>SP-BPI 3.1: Ratio: Number of tailored training materials linked to the results of tracking tools after/before the DV/AV implementation during a period*</i>	
WHIRLPOOL	4	<i>Objective: To increase the productivity</i> <i>SP-BPI 4.1: Ratio: Overall Equipment Efficiency (OEE)¹³ after / before the DV/AV implementation during a period*</i>	1
AGUSTAWEST LAND	3	<i>Objective: To improve the monitoring and management of tools tracking linked to training purpose in FAL (Final Assembly Line) and Service Centre</i> <i>SP-BPI 3.1: Ratio: Number of tailored training materials linked to the results of tracking tools after/before the DV/AV implementation during a period*</i>	1
PIACENZA	5	<i>Objective: Improve the monitoring of the production capacity</i>	1

¹¹ Ergonomic and collision risks or hazards for workers. TRW defines a hazard based on a mathematical formula, having up to five levels of dangerousness.

¹² TRW describes an action plan aiming to eliminate or minimize the consequences of the risk while associating them with specific level of risk

¹³ Overall Equipment Effectiveness (OEE): is the total amount of time used to produce good product versus the total available time. (See: FITMAN D4 4 FITMAN Technical - Business Indicators for Smart Factory v1.2 and D4.6 FITMAN Technical - Business Indicators for Smart Factory v0.2)

		<i>SP-BPI 5.1: Ratio: number of production records including machine identification after / before the DV/AV implementation during a period*</i>	
Total number of BPIs for SMART - Productivity			9
Comments on SMART - Productivity:			
<ul style="list-style-type: none"> ▪ For TRW, the objectives are mainly linked with increasing the efforts in production related to standards, risk and safety (Human incidents and accidents at the shop floor). The BPIs have the same nature and are based on events at the shop floor level. Two BPIs (BPI 2.4 and BPI 2.5) are defined at operational level and the others are related to tactical or strategic levels (depending on the decisions made at these levels). The production type has no effect on the BPIs. <p>The BPIs' relations:</p> <ul style="list-style-type: none"> ○ BPI 2.1, BPIs 2.2 and 2.3: The increase in number of standard and regulations (related to BPI 2.1) might also increase the value of BPIs 2.2 and 2.3 by providing formalized information on potential risks. In fact, based on the new standards, identification of modeled risks and preventive actions might be easier. ○ BPI 2.4, BPI 2.5: New H&S monitoring systems might also involve new risk detectors, alarms and warnings setups and vice versa. Therefore, the value of each indicator might be impacted by the other. B ○ BPI 2.3, 2.4 and 2. : These BPIs can share some parameters. For example, a H&S monitoring system (related to BPI2.4) or as a risk detector set up (related to BPI2.5) can a be considered as a preventive action (related to BPI2.3). ○ BPI 2.6 and other BPIs: the number of required training sections might be increased by increasing the value of other BPIs. For example, new regulations new modeled risks and preventive actions or new H&S (Heath & Safety) monitoring system and risk detector set ups might demand training sessions. <ul style="list-style-type: none"> ▪ For WHIRLPOOL, the objective concerns the productivity and the BPI has the same nature based on the events at the shop floor level. In fact, the BPIs is focused on equipments at operational level. The production type has no effect on the BPI. ▪ For AGUSTAWESTLAND, the objective focuses on the trainings for monitoring and management of tools tracking. The BPI has the same nature and is defined at the shop floor level (operational level). The production type has no effect on the BPI. ▪ For PIACENZA, the objective concerns the monitoring of the production capacity. The BPI has the same nature but it is represented in a larger context. In fact, rather the overall productivity, the BPI includes the productivity of each machine. The kind of production has no effect on the BPI. This BPI is defined at operational level (smart factory). ▪ Considering the four trials, for TRW and AGUSTAWESTLAND the objectives are connected indirectly to the improvement of productivity. In fact, this improvement is through the efforts related to Human health and safety and trainings in the shop floor. For WHIRLPOOL and PIACENZA, the objectives are directly connected with the increase of the productivity. For TRW, the BPIs are defined at several levels of management but for the other trials the BPIs are defined at operational level. All the BPIs are independent of the production type. Besides these generic relations between the BPIs and objectives of the trials in SMART-Productivity category, no further relations can be mentioned between the values of theses BPIs. In fact, these values are dependent to the nature of each trial. 			

DIGITAL - Productivity			
TRIALS	N°	BPIs	Total
CONSULGAL	7	<p>Objective: Reduction in the use of paper</p> <p>DP-BPI 7.1: Ratio: Average number of pages used in the test results recording, archival, after/before the DV/AV implementation during one concrete operation.</p>	1
AIDIMA	11	<p>Objective: To increase the number of electronic sources analyzed by trends experts due to FITMAN automated</p> <p>DP-BPI 11.1: Ratio: Number of electronic sources analyzed by trends experts after/before the DV/AV implementation during a period*</p> <p>Objective: To increase the number of weak signals identified due to FITMAN</p> <p>DP-BPI 11.2: Ratio: Number of weak signals identified after/before the DV/AV implementation during a period*</p> <p>Objective: To increase the number of index cards due to FITMAN automated solutions</p> <p>DP-BPI 11.3: Ratio: Number of index cards created after/before the DV/AV implementation during a period*</p> <p>Objective: To increase the number of private R&D projects worked out in collaboration with Home Trends Observatory analysts</p> <p>DP-BPI 11.4: Ratio: Number of R&D projects based on Home Trends Report after/before the DV/AV implementation during a period*</p> <p>Objective: To increase the number of private projects for new Product Development worked out in collaboration with Home Trends Observatory analysts</p> <p>DP-BPI 11.5: Ratio: Number of new products based on trends after/before the DV/AV implementation during a period*</p> <p>Objective: To increase the number of companies those purchase either electronic or physical Home Trends Report.</p> <p>DP-BPI 11.6: Ratio: Number of companies purchasing biannual Home Trends Report after/before the DV/AV implementation during a period*</p> <p>Objective: To increase the number of private firms and industry professionals attending home trends reports seminars.</p> <p>DP-BPI 11.7: Ratio: Number of companies professionals attending home trends reports seminars after/before the DV/AV implementation during a period*</p> <p>Objective: To increase the number of external home trends</p>	16

		<p>research departments using FITMAN solutions for trends forecasting. (External means not member of AIDIMA organization chart).</p> <p>DP-BPI 11.8: Ratio: Number of trends research institutes using FITMAN solutions after/before the DV/AV implementation during a period*</p> <p>Objective: To increase the number of companies using FITMAN opinion mining solutions</p> <p>DP-BPI 11.9: Ratio: Number of companies using FITMAN opinion mining solutions after/before the DV/AV implementation during a period*</p> <p>Objective: To increase the number of identified electronic customer opinions about the firm or its products, services and brands</p> <p>DP-BPI 11.10: Ratio: Number of identified electronic customer opinions after/before the DV/AV implementation during a period*</p> <p>Objective: To improve the identification of online fake opinions about the firm or its products, services and brands.</p> <p>DP-BPI 11.11: Ratio: Number of online fake opinions identified after/before the DV/AV implementation during a period*</p> <p>Objective: To increase the cases of non-reported customer online dissatisfaction related to product and/or service.</p> <p>DP-BPI 11.12: Ratio: Number of reported complaint response after/before the DV/AV implementation during a period*</p> <p>Objective: To increase the brand presence in positive Social Network comments</p> <p>DP-BPI 11.13: Ratio: Number of positive online WOM (Word-Of-Mouth) after/before the DV/AV implementation during a period*</p> <p>Objective: To improve the identification of opinion leaders amongst customers (i.e. bloggers, etc.).</p> <p>DP-BPI 11.14: Ratio: Number of opinion leaders identified after/before the DV/AV implementation during a period*</p> <p>Objective: To increase the number of design sketches per piece of furniture</p> <p>DP-BPI 11.15: Ratio: number of design sketches per piece of furniture after/before the DV/AV implementation during a period*</p> <p>Objective: To increase the number of players taking part in the piece of furniture design</p> <p>DP-BPI 11.16: Ratio: number of players taking part in the piece of furniture design after/before the DV/AV implementation during a period*</p>	
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AGUSTAWEST LAND	3	<p>Objective: To improve the documentation management making the search of data easier and faster.</p> <p>DP-BPI 3.1: Ratio: Number of people/departments to contact in order to have the information actually not digitalized or available on different sources after/before the DV/AV implementation during a period*</p> <p>DP-BPI 3.2: Ratio: Number of technical interfaces (including files, browser, paper documents,) to contact to have access to all the needed information after/before the DV/AV implementation during a period*</p>	2
Total number of BPIs for DIGITAL - productivity			19
<p>Comments on DIGITAL - Productivity:</p> <ul style="list-style-type: none"> For CONSULGAL, the objective is to improve the productivity by reducing the use of papers in the test record due to the increase of the test activities. In fact, CONSULGAL is interested in using the common web platform for all the stakeholders to store and retrieve information and documents. The BPI has the same nature and is based on the events at the shop floor (tests on the product) at operational level. The production type has no effects on the BPIs. For AIDIMA, the objectives are focused on the product development. They can be divided in three groups. The objectives 1 to 8 are connected to the trend signals that are related to the current furniture movements in the market, the objectives 9 to 14 are related to the users' opinions and the objectives 15 and 16 are linked to the customer requirement leading to the development of new concepts for a product. The BPIs respect the nature of their corresponding objectives and are defined at the tactical level (customer and market related processes). Although, in some BPIs the term "furniture" is used, it can be replaced by any other type of product. Therefore, the production type has no effect on the BPIs. <p>The BPIs' relations:</p> <ul style="list-style-type: none"> The BPIs 11.1 to 11.3 are connected in a chronological way concentrating on the assessment of the weak signals (market trends). Their values are calculated independently but these values altogether can indicate the performance of trends assessment. The BPI 11.10 includes the customer opinions: <i>fake opinions</i> (related to BPI 11.11), <i>complaints</i> (related to BPI 11.12), <i>positive WOM (Word-Of-Mouth)</i> (related to BPI 11.13) or leaders opinions (related to BPI 11.14). The BPIs 11.15 et 11.16 concern the design of furniture but their values are not connected. <ul style="list-style-type: none"> For AGUSTAWESTLAND, the objective is related to improve the documentation management (to make the search of data easier and faster) in order to increase the productivity. The BPIs have the same nature. They BPIs are defined at the tactical level (management of documentation process). The production type has no effects on the BPIs. <p>The BPIs' relations: The two BPIs are connected to one objective concerning the improvement of the documentation management. They are complementary to make the search of data easier and faster but the value of each BPI is independent of the other.</p> <ul style="list-style-type: none"> Considering the three trials, for CONSULGAL, the objective is connected with the improvement of the productivity in the test activity (record of the results) by using the common web platform instead of a paper-based process. For AIDIMA, the whole objectives 			

and BPIs are related to product development and they are concentrated on the trend signals, the users' opinions and the customer requirement. For AGUSTAWESTLAND, the objective is connected to the documentation management with aim to increase the rhythm of the activities. In the three cases there are no links between the production type and the BPIs and they are all defined at tactical level of management. Besides these generic relations between the BPIs and objectives of the trials in DIGITAL-Productivity category, no further relations can be mentioned between the values of these BPIs. In fact, these values are dependent to the nature of each trial.

VIRTUAL - Productivity

TRIALS	Nº	BPIs	Total
COMPLUS	9	Objective: Improve the performance of sharing best practices in reference processes and IT using a platform	2
		VP-BPI 9.1: Ratio: Number of standardized IT landscape / Number of total IT landscape, after / before the DV/AV implementation during a period*	
		Objective: To improve the service that allows a transparent and visual Network ¹⁴ Configuration	
		VP-BPI 9.2: Ratio: Level of transparency of the Network according to the trial requirements after / before the DV/AV implementation during a period*	
APR	6	Objective: Optimize the production time	1
		VP-BPI 6.1: Ratio: Customer service rate after / before the DV/AV implementation during a period*	
TANET	8	Objective: To increase the number of business opportunities	3
		VP-BPI 8.1: Ratio: Number of Tenders ¹⁵ accrued monthly after / before the DV/AV implementation during a period*	
		Objective: To reduce the time to integrate the new business opportunity sources	
		VP-BPI 8.2: Ratio: Number of Active Facilitators after / before the DV/AV implementation during a period*	
		Objective: To increase the number of services offered for tender matching on the platform	
		VP-BPI 8.3: Ratio: Number of Registered service providers after / before the DV/AV implementation during a period*	
Total number of BPIs for VIRTUAL - Productivity			6

Comments on VIRTUAL - Productivity:

- For COMPLUS, the objectives are linked with improvement of productivity through a platform for sharing information and improving the LED development Network. The BPIs have the same nature as their corresponding objectives and are based on the efforts resulting in new standardized IT landscapes and more transparent network. These BPIs can be defined at tactical level because of the supportive role of IT landscapes and LED network for production (operational level). The production type has no effect on the first BPI but in the

¹⁴ LED development network

¹⁵ Term used in trial indicating the business opportunity

second the production should be based on a collaborative product development network.

The BPIs' relations: The increase in the number of standardized IT landscape (related to BPI9.1) might increase also the transparency of LED Network (related to BPI.2).

- For APR, although the objective is linked to the production time, the finality is to optimize this time not necessarily to reduce it. This optimization can be done by increasing the productivity, particularly the rate of Customer service, as it is mentioned in the corresponding BPI. The BPI is related to the customer service which is at operational level. The production type has no effect on the BPI.
- For TANET, although the objectives are related to improving the productivity by focusing on business opportunities. The BPIs have the same nature as their objectives and they are related to the processes situated at tactical level. Some traces of production type or the trial are observed in the BPIs. In fact, the business opportunity analysis, Active *Facilitators* and service providers are the elements specific to the trial (as a member of a SMEcluster).

The BPIs' relations: The values of BPIs are not affected by each other but these values altogether can indicate the level of realizing a higher objective which is to increase the business opportunities.

- Considering the three trials, the objectives are focused on the improvements in productivity. In fact, this improvement is through the efforts related to improving Information Sharing, Product development Network, Customer service and Business opportunities. For COMPLUS and TANET, the BPIs are define at tactical level of management and for APR, at operational level. Only for APR, some links between the BPIs and production type are observed. Besides these generic relations between the BPIs and objectives of the trials in VIRTUAL-Productivity category, no further relations can be mentioned between the values of theses BPIs. In fact, these values are dependent to the nature of each trial.

Comments on Productivity BPIs for all the domains

Considering all the trials related to the productivity criterion, the objectives are mainly focused on increasing the latter by improving the production, customer service and data processing. The BPIs have mostly the same nature as their objectives. The BPIs are defined at operational and tactical levels of management. Only for TANET, there is a link between the production type and the BPIs but in other trials, the BPIs are independent of the production type.

Generic comments:

We have performed a detailed analysis to try to find links between the BPIs. These links could exist in few cases but it is impossible to formalize the relations between BPIs due to their nature.

5.5. Using the V&V package for data comparison

V&V Package instantiation has been implemented in a single web based repository with the aims to have a centralized source of information, to have the possibility to monitor on a regular base the data inserted and to extract data for control and consolidation purposes.

The main utilization of this information will be carried out in T7.1 Synthesis of Use Case Trials Experiences, when we will collect also the To-Be values of indicators. That should allow us to compare As-Is (before implementation) values with values of indicators after the implementation of FITMAN Trials.

In the central repository values of indicators are defined according a unique coding system enabling to aggregate them across different trials or to associate each of them based on assigned category.

Technical indicators across all trials have the same coding, enabling aggregation for a set of surveys of a trial (Community Survey) or across trials (General Survey).

Here following the coding of technical indicators.

Table 5.6 Technical Indicators Coding

<i>ID</i>	<i>Desc</i>	<i>Class</i>
1	P1	Step 1, Self-certification, Development Team
2	P2	Step 2, Self-certification, Development Team
3	P3	Step 3, Self-certification, Development Team
4	P4	Step 4, Self-certification, Development Team
5	P5	Step 5, Self-certification, Development Team
6	Openness	IT, General, Trial
7	Interoperability Maturity	IT, General, Trial
8	Ease of application	IT, General, Trial
9	User's Role	IT, Community, Trial
10	Fulfillment of requirements	IT, Community, Trial
11	Learnability	IT, Community, Trial
12	Understandability	IT, Community, Trial
13	User's attraction level	IT, Community, Trial
14	Efficiency	IT, Community, Trial

In the same way software components (GEs, SEs and TSCs) are univocally identified as they are implemented in various trials that will enable an aggregation based on common components utilized in different trials.

Here following an example of the Software Components coding.

Table 5.7 Software Components Coding

Software Component Code	Software Component Type	Software Component
01	GE	Apps.Repository
02	GE	Apps.Marketplace
03	GE	Apps.ApplicationMashup
04	GE	Apps.LightSemanticComposition
05	GE	Apps.Mediator
06	GE	Cloud.DCRM
07	GE	Cloud.SM
08	GE	Cloud.ObjectStorage
09	GE	Cloud.SelfServiceInterfaces
10	GE	IoT.Gateway.DataHandling
11	GE	IoT.Gateway.ProtocolAdapter
12	GE	IoT.Backend.IoTBroker

Data from the web based tool are transferred for further elaboration in an MS Access environment for queries, consolidation and reporting.

The first comparative analysis allows consolidating per Software Components specific indicators, in this way we can see how the same Software Component behaves in different environments.

Table 5.8 Consolidation per Software Component

SW_Component	Trial_Name	PI_Desc	Value
Secure Event Management	TRW	Openness	Level 2: Releasing code as open source
Secure Event Management	AGUSTA WESTLAND	Openness	Level 1: Enablers as a Service
Secure Event Management	WHIRLPOOL	Openness	Level 2: Releasing code as open source
Secure Event Management	PIACENZA	Openness	Level 1: Enablers as a Service

Of course we can see how a trial ranks the utilization of software components.

Table 5.9 Consolidation of Technical Indicators per Trial

Trial_Name	SW_Component	PI_Desc	Value
VOLKSWAGEN	Apps.Repository	Openness	Level 2: Releasing code as open source
VOLKSWAGEN	Apps.Marketplace	Openness	Level 2: Releasing code as open source
VOLKSWAGEN	Apps.ApplicationMashup	Openness	Level 2: Releasing code as open source
VOLKSWAGEN	Data.PubSub	Openness	Level 1: Enablers as a Service
VOLKSWAGEN	Collaborative Assets Management	Openness	Level 2: Releasing code as open source
VOLKSWAGEN	Collaboration Platf. BP Mgmt	Openness	Level 1: Enablers as a Service

With the same criteria also the business indicators defined for each trial have been categorized in 4 classes as depicted in Table 5.5. Here following an example for few Business Indicators belonging to the same class LT (Lead Time).

Table 5.10 Business Indicators belonging to LT (Lead Time) Class

PI_Classe	Trial_Name	Scenario_Descr	PI_Desc	PI_Name
Lead Time (LT)	AGUSTA WESTLAND	SUPPORT FOR MONITORING AND MANAGEMENT OF TOOL TRACKING	TTT	TOOLS TRACKING TIME
Lead Time (LT)	AGUSTA WESTLAND	SUPPORT FOR MANAGEMENT OF DOCUMENTATION AND REPORT CREATION	DDT	DATA DIGITALIZATION TIME
Lead Time (LT)	AIDIMA	FURNITURE TRENDS FORECASTING FOR PRODUCT DEVELOPMENT	TIME TO MARKET HTR	TIME TO MARKET FOR PUBLISHING THE HOME TRENDS REPORT
Lead Time (LT)	AIDIMA	OPINION MINING IN FURNITURE PRODUCTS	COMPL. TIME PROCESS	COMPLAINTS RESOLUTION TIME PROCESS
Lead Time (LT)	AIDIMA	COLLABORATIVE WORK FOR PRODUCT DESIGN	TIME SAVING TECH. OFF.	TIME SAVING FOR THE DESIGN PROCESS IN THE TECHNICAL OFFICE
Lead Time (LT)	APR	IMPROVE INFORMATION QUALITY IN THE INTERACTION WITH CUSTOMERS	RESP.TIME	QUOTES DEMAND RESPOND TIME
Lead Time (LT)	APR	IMPROVE INFORMATION QUALITY IN THE INTERACTION WITH CUSTOMERS	AN.CTRL	CUSTOMER RECOVERY ANALYSIS AND CONTROL TIME
Lead Time (LT)	APR	IMPROVE INFORMATION QUALITY IN THE INTERACTION WITH CUSTOMERS	CUST.REC.	AVERAGE TIME OF CUSTOMER RECOVERY
Lead Time (LT)	APR	IMPROVE INFORMATION QUALITY IN THE INTERACTION WITH CUSTOMERS	ACKN.REC.	AVERAGE TIME TO CONFIRM THE ORDER WITH ACKNOWLEDGEMENT OF RECEIPT
Lead Time (LT)	APR	IMPROVE INFORMATION QUALITY IN THE INTERACTION WITH CUSTOMERS	AN.CTRL.ORD.	TIME FOR ANALYSIS AND CONTROL OF ORDERS
Lead Time (LT)	COMPLUS	NETWORK TRANSPARENCY FOR MORE EFFICIENT SUPPLIER SEARCH	CONF. DATA	CONFIGURATION AND DATA ENTRY
Lead Time (LT)	COMPLUS	NETWORK TRANSPARENCY FOR MORE EFFICIENT SUPPLIER SEARCH	SEARCH. SUPP.	SEARCHING OF THE SUPPLIER
Lead Time (LT)	CONSULGAL	IDENTIFICATION OF CONCRETE CHARACTERISTICS AND CONCRETING PLAN	LT Char.&Plan	AVERAGE LT TO ACCESS INFORMATION
Lead Time (LT)	CONSULGAL	IDENTIFICATION OF CONCRETE CHARACTERISTICS AND CONCRETING PLAN	EXCH.TIME	TIME FOR DATA EXCHANGE
Lead Time (LT)	CONSULGAL	SAMPLES COLLECTION AND TESTING	LT RES.	AVERAGE LT TO PERFORM AND RECORD RESULTS
Lead Time (LT)	CONSULGAL	SAMPLES COLLECTION AND TESTING	EXCH.TIME	TIME FOR DATA EXCHANGE
Lead Time (LT)	CONSULGAL	TEST RESULTS TREATMENT AND EVALUATION	LT AN.RES.	AVERAGE LT TO ANALYZE RESULTS
Lead Time (LT)	CONSULGAL	TEST RESULTS TREATMENT AND EVALUATION	EXCH.TIME	TIME FOR DATA EXCHANGE
Lead Time (LT)	VOLKSWAGEN	INQUIRY SERVICE	AV.LT	AVERAGE PRODUCTION LEAD TIME PER METER
Lead Time (LT)	PIACENZA	PRODUCTION CAPACITY PURCHASER	AV.LT	AVERAGE PRODUCTION LEAD TIME PER METER
Lead Time (LT)	TANET	IMPROVEMENT OF FACILITATOR ROLE	CLUST.	END-TO-END CLUSTERING
Lead Time (LT)	TANET	IMPROVEMENT OF FACILITATOR ROLE	TEND.AUT.	AUTOMATED TENDER INPUT TIME
Lead Time (LT)	VOLKSWAGEN	MANAGEMENT OF THE MACHINE REPOSITORY	MR UP.TIME	MR UPDATE TIME
Lead Time (LT)	VOLKSWAGEN	INQUIRY SERVICE	INQ.RESP.COST	INQUIRY RESPOND COST
Lead Time (LT)	VOLKSWAGEN	INQUIRY SERVICE	AV.LT	AVERAGE LT TO ACCEDE THE EXPERTS KNOWLEDGE
Lead Time (LT)	PIACENZA	PRODUCTION CAPACITY PURCHASER	AV.LT	AVERAGE LT TO ACCEDE THE EXPERTS KNOWLEDGE

This classification allows us to analyze how different indicators belonging to the same class behave in different trials. We can as well compare how expected improvements are related with actual results.

Here following an example of how different trials foresee expected results in the four above mentioned categories for Business Indicators (Table 5.6).

Table 5.11 Clustered Expectations from Trials

Normalized Change		Indicator Classification			
TRIAL / SCENARIO		Cost (CO)	Lead Time (LT)	Productivity (P)	Quality (Q)
▼ APR		181,94%	150,00%	3,23%	42,86%
	IMPROVE INFORMATION QUALITY IN THE INTERACTION WITH CUSTOMERS	100,00%	150,00%	3,23%	42,86%
	IMPROVE INFORMATION QUALITY IN THE INTERACTION WITH SUPPLIERS	209,26%			
▼ CONSULGAL		47,50%	64,00%	300,00%	
	IDENTIFICATION OF CONCRETE CHARACTERISTICS AND CONCRETING PLAN		64,00%		
	SAMPLES COLLECTION AND TESTING	30,00%	64,00%	300,00%	
	TEST RESULTS TREATMENT AND EVALUATION	65,00%	64,00%		
▼ TANET			250,00%	266,67%	
	IMPORT OF TENDER OPPORTUNITIES			266,67%	
	IMPROVEMENT OF FACILITATOR ROLE		250,00%		
▼ TRW				27,22%	
	RISK DETECTION AND INFORMATION			38,75%	
	RISK MODELLING			18,00%	
▼ VOLKSWAGEN		65,00%	51,00%		
	INQUIRY SERVICE	80,00%	49,33%		
	MANAGEMENT OF THE MACHINE REPOSITORY	50,00%	56,00%		
▼ WHIRLPOOL		4,50%		17,83%	4,65%
	BIG DATA SCENARIO			8,00%	4,12%
	EVENT SCENARIO	4,50%		22,75%	4,98%

In conclusion, the availability of always up-to-date data in the web repository and utilization of elaboration engine, allows aggregating and comparing both technical and business data. In T7.1 these functionalities has been utilized to provide a numerical base to elements elicited from Trial experimentation.

6. Experiences of using V&V methodology

Trial experiences regarding the application of V&V methodology have been received through different project phases and sources as:

- 1) The trial journals inserted in the Surveys (see D2.3). The instantiated surveys (see 7.2 Next steps) allowed to collect not only numerical values of Business and Technical Indicators, but also useful first-hand feedbacks from users and Trial Owners, for example information regarding challenges and problems and how they have been solved or by-passed. All trials have not yet started yet using the journal, but they have been advised to do so during the rest of the project.
- 2) Data consolidation i.e. the information about the actual data input by the trials.
- 3) Day-to-day interaction, support requests for V&V “help desk” and some unstructured feedback has been also received in the trainings with ad-hoc questionnaires distributed to specific stakeholders.

These have been reported in chapters above.

Additionally, in order to get up-to-date understanding about the trial experiences in the phase, when the experimentation and measurements have started, a systematic assessment was conducted about how users (Trial owner, SW developer, Business and Process people) are really familiar and comfortable with the Verification and Validation Methodology and deployed tools. Thus a questionnaire for the trials about the experiences of using the V&V method was prepared. The content and the results are described in the following chapters.

6.1. Feedback on the V&V methodology usage

A questionnaire was designed to collect feedback on the V&V methodology usage. The questionnaire contained three different parts with focus on;

1. Trial Owner
2. Trial User Community
3. Technology Partners

Paper-based questionnaire forms were distributed and answers were collected during the FITMAN General Meeting in Munich September 15th to 16th. Only the parts for Trial Owner and Technology Partners were used. The maturity of the trials and the persons present at the meeting did not allow for collecting Trial User Community feedback. This can be handled later on, potentially using electronic forms.

Questionnaire to Trial Owners

V&V methodology

As a whole are you familiar and aware of the V&V Methodology?:

What is missing from the V&V Methodology?

Do you have any overall comment on the V&V methodology?

FITMAN V&V training

Have you participated in the V&V training?

Was the training sufficient?

What did you like / dislike?

What did you learn?

What could be improved?

The timing of training?

V&V Package.

Which part of the methodology have you used?

The selection of the persons to be involved in the assessment?

The definition of Business Performance Indicators?

The identification of the data sources for the indicators?

The definition of Indicators values?

As a whole how did the V&V Methodology support the assessment of business performance and that trial needs are met?

Understandability and appropriateness of the Technical Indicators for IT components?

Do you think that these three technical indicators are sufficient for the IT components or is something missing?

As a whole how did the V&V methodology support the assessment of technological aspects?

Trial Journal

Which part of the Trial Journal have you used?

Usage of the SurveyMonkey information collection?

Does the SurveyMonkey support the FITMAN V&V Methodology?

Any other comments related to the FITMAN V&V Methodology?

Questionnaire to Technology Partners

V&V methodology

As a whole are you familiar and aware of the V&V Methodology?

What is missing from the V&V Methodology?

Do you have any overall comment on the V&V methodology?

FITMAN V&V training

Have you participated in the V&V training?

Was the training sufficient?

What did you like / dislike?

What did you learn?

What could be improved?

The timing of training?

V&V Package.

How many Specific Enablers (SEs) were subject for Self Certification?

Did you get support and/or training (Webinar) for Self Certification?

The timing of support and/or training for Self Certification of the Specific Enablers?

The Self Certification usefulness?

Did Self Certification improve the quality?

Usage of the SurveyMonkey information collection

Have you used the SurveyMonkey tool for Self Certification information collection?

Did you get support and/or training (other than the training events) for SurveyMonkey usage?

Understandability of the SurveyMonkey tool?

Does the SurveyMonkey support the FITMAN V&V Methodology?

Any other comments related to the FITMAN V&V Methodology?

A full listing of all the three questionnaires and answering alternatives are included in Appendix 4.

6.2. Results and analysis of feedback from the V&V methodology questionnaire

Due to the schedule of FITMAN activities and the current level of maturity in the trials, the timing of the questionnaire was not optimal. However WP2 ends at M18 and it was necessary to get user experience from the FITMAN V&V methodology. We got all together 21 answers from the trials: 12 answers from technology partners and 9 from trial owners. The response rate was very good. We received answers from 90% of the trials concerning the technology partners and 90% concerning the trial owners. A summary of the results is presented below.

6..2.1. Results of the questionnaire for technology partners

Twelve technology partners answered the questionnaire. A summary of the results is presented in the table below. As a general conclusion the results show that the technology partners are familiar with the V&V method, and are generally satisfied with most parts of the method, and with the training that they have received for it. We can draw some specific conclusions from the answers:

1. V&V Methodology
 - 100% of the respondents were very familiar or familiar with the V&V Methodology
 - 83% find the methodology sufficient, and the rest find it somewhat sufficient.
2. FITMAN V&V training
 - 100% found the training to be useful or somewhat useful
 - 78% found the timing of the training to be suitable.
3. V&V package
 - 38% had not used self-certification for any Specific Enabler
 - Over half (60%) found the self-certification of SE's to be useful
 - 60% thought that self-certification has improved the quality of the SE's
4. Usage of the Survey Monkey information collection
 - 100% responded that the Survey Monkey tool supports FITMAN V&V very well or well.

Table 6.1 Summary of the questionnaire answers of the technology partners (n=12)

1. V&V Methodology	As a whole are you familiar and aware of the V&V Methodology?	very familiar	familiar	not so familiar	never heard of
		17 %	83 %	0 %	0 %
	Is the V&V Methodology sufficient?	sufficient	somewhat sufficient	somewhat insufficient	insufficient
		83 %	17 %	0 %	0 %
2. FITMAN V&V training	Have you participated in the V&V training?	yes	no		
		83 %	17 %		
	The training was:	useful	somewhat useful	somewhat useless	useless
		65 %	35 %	0 %	0 %
	The timing of training was:	too early	suitable	too late	
		11 %	78 %	11 %	
3. V&V package	How many Specific Enablers (SEs) were subject for Self Certification?	0	1	2	more
		38 %	13 %	13 %	38 %
	Did you get support and/or training (Webinar) for Self Certification?	yes	no		
		57 %	43 %		
	The timing of support and/or training for Self Certification of the SE's was:	too early	suitable	too late	
		0 %	100 %	0 %	
	The Self Certification of the Specific Enablers	understandable	understandable	somewhat difficult	difficult
		67 %	17 %	17 %	0 %
4. Usage of the SurveyMonkey information collection	The Self Certification was:	useful	somewhat useful	somewhat useless	useless
		60 %	40 %	0 %	0 %
	Did Self Certification improve the quality?	yes	no		
		60 %	40 %		
	Have you used the The SurveyMonkey tool for Self Certification information collection?	yes	no		
		100 %	0 %		
	Did you get support and/or training (other than the training events) for SurveyMonkey usage?	yes	no		
		38 %	63 %		
	The SurveyMonkey tool was:	understandable	somewhat understandable	somewhat difficult	difficult
		70 %	30 %	0 %	0 %
	Does the SurveyMonkey support the FITMAN V&V Methodology?:	very well	well	not so well	poorly
		22 %	78 %	0 %	0 %

In the questionnaire there were also some free text questions. *The overall comments about the methodology* were mainly positive. It was seen to be comprehensive and yet simple enough from the technical partners' point of view. One of the respondents felt, however, that the implementation is quite difficult due to different areas and aspects to be managed.

The training events were mainly seen to be necessary and an efficient way to learn to use the method. More precisely, the participants valued that there had been sent a template for the trials to prepare for the training in advance as well as clarity of presentations and interactive nature of the trainings. They appreciated very much the possibility to be able to ask questions and to discuss the trial issues related to V&V. Respondents appreciated also the geographical organization of the events. The participants felt that they got a quite clear picture about the method and the tools, and got enough information for the next steps on how to proceed. However, one respondent felt that they did not get enough guidance for the last steps of the V&V. Other improvement suggestions were that we could have made access to the training material earlier; a demo about using the methodology would have been good to have; the trainers should have assured that the participants really understood the method at the end of the day; and one respondent felt that half a day event would have been sufficient.

About *the Self Certification* part of the methodology, the respondents appreciated especially three things: the developer acceptance survey, reviewing all functionalities and ensuring that the SE works as expected.

6..2.2. Results of the questionnaire trial owners

Nine trial owners answered the questionnaire. They represented 9 out of 10 trials. A summary of the results is presented in the table below. As a general conclusion the results show that the trial owners are familiar with the V&V method, but not as familiar as the technology partners, which is understandable. The trial owners are generally satisfied with most parts of the method, and with the training that they have received for it. However they felt that the definition of Business Indicators was quite laborious as an average. We can draw some specific conclusions from the answers:

1. V&V Methodology

- 89% of the respondents were familiar with the V&V Methodology, and 11% not so familiar.
- 63% find the methodology sufficient, and the rest find it somewhat sufficient.

2. FITMAN V&V training

- 100% found the training to be useful or somewhat useful
- 100% found the timing of the training to be suitable.

3. V&V package

3.1 Business Indicators

- 100% of the respondents have used the BI part of the V&V package
- The definition and identification issues concerning the BI's was seen quite laborious:
 - 44% found the definition of BI's somewhat laborious
 - 56% found the identification of the data sources for the indicators somewhat laborious
 - 67% found the definition of indicator values somewhat laborious
- 100% thought that the V&V method supports the BI assessment very well or well, and that the trial needs are met.

3.2 Technical Indicators

- 87% of the respondents have used the TI part of the V&V package
- 88% agreed that the TI's are appropriate, 12% somewhat disagreed (see the additional answers after the table)
- 43% thought that the TI's assessed with the method are somewhat insufficient. The rest thought that they are sufficient or somewhat sufficient.
- 100% thought that the V&V method supports the TI assessment very well or well, and that the trial needs are met.

3.3 Trial Journal

- 67% of the respondents have used the BI part of the Trial Journal, 44% both of the TI parts.

4. Usage of the Survey Monkey information collection

- For 67% of the trial owners the Survey Monkey tool has been understandable and for 22 % somewhat understandable. 11% of them have found the tool to be somewhat difficult.
- 100% responded that the Survey Monkey tool supports FITMAN V&V very well or well.

Table 6.2 Summary of the questionnaire answers of the trial owners (n=9)

1. V&V Methodology	As a whole are you familiar and aware of the V&V Methodology?	very familiar	familiar	not so familiar	never heard of	
		0 %	89 %	11 %	0 %	
	Is the V&V Methodology sufficient?	sufficient	somewhat sufficient	somewhat insufficient	insufficient	
		63 %	38 %	0 %	0 %	
2. FITMAN V&V training	Have you participated in the V&V training?	yes	no			
		89 %	11 %			
	The training was:	useful	somewhat useful	somewhat useless	useless	
		50 %	50 %	0 %	0 %	
	The timing of training was:	too early	suitable	too late		
		0 %	100 %	0 %		
3. V&V package: 3.1 Business Indicators	Which part of the methodology have you used?	Definition of Trial Scen., Processes & Bus.Obj.	Definition of PI's	Setting AS-IS values for BPI's	Definition of TARGET values for BPI's	Reporting TO-BE values for BPI's
		100 %	100 %	100 %	89 %	56 %
	The selection of the persons to be involved in the assessment was:	easy	somewhat easy	somewhat laborious	laborious	
		56 %	44 %	0 %	0 %	
	The definition of Business Performance Indicators was:	easy	somewhat easy	somewhat laborious	laborious	
		33 %	22 %	44 %	0 %	
	The identification of the data sources for the indicators was:	easy	somewhat easy	somewhat laborious	laborious	
		33 %	11 %	56 %	0 %	
	The definition of Indicator values (AS-IS, Target, TO-BE)	easy	somewhat easy	somewhat laborious	laborious	
		11 %	11 %	67 %	11 %	
	As a whole how did the V&V Methodology support the assessment of business performance and that trial needs are met?	very well	well	not so well	poorly	
		11 %	89 %	0 %	0 %	
3. V&V package: 3.2 Technical Indicators	Which part of the methodology have you used?	Validation to determine whether the req. of IT comp. of the products are met	Technical indicators not used			
		89 %	11 %			
	The Technical Indicators for IT componets (Ges and Ses) are:	understandable	somewhat understandable	somewhat difficult	difficult	
		75 %	13 %	13 %	0 %	
	The Technical Indicators for IT componets (Ges and Ses) are appropriate:	fully agree	agree	somewhat disagree	disagree	
		0 %	88 %	13 %	0 %	
	Do you think that these three technical indicators are sufficient for the IT components or is something missing?	sufficient	somewhat sufficient	somewhat insufficient	insufficient	
		29 %	29 %	43 %	0 %	
	As a whole how did the V&V Methodology support the assessment of technologica aspects?	very well	well	not so well	poorly	
		17 %	83 %	0 %	0 %	
3. V&V package: 3.3 Trial Journal	Which part of the Trial Journal have you used?	Business Journal: Collection of important operational issues	Tech Journal: collection of the implementation issues	Tech Journal: collection of the operational problems		
		67 %	44 %	44 %		
4. Usage of the SurveyMonkey information	Did you get support and/or training (other than the training events) for SurveyMonkey usage?	yes	no			
		44 %	56 %			
	The SurveyMonkey tool was:	understandable	somewhat understandable	somewhat difficult	difficult	
		67 %	22 %	11 %	0 %	
	Does the SurveyMonkey support the FITMAN V&V Methodology?:	very well	well	not so well	poorly	
		33 %	67 %	0 %	0 %	

In the questionnaire there were also some free text questions. *The overall comments about the methodology* were positive also from the trial owners' point of view. One of the respondents pointed out that it would be good to include a way to identify noise in the method.

The training events were mainly seen to be necessary and as an efficient way to learn to use the method. More precisely, the participants valued that the information given in the event was in a form that was easy to understand and that the event was clear, simple and pragmatic. The participants felt that they got a quite clear picture about the method, instruments and about how to set up the V&V in the trial. As improvement suggestions they would have liked to have simplification of roles of users, and to have little more in depth view into the methodology.

We received some improvement suggestions also for *the technical indicators part of the V&V method*. Some of the trial owners felt that cost assessment should be added as well as a scalability indicator. One of the trials also wanted to have better technical documentation. *The trial journal* was seen by one trial owner too laborious to use due to lower technical knowledge and due to the fact that people are busy.

7. Conclusions

7.1. Conclusions

The Task T2.5 is the final task in WP2. The WP has delivered a unique FITMAN Verification & Validation Method, accompanied by the V&V assessment package, which has been instantiated for each Use Case Trial. The WP has also delivered ongoing support the users of the V&V Methodology. The experiences of using V&V methodology, reported in the previous Chapter, are encouraging. However due to timing of FITMAN activities, the current level of maturity in the trials has not yet allowed a full scale deployment of the FITMAN V&V. The Use Case evaluation is still on-going in WP4-5-6 at M18 and the new SEs brought in by the new FITMAN beneficiaries, the Open Call winners, will add new elements to be assessed in WP12-13-14. This will not, however, change the methodology of WP2 which has now come to its conclusion.

From a sustainability point of view the WP2 has delivered assets that are of high value. The following is a list exploitable assets.

- FITMAN Verification & Validation Assessment Methodology
- FITMAN Verification & Validation Business Indicators
- FITMAN Verification & Validation Technical Indicators
- FITMAN Verification & Validation Communication Package
- FITMAN Verification & Validation Experience and Lessons Learned

More details of on potential markets or segment, important customer segment together with planned exploitation vehicles and channels can be found in *Deliverable D9.2 Exploitation action planning*.

7.2. Next steps

FITMAN has embedded starting from the definition of the project work plan a dedicated set of actions aiming to assess and measure the impact of implementation of FITMAN platform in the selected Trials. That would also be leveraged beyond the project duration for supporting other implementations adopting the platform (see the figure below).

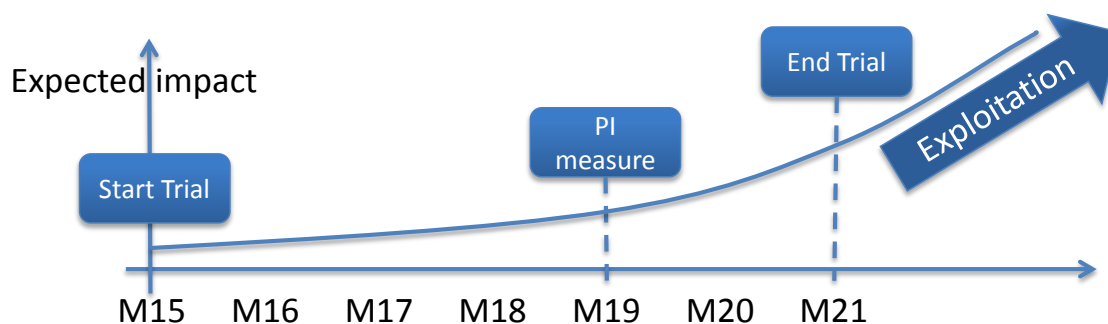


Figure 7.1. Timing of the expected impacts.

The methodology defined in WP2 has been carefully deployed and monitored both from the operational (T2.5) and content (T[4-5-6].4) perspectives with the objective to collect consistent, homogeneous and meaningful values from Trials.

Task T7.1 will take the ownership for a systematic data collection and consolidation activity is taking place. The objective is to observe how Indicator values (Business and Technical) evolve along the Trials implementations starting from original (before implementation) values towards targets defined in agreement with the process and business owners. In the meanwhile experiences and lessons learnt are collected (via the Trials' Journals) for providing a comprehensive description of the Trials evolution during the implementations. Task T7.1, via collection of experiences, AS-IS vs. TO-BE values of Technical and Business Performance Indicators measures and cross-trial analysis will identify best practices and consolidate results, this is based on the current experimentations held in WP4-5-6.

Data collection process in T7.1 is fully based on a Web based technology. The reason for this choice has been described in D2.4, but they can be summarized as follows:

- Unified vehicle for data collection
- Protected environment (personal and protected access)
- “real time” availability of the last version of data in the central repository with no latency in collecting data

Data collected belong to major categories as defined in WP2 (V&V methodology): Technical and Business Indicators.

In the following picture the 5 data categories collected via the instantiated surveys are represented. All these data are described in D7.1.

Table 7.1. The data categories collected via the instantiated surveys.

#	Topic	Survey	Level	What	Who	When
1	BPI	General	Scenario	PI	Trial owners	Start W27 – Jun 30
2	Technical indicators level P5	General	Component	(3 TI : openness, Inter-operability, Ease of Applic)	Trial owner / Technical partner	Start W22 – May 26
3	Trial Journal	General	Trial	Technology and business	Trial owner	On going
4	Technical indicators level T1	Community	Trial	(5: Fullfil, learnability, Underst, User attract, effective)	Community	Start W27 – Jun 30
5	Self certification	Self	Component	SEs (2 + 6)	NTUA + SEs developers	On going

1. Business indicators collected by scenario
2. Technical Indicators (According level P5 of methodology) for each SW component (GE and SE)
3. Unstructured Data with day-by-day experiences
4. With a community based approach (via a panel of user) and overall evaluation of the FITMAN based trial is collected
5. All SW developers has been requested a specific assessment of the developed SEs

Task T7.1 will constitute as well the data foundation for a set of analysis action of impact of FITMAN architecture, namely we can mention:

- T7.[2-6]: aiming to provide and formulating recommendations to FI bodies
- T8.1: comparative evaluation of trial results, road mapping for future trials.
- T8.2: Focus on Trial expansion of trials in Phase III
- T9.2: socio-economic impact assessment. This starts from WP7 (T7.1) but projects the scenarios to the future 3-5 years (exploitation). I envisage here the definition of some scenarios of FI Technologies adoption in manufacturing: worst case, best case, most probable case. It will also use the consolidated trial outputs to make an assessment of the potential for wider socio-economic impact through replication of FITMAN results
- T10.3 (Project Impact assessment report) It will consider the six step methodology and process for the impact monitoring. The status of the impact factors to maximize the potential for achievement of the impact objectives and the impact success theses will be updated to the situation as at M24
- The following picture represents the relationships among tasks.

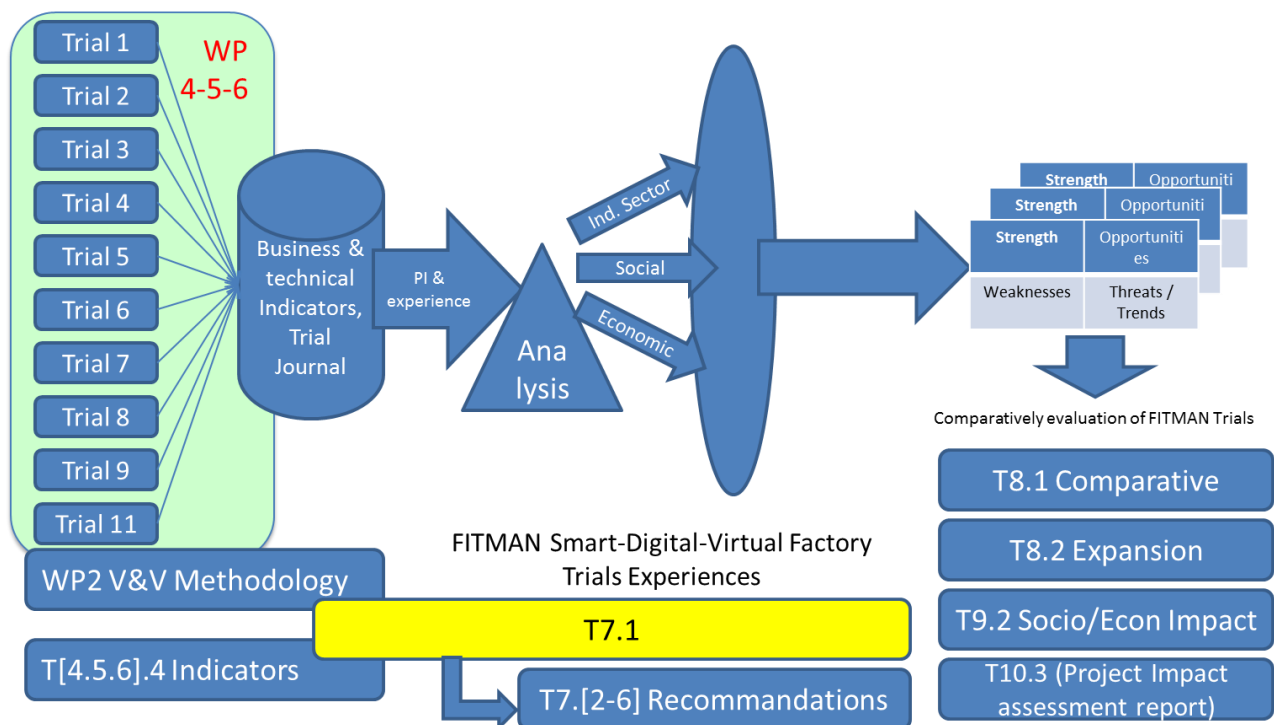


Figure 7.1. The relationships among FITMAN tasks.

8. References

1. Deliverable D2.1 - FITMAN Verification & Validation Method and Criteria
2. Deliverable D2.2 - FITMAN V&V Business and Technical Indicators
3. Deliverable D2.3 – FITMAN V&V Generic Assessment Package
4. Deliverable D2.4 – FITMAN V&V Assessment Package Instantiations per Trial
5. Deliverable D3.1 – Trial IT Infrastructure and Platforms
6. Deliverable D3.2 - FITMAN Trials Business Cases WP3 Design and Development of FITMAN Experimentation Sites
7. Deliverables 4.4-5.4-6.4 – FITMAN Technical – Business Indicators for Smart/Digital/Virtual Factory
8. FITMAN – Description of Work (DoW) Amendment 2.0

Appendixes

Appendix 1. Summary of defined business indicators

This chapter presents the new list of BPIs per category of the Trials

Updated list of BPIs for SMART Trials:

SMART		
BPIs	N°	TRIALS
Ratio: Number of standards and regulations added in the repository after/before the DV/AV implementation during a period*	2	TRW
Ratio: Number of accidents and incidents in the factory after / before the DV/AV implementation during a period*	2	TRW (BS1)
Ratio: Number of risks that has been defined after/ before the DV/AV implementation during a period*	2	TRW
Ratio: Number of preventive actions after /before the DV/AV implementation during a period*	2	TRW
Ratio: Number of human errors in the design of prevention strategy planning after /before the DV/AV implementation during a period*	2	TRW
Ratio: Number of accidents and incidents in the factory after / before the DV/AV implementation during a period*	2	TRW(BS2)
Ratio: Number of deployed H&S (Heath & Safety) monitoring system after / before the DV/AV implementation during a period*	2	TRW
Ratio: Number of risk detectors, alarms and warnings set up after / before the DV/AV implementation during a period*	2	TRW
Ratio: Number of training sessions regarding H&S after / before the DV/AV implementation during a period*	2	TRW
BPIs	N°	TRIALS
Ratio: Fall Off Rate (FOR) ¹⁶ after/before the DV/AV implementation during a period*	4	WHIRLPOOL
Ratio: Service Incidence Rate (SIR) ¹⁷ after / before the DV/AV implementation during a period*	4	WHIRLPOOL
Ratio: Overall Equipment Efficiency (OEE) ¹⁸ after / before the DV/AV implementation during a period*	4	WHIRLPOOL
Ratio: Number of breakdown between two planned maintenances after /before the DV/AV implementation during a period*	4	WHIRLPOOL
Ratio: % of defective parts to rework after /before the DV/AV implementation during a period*	4	WHIRLPOOL

¹⁶ Fall Off Rate (FOR): represent the internal defectiveness; is the ratio between the number of defects detected along the production line and the total production volume in a specified period (shift; day; month; YTD)

¹⁷ Service Incident Rate (SIR): is the percentage of how many calls received from the Customer Service on the overall production in a time period

¹⁸ Overall Equipment Effectiveness (OEE): is the total amount of time used to produce good product versus the total available time

Ratio: Conversion cost per unit after /before the DV/AV implementation during a period*	4	WHIRLPOOL
Ratio: Total cost of products scrapped after /before the DV/AV implementation during a period*	4	WHIRLPOOL

Updated list of BPIs for DIGITAL Trials:

DIGITAL		
BPIs	N°	TRIALS
Ratio: Inquiry respond time after / before the DV/AV implementation during a period* <i>BPI proposed by I-VLab</i>	1	VOLKSWAGEN
Ratio: Time needed for the assessment of product related inquiries after / before the DV/AV implementation during a period*		
Ratio: MR Update cost after / before the DV/AV implementation during a period*	1	VOLKSWAGEN
Ratio: MR Update time after / before the DV/AV implementation during a period*	1	VOLKSWAGEN
Ratio: Inquiry respond cost after / before the DV/AV implementation during a period*	1	VOLKSWAGEN
Ratio: Average lead time to access experts knowledge about production equipment after / before the DV/AV implementation during a period*	1	VOLKSWAGEN
Ratio: Evaluation accuracy rate ¹⁹ after / before the DV/AV implementation during a period	1	VOLKSWAGEN
BPIs	N°	TRIALS
Ratio: Average lead time to access the information relating to concrete characteristics and concreting plan after/before the DV/AV implementation during the concrete control process.	7	CONSULGAL
Ratio: Average number of pages used in the test results recording, archival, after/before the DV/AV implementation during one concrete operation.	7	CONSULGAL
Ratio: Average lead time needed to perform and record the test results after/before the DV/AV implementation during one concrete operation.	7	CONSULGAL
Ratio: Average lead time needed to analyze the test results after/before the DV/AV implementation during one concrete operation.	7	CONSULGAL
Ratio: Time for data exchange between stakeholders after/before the DV/AV implementation during the concrete control process.	7	CONSULGAL
Ratio: Average cost needed to perform and record the test result after/before the DV/AV implementation during one concrete operation.	7	CONSULGAL
Ratio: Average cost needed to analyze the test result after/before the DV/AV implementation during one concrete operation.	7	CONSULGAL
BPIs	N°	TRIALS

¹⁹ Accuracy of the implementation cost (Evaluated implementation cost / real implementation cost) (See: FITMAN D5 4 FITMAN Technical - Business Indicators for Digital Factory V16 Uninova-13.04.2014)

Ratio: Search time process per source after/before the DV/AV implementation during a period*	11	AIDIMA
Ratio: Number of electronic sources analysed by trends experts after/before the DV/AV implementation during a period*	11	AIDIMA
Ratio: Number of weak signals identified after/before the DV/AV implementation during a period*	11	AIDIMA
Ratio: Number of index cards created after/before the DV/AV implementation during a period*	11	AIDIMA
Ratio: Number of R+D projects based on Home Trends Report after/before the DV/AV implementation during a period*	11	AIDIMA
Ratio: Number of new products based on trends after/before the DV/AV implementation during a period*	11	AIDIMA
Ratio: Time to market for publishing the Home Trends Report after/before the DV/AV implementation during a period*	11	AIDIMA
Ratio: Number of companies purchasing biannual Home Trends Report after/before the DV/AV implementation during a period*	11	AIDIMA
Ratio: Number of companies professionals attending home trends reports seminars after/before the DV/AV implementation during a period*	11	AIDIMA
Ratio: Number of trends research institutes using FITMAN solutions after/before the DV/AV implementation during a period*	11	AIDIMA
Ratio: Complaints resolution time process after/before the DV/AV implementation during a period*	11	AIDIMA
Ratio: Number of reported complaint response after/before the DV/AV implementation during a period*	11	AIDIMA
Ratio: Number of companies using FITMAN opinion mining solutions after/before the DV/AV implementation during a period*	11	AIDIMA
Ratio: Number of identified electronic customer opinions after/before the DV/AV implementation during a period*	11	AIDIMA
Ratio: Number of online fake opinions identified after/before the DV/AV implementation during a period*	11	AIDIMA
Ratio: Number of non- reported customer online dissatisfaction identified after/before the DV/AV implementation during a period*	11	AIDIMA
Ratio: Number of positive online WOM (Word-Of-Mouth)after/before the DV/AV implementation during a period*	11	AIDIMA
Ratio: Number of opinion leaders identified after/before the DV/AV implementation during a period*	11	AIDIMA
Ratio: Average lead time for the design process after/before the DV/AV implementation during a period*	11	AIDIMA
Ratio: number of design sketches per piece of furniture after/before the DV/AV implementation during a period*	11	AIDIMA
Ratio: number of players taking part in the piece of furniture design after/before the DV/AV implementation during a period*	11	AIDIMA

Updated list of BPIs for VIRTUAL Trials:

VIRTUAL		
BPIs	Nº	TRIALS
Ratio: Number of mistakes and errors after / before the DV/AV implementation during a period*	9	COMPlus
Ratio: Number of standardized IT landscape / Number of total IT landscape, after / before the DV/AV implementation during a period*	9	COMPlus
Ratio: Average time for configuration and data entry of LED Network after / before the DV/AV implementation during a period*	9	COMPlus
Ratio: Level of transparency of the Network according to the trial requirements after / before the DV/AV implementation during a period*	9	COMPlus
Ratio: Average development time for searching of the supplier in the LED Network after / before the DV/AV implementation during a period*	9	COMPlus
BPIs	Nº	TRIALS
Ratio: Time limit for responding of quotes (current/new product) after / before the DV/AV implementation during a period* <i>BPI proposed by I-VLab:</i>	6	APR
Ratio: Lead time for responding of quotes (current/new product) after / before the DV/AV implementation during a period*		
Ratio: % Number of unsuccessful quotes due to high price/Total number of quotes processed after / before the DV/AV implementation during a period*	6	APR
Ratio: % of time for analysis and control of customer recovery after / before the DV/AV implementation during a period* <i>BPI proposed by I-VLab:</i>	6	APR
Ratio: Lead time for analysis and control of customer recovery after / before the DV/AV implementation during a period*		
Ratio: Average customer recovery lead time after / before the DV/AV implementation during a period*	6	APR
Ratio: Average lead time to confirm the order with acknowledgement of receipt (with/ without quote) after / before the DV/AV implementation during a period*	6	APR
Ratio: % of time for analysis and control of orders after / before the DV/AV implementation during a period* <i>BPI proposed by I-VLab:</i>	6	APR
Ratio: Lead time for analysis and control of customer recovery after / before the DV/AV implementation during a period*		
Ratio: Customer service rate after / before the DV/AV implementation during a period*	6	APR
Ratio: Number of products received back due to faults after / before the DV/AV implementation during a period*	6	APR
Ratio: Internal Stock out rate after / before the DV/AV implementation during a period*	6	APR
Ratio: External Stock out rate after / before the DV/AV implementation during a period*	6	APR
Ratio: Value of stock at the end of last period after / before the DV/AV implementation during a period*	6	APR

BPIs	N°	TRIALS
Ratio: Tenders accrued monthly after / before the DV/AV implementation during a period* <i>BPI proposed by I-VLab:</i> Ratio: Number of Tenders accrued monthly after / before the DV/AV implementation during a period*	8	TANET
Ratio: Number of Active Facilitators after / before the DV/AV implementation during a period*	8	TANET
Ratio: Number of Registered service providers after / before the DV/AV implementation during a period*	8	TANET
Ratio: End-to-end clustering time (hours) after / before the DV/AV implementation during a period*	8	TANET
Ratio: Automated tender input time (minutes) after / before the DV/AV implementation during a period*	8	TANET

Updated list of BPIs for SMART/DIGITAL Trial:

BPIs	N°	TRIALS
NEW Ratio: Average time spent to track the tools management during working operation after/before the DV/AV implementation during a period*	3	AgustaWestland
NEW Ratio: Number of tailored training materials linked to the results of tracking tools after/before the DV/AV implementation during a period*	3	AgustaWestland
Ratio: Average time to make data available in a digital format to different business units after/before the DV/AV implementation during a period*	3	AgustaWestland
Ratio: Number of people/departments to contact in order to have the information actually not digitalised or available on different sources after/before the DV/AV implementation during a period*	3	AgustaWestland
Ratio: Number of technical interfaces (including files, browser, paper documents,) to contact to have access to all the needed information after/before the DV/AV implementation during a period*	3	AgustaWestland

Updated list of BPIs for SMART/VIRTUAL Trial

BPIs	N°	TRIALS
Ratio: Machine fixed costs per produced unit after / before the DV/AV implementation during a period*	5	PIACENZA
Ratio: Average production lead time per meter produced from order to delivery after / before the DV/AV implementation during a period*	5	PIACENZA
Ratio: The quantity of energy spent per meter produced after / before the DV/AV implementation during a period*	5	PIACENZA
Ratio: Number of production records including machine identification after / before the DV/AV implementation during a period*	5	PIACENZA
Ratio: Percentage of forecast error after / before the DV/AV implementation during a period*	5	PIACENZA

Appendix 2. Data Collection Forms

Technical Indicators Sub-form GE - Apps.LightSemanticComposition

- 06004006 - Openness
- ☐ Level 0: Open specifications –Developers can view & study the requirements posed and implement them as they wish.
 - ☐ Level 1: Enablers as a Service – Developers can utilize software provided as a service through open interfaces.
 - ☐ Level 2: Releasing code as open source - Developers can inspect, download, run and improve the open source code according to their needs.
 - ☐ Level 3: Consulting with the use cases about their needs and collaboratively contributing to the source repository, design documents, and bug reports.

Comments (if any):

- 06004007 - Interoperability Maturity
- ☐ Level 0: Isolated Approach: No API exposing the GE / SE functionalities is available.
 - ☐ Level 1: Baseline Unified Approach (International Standards exists): Offering an API exposing main part of the GE / SE functionalities, in its own format.
 - ☐ Level 2: Open Unified Approach (No International Standards exists): Offering an API exposing main part of the GE / SE functionalities, in its own format.
 - ☐ Level 3: Standardized Integrated Approach (International Standards exists): Offering an API exposing main part of the GE / SE functionalities, following international standards.

Comments (if any):

- 06004008 - Ease of application
- ☐ Level 0: "no applicability in our environment without extra applying actions or means".
 - ☐ Level 1: "applicable with significant amount of work".
 - ☐ Level 2: "applicable with limited amount of work".
 - ☐ Level 3: "Easily applicable in our environment".

Comments (if any):

Example of Technical Indicators Form

Business Indicators Sub-form BS 1 - Business Scenario 1

QUOTES DEMAND RESPOND TIME (RESPTIME)

Description: Time limit for responding to quotes demand (current/new product).

Insert Value 1, Value 2 (if needed), Value 3 (if needed) and Target Value as the RATIO between the value of this indicator after and before the implementation.

Please, justify the choice of Target Value in the Comments field.

061 - RESPTIME Current Value

061 - RESPTIME 1

061 - RESPTIME 2

061 - RESPTIME 3

061 - RESPTIME Target

061 - RESPTIME Comments

Example of Business Indicators Form

Technical Indicators - Trial Integrated Solution

Please indicate your role in the Trial.

- 09000009 - User's Role
- ☐ Trial Solution Owner
 - ☐ Member of the Trial Team
 - ☐ Member of the IT Support Team

Comments (if any):

STATEMENT: "The solution fulfils the trial requirements".

- 09000010 - Fulfillment of requirements
- ☐ I strongly agree
 - ☐ I agree
 - ☐ I disagree
 - ☐ I strongly disagree

Comments (if any):

Example of Community-based Form

Self-certification Form

Please indicate the adopted Verification Technique (Recommended or Alternative) and the result of the related test.

RECOMMENDED VERIFICATION TECHNIQUE: WHITE BOX TESTING: UNIT TESTING

SHORT DESCRIPTION: Unit testing is a software verification process in which the smallest testable parts of an application, called units, are individually and independently scrutinized for proper operation. Each unit is tested separately before integrating them into modules to test the interfaces between modules.

V&V SUCCESS CONDITIONS:

- The development team has written tests for all the code and believes there are no other tests to be written for specific functionalities.
- All bugs reported during the tests are fixed.

04040001 - STEP P1

☐ White Box Testing: Unit Testing - Positive Result

☐ White Box Testing: Unit Testing - Negative Result

☐ White Box Testing: Unit Testing - NA

☐ Alternative Verification Technique - Positive Result

☐ Alternative Verification Technique - Negative Result

☐ Alternative Verification Technique - NA

Comments (if any):

Example of Self-certification Form

Appendix 3. Results of the versatility assessment

The number of GEs in the first release: 27 analysed, 15 selected, 12 not selected

The number of GEs in the 2nd and 3rd release: 25 analysed, 11 selected, 14 not selected

Thus:

Versatility_GE package usage index = Proportion of GEs that were used by any (at least one) trial = number of used GEs/ number of all GEs:

$$\text{Versatility_GEpackage_index} = 26 / 52 = 0,5 = 50\%$$

→ 50% of the GEs could be applied in FITMAN trials, which is a good number taking into account the restrictions.

Versatility_for GE_i = Proportion of trials applying a GE_i:

$$\text{Versatility_for GE}_i = N_{\text{trial_GE}_i \text{ used for}} / N_{\text{trials}}$$

Table 5.1 in chapter 5 above can be used to calculate this index. The results are shown in table A3.1. The highest value of GE usage (used in 5 or half of the trials) is very high. These GEs seem to be very generic; usable in different solutions. The mean value for GE level versatility is 0,3; that is each selected GE is used in average 3 trials.

Table A3.1 : Versatility at GE level

GE _i	Number of trials where used	GE Versatility	GE _i	Number of trials where used	GE Versatility
GE1	5	0,5	GE14	1	0,1
GE2	4	0,4	GE15	5	0,5
GE3	5	0,5	GE16	1	0,1
GE4	3	0,3	GE17	4	0,4
GE5	5	0,5	GE18	4	0,4
GE6	1	0,1	GE19	1	0,1
GE7	1	0,1	GE20	4	0,4
GE8	1	0,1	GE21	2	0,2
GE9	1	0,1	GE22	1	0,1
GE10	1	0,1	GE23	3	0,3
GE11	1	0,1	GE24	2	0,2
GE12	1	0,1	GE25	1	0,1
GE13	1	0,1	GE26	0	0,0

Appendix 4. V&V methodology usage questionnaires

Trial Owner questionnaire

Trial Owners

FITMAN WP2 Questionnaire to collect experiences on using the FITMAN V&V Methodology

The purpose of the questionnaire is to collect information and user experiences of applying the FITMAN V&V methodology. Please see attached short overview of the FITMAN V&V Methodology.

The answers will be treated confidentially. Summaries of results will be reported in D2.5 FITMAN V&V Assessment Summary. Please provide the following information where applicable.

Your Name: _____ Trial / Company: _____ Date: _____

1. V&V methodology

As a whole are you familiar and aware of the V&V Methodology?:

very familiar / familiar / not so familiar / never heard of / na

Is the V&V Methodology sufficient?:

sufficient / somewhat sufficient / somewhat insufficient / insufficient / na

What is *missing* from the V&V Methodology: _____

Do you have any overall comment on the V&V methodology: _____

2. FITMAN V&V training

Have you participated in the V&V training?: Yes / No / na

Was the training: useful / somewhat useful / somewhat useless / useless / na

What did you like / dislike?: _____

What did you learn?: _____

What could be improved?: _____

The timing of training was?: too early / suitable / too late / na

3. V&V package

3.1 **Business Indicators**, which assesses whether the overall trial solution offers sufficient added value to the company.

Which part of the methodology have you used?

- ☐ Definition of Trial Scenarios, Processes and Business Objectives.
- ☐ Definition of Business Performance Indicators (BPI)
- ☐ Setting AS-IS values for Business Performance Indicators
- ☐ Definition of TARGET values for Business Performance Indicators
- ☐ Reporting TO-BE values for Business Performance Indicators

The selection of the persons to be involved in the assessment

was: easy / somewhat easy / somewhat laborious / laborious / na

The definition of Business Performance Indicators

was: easy / somewhat easy /somewhat laborious / laborious / na

The identification of the data sources for the indicators

was: easy / somewhat easy /somewhat laborious / laborious / na

The definition of Indicators values (AS-IS, Target, TO-BE)

was: easy / somewhat easy /somewhat laborious / laborious / na

As a whole how did the V&V Methodology support the assessment of business performance and that trial needs are met?: very well / well / not so well / poorly / na

3.2 Technical Indicators, which assesses whether the technological aspects are met.

Which part of the methodology have you used?

☐ Validation to determine whether the requirement of IT components (GEs and SEs) of the product are met. (Openness, Interoperability maturity and Ease of application)

☐ Technical Indicators not used

The Technical Indicators for IT components (GEs and SEs)

are: understandable / somewhat understandable / somewhat difficult / difficult / na

are appropriate: fully agree / agree / somewhat disagree / disagree /na

Do you think that these three technical indicators are sufficient for the IT components or is something missing?: sufficient / somewhat sufficient / somewhat insufficient / insufficient / na

If insufficient, what is missing?: _____

As a whole how did the V&V methodology support the assessment of technological aspects?: very well / well / not so well / poorly / na

3.3 Trial Journal, the tool for collection of unstructured information.

Which part of the Trial Journal have you used?

Business Journal:

☐ Collection of the important operational issues faced in the implementation of the system in the Trial, e.g. organizational and business difficulties, degradation of the business system.

Technical Journal

☐ Collection of the implementation issues encountered in the implementation of the Trial system

☐ Collection of the operational problems (e.g. major bugs, blocking errors, etc.)

Any comments for the trial journal: Is it a good way to collect comments/ information?:

4. Usage of the SurveyMonkey information collection

Did you get support and/or training (other than the training events) for SurveyMonkey usage: Yes / No / na

The SurveyMonkey tool

was: understandable / somewhat understandable / somewhat difficult / difficult / na

Does the SurveyMonkey support the FITMAN V&V Methodology?
very well / well / not so well / poorly / na

5. Any other comments related to the FITMAN V&V Methodology

Thank You.

User Community questionnaire

User Community

FITMAN WP2 Questionnaire to collect experiences on using the FITMAN V&V Methodology

The purpose of the questionnaire is to collect information and user experiences of applying the FITMAN V&V methodology. The answers will be treated confidentially. Summaries of results will be reported in D2.5 FITMAN V&V Assessment Summary. Please provide the following information where applicable.

Name: _____ **Trial / Company:** _____ **Date:** _____

1. FITMAN V&V training

Have you participated in the V&V training: Yes / No / na

The training was: useful / somewhat useful / somewhat useless / useless / na

What did you like / dislike _____

What did you learn? _____

What could be improved? _____

The timing of training was?: too early / suitable / too late / na

2. V&V methodology

2.2 The **technical perspective** which assesses whether the technological aspects are met.

Which part of the methodology have you used?

- ☐ Validation to examine whether the overall trial solution satisfies intended use and user needs. (Fulfilment of requirements, Learnability, Understandability, User's attraction level, Efficiency)

The Technical Indicators for trial solution (Fulfilment of requirements, Learnability, Understandability, User's attraction level, Efficiency)

are: understandable / somewhat understandable / somewhat difficult / difficult / na

are appropriate: fully agree / agree / somewhat disagree / disagree / na

2.3 FITMAN V&V Methodology to Collection of unstructured information, the **Trial Journal**.

Which part of the Trial Journal have you used?

Business Journal:

- ☐ Collection and analysis of the most important operational issues faced in the implementation of the system in the Trial, e.g. organizational and business difficulties, degradation of the business system.

Technical Journal

- ☐ Collection of the implementation issues encountered in the implementation of the Trial system
- ☐ Collection of the operational problems (e.g. major bugs, blocking errors, etc.)

3. SurveyMonkey

What part of the SurveyMonkey information collection did you use?

- ☐ General Forms to collect Business Performance Indicator values (AS-IS, Target, TO-BE)
- ☐ General Forms to collect Technical Indicators (Openness, Interoperability maturity and Ease of application) within a scale of different levels (0 – 3)
- ☐ Community-based Forms to collect opinions and subjective perceptions in using the solution (Fulfilment of requirements, Learnability, Understandability, User's attraction level, Efficiency)
- ☐ Self-certification Forms for the software (SE) component developers
- ☐ Trial Journal

Usage of SurveyMonkey information collection

Did you get support and/or training (other than the training events) usage: Yes / No / na

The timing support and/or training for SurveyMonkey usage was: too early / suitable / too late / na

The SurveyMonkey tool

was: understandable / somewhat understandable / somewhat difficult / difficult / na

Does the SurveyMonkey support the FITMAN V&V Methodology?:

very well / well / not so well / poorly / na

4. Overall Comment on the V&V methodology:

Technology Partner questionnaire

Technology Partners

FITMAN WP2 Questionnaire to collect experiences on using the FITMAN V&V Methodology

The purpose of the questionnaire is to collect information and user experiences of applying the FITMAN V&V methodology. Please see attached short overview of the FITMAN V&V Methodology.

The answers will be treated confidentially. Summaries of results will be reported in D2.5 FITMAN V&V Assessment Summary. Please provide the following information where applicable.

Your Name: _____ **Trial / Company:** _____ **Date:** _____

1. V&V methodology

As a whole are you familiar and aware of the V&V Methodology?:

very familiar / familiar / not so familiar / never heard of / na

Is the V&V Methodology sufficient?:

sufficient / somewhat sufficient / somewhat insufficient / insufficient / na

What is *missing* from the V&V Methodology: _____

Do you have any overall comment on the V&V methodology: _____

2. FITMAN V&V training

Have you participated in the V&V training?: Yes / No / na

Was the training: useful / somewhat useful / somewhat useless / useless / na

What did you like / dislike?: _____

What did you learn?: _____

What could be improved?: _____

The timing of training was?: too early / suitable / too late / na

3. V&V package

3.4 FITMAN V&V Methodology for **Self Certification of the Specific Enablers** (SEs) development

How many Specific Enablers (SEs) were subject for Self Certification?: 0 / 1 / 2 / more

Did you get support and/or training (Webinar) for Self Certification?: Yes / No / na

The timing of support and/or training for Self Certification of the Specific Enablers

was: too early / suitable / too late / na

The Self Certification of the Specific Enablers

was: understandable / somewhat understandable / somewhat difficult / difficult / na

The Self Certification was: useful / somewhat useful / somewhat useless / useless / na

What was most useful?: _____

Did Self Certification improve the quality?: Yes / No / na

4. Usage of the SurveyMonkey information collection

Have you used the The SurveyMonkey tool for Self Certification information collection
Yes / No / na

Did you get support and/or training (other than the training events) for SurveyMonkey
usage: Yes / No / na

The SurveyMonkey tool
was: understandable / somewhat understandable / somewhat difficult / difficult / na

Does the SurveyMonkey support the FITMAN V&V Methodology?:
very well / well / not so well / poorly / na

5. Any other comments related to the FITMAN V&V Methodology

Appendix 5. FITMAN Verification & Validation Handbook

The handbook is provided in a separate document