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Versioning and contribution history

Version	Description	Editor
0.1	First draft	Ahmed Bufardi
0.2	Integration of feedback from Dimitris Kiritsis and Hadrien Szigeti	Ahmed Bufardi

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1 Executive summary

Competitiveness on industry relies on manufacturing companies adopting new ICT paradigms. This requires progress in the way new ICT competences are developed in these companies. For industrial learning (IL) pilot, we explored several new ways to develop ICT skills and knowledge for manufacturing. Our key learnings from the different ActionPlanT Industrial Learning Pilot Events (ILPEs) are:

- The ILPEs allowed us to know which aspects of IL (organization, delivery mechanism, documentation, target group, etc.) were efficiently addressed and which need further efforts or even alternative approaches. The evaluation of these aspects was done by both the trainees and the invited experts,
- Based on the feedback from the trainees who attended the different ILPEs, it appears that the difficulty of acquiring learning aspects is proportional to their complexity (in ascending order: attitude, knowledge, skills, competence). For example, the increase of interest in the introduced business principles and supporting technologies was much higher compared to the improvement realized in knowledge, skills and competence (for example in ILPE#2, 50% of participants qualified their interest in the introduced business principles and supporting technologies as high before the ILPE and this percentage increased to 100% after the ILPE). Acquiring skills and competence require more efforts than for improving attitude and acquiring knowledge,
- There is a difficulty to recruit training candidates from companies especially SMEs unless there is a strong commitment at the management level as it was the case for ILPE#4. This issue should be given great attention when organizing this type of event. Raising the awareness of manufacturing companies about the importance of IL as a means to develop ICT for manufacturing skills is crucial. The benefits for companies allowing their workforce to attend such training events should be clearly highlighted,
- The tested delivery mechanisms are judged by the trainees to be relevant for the learning topics considered in the ILPEs (on a scale from 2 to 10 (2-4-6-8-10), 55% of participants rated 8 to 10 the delivery mechanism used in ILPE#1, 70% for ILPE#2, 88% for ILPE#3 and 63% for ILPE#4). There should be encouragement of organizing events similar to ActionPlanT ILPEs in order to identify which delivery mechanisms are most suitable to deliver training about ICT for manufacturing themes,
- New learning content for IL should be extracted from recent achievements of research and innovation actions in the domain of ICT for manufacturing whose outcomes are potentially implementable in manufacturing,
- The ActionPlanT IL model is suitable to define IL actions. For example, in ILPE#2 we used the bottom-up approach of the model where we identified the “application of lean principles” as a professional need for the community (target audience) of “green belt engineers” in an electronics manufacturing industry which guided us to define appropriate content that we delivered using a game-based learning mechanism,
- The overall organization of the 4 ILPEs was positively evaluated by the trainees (on a scale from 2 to 10 (2-4-6-8-10), 67% of participants rated 8 to 10 the overall organization of ILPE#1, 100% for ILPE#2, 75% for ILPE#3 and 68% for ILPE#4).

Detailed information about ActionPlanT is provided in the following sections and the evaluation reports of ILPEs are included in the annexes.

2 Introduction

The IL work stream of ActionPlanT project consists of developing and validating a concept for IL, a set of e-skills for future manufacturing, recommendations and guidelines for the future development and implementation of IL in manufacturing. The outputs are piloted, via ILPEs and workshops amongst stakeholders in industry, academia, and the European technology platforms alike.

The ActionPlanT objective for IL is to create awareness and transfer state-of-the-art knowledge and perspectives about the benefits of ICT as an enabler for the efficient and sustainable Factories of the Future (FoF) and the development of required new sustainable business models.

In ActionPlanT, we define IL as follows:

> *IL is the process of identifying and implementing professional competencies triggered by new scientific and technological knowledge and implemented in an industrial context to address new professional needs.*

To be a major driver for promoting excellence and innovation in European manufacturing, IL needs to adapt its learning content, learning processes and delivery schemes in order to meet the new requirements of ICT-based manufacturing.

IL implementation is executed in the ActionPlanT project through the organization of ILPEs. ILPEs are considered as instances of the comprehensive IL model and methodology (Kiritsis et al., 2012) developed in Task 4.1 and reported in details in Deliverable D4.1. To this end, a series of one-day ILPEs, dedicated to “ICTs for manufacturing” were programmed for the duration of the ActionPlanT project.

This Deliverable reports on the different ILPEs which were organized within ActionPlanT project to test, evaluate and validate the ActionPlanT IL model and methodology. It summarizes the main outputs of activities undertaken in Task 4.3.

The focus of WP4 tasks and the relationship between Task 4.3 and the other WP4 tasks are shown in Figure 1.

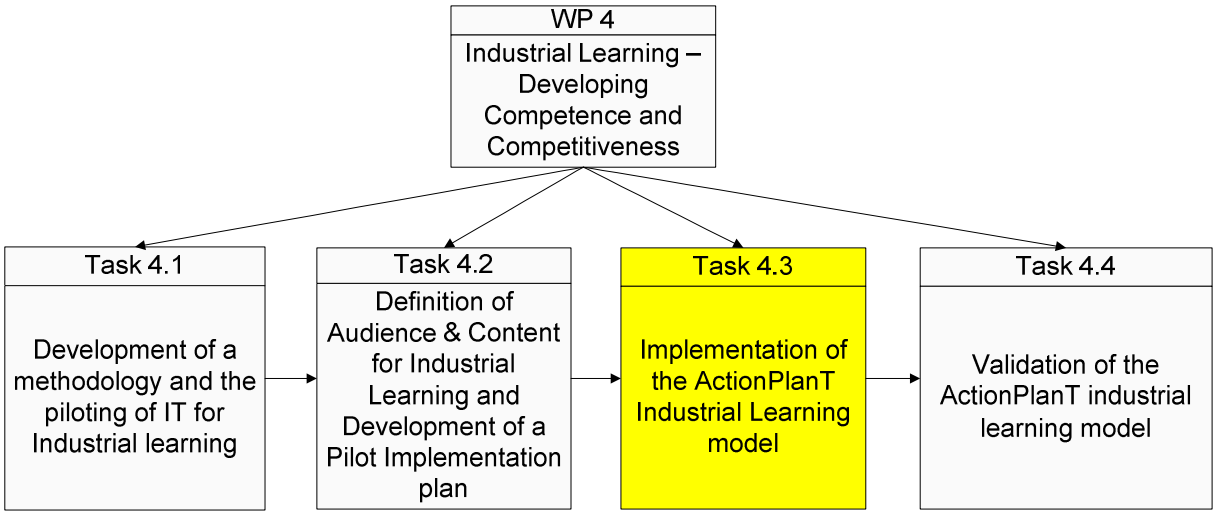

Figure 1. Main tasks in WP4 and their relationships

The main components of an ILPE are shown in Figure 2.

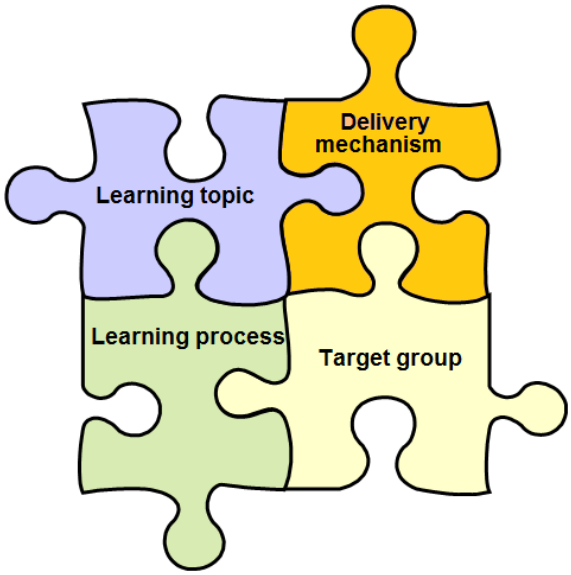

Figure 2. Main components of an ILPE

The learning process is the process by which the learning topic is delivered to the target group using the delivery mechanism.

ILPEs are structured around a theoretical session for basic knowledge/technology transfer and a practical session for hands-on exercise.

ILPEs address a number of indicative, but also representative, knowledge topics on ICT for manufacturing, addressing appropriately all four major building blocks of the learning process: attitude, knowledge, skills and competence.

The major goals for the ActionPlanT ILPEs are: faster competence improvement, focusing on knowledge and skills, and increase in attitude.

An initial schedule of ActionPlanT ILPEs to be organized within the project was worked out in Task 4.2 and reported in Deliverable D4.2.

ILPEs involve different ICT for manufacturing topics and delivery mechanisms for IL. The partition of the topics and delivery mechanisms over the different workshops and events organized in the framework of the ActionPlanT project is provided in deliverable D4.2.

In total, 4 ILPEs were organized at different European countries with the collaboration of ActionPlanT partners from these countries.

The ILPEs tested and evaluated various ICT for manufacturing topics and different delivery mechanisms for different target groups.

Trainees for ILPEs are recruited from different companies and institutes with a strong interest in the “ICT for manufacturing” themes considered in the ILPEs. Both homogeneous and heterogeneous groups were considered.

To evaluate the ILPEs, a set of metrics for impact measurement of the four building blocks of the learning process is developed in Task 4.4 and incorporated into the ILPE questionnaire (Mavrikios et al., 2011).

The recommendations from the trainees and IL experts about the improvement of the different aspects of ILPEs are taken into account in the organisation of the subsequent ILPEs.

An evaluation report is produced for each ILPE.

3 Approach to define ILPEs

The ActionPlanT IL implementation approach is illustrated in Figure 3. It shows the links between the ILPEs on the one side, and the ActionPlanT IL model, the IL specifications framework and the IL model validation on the other side.

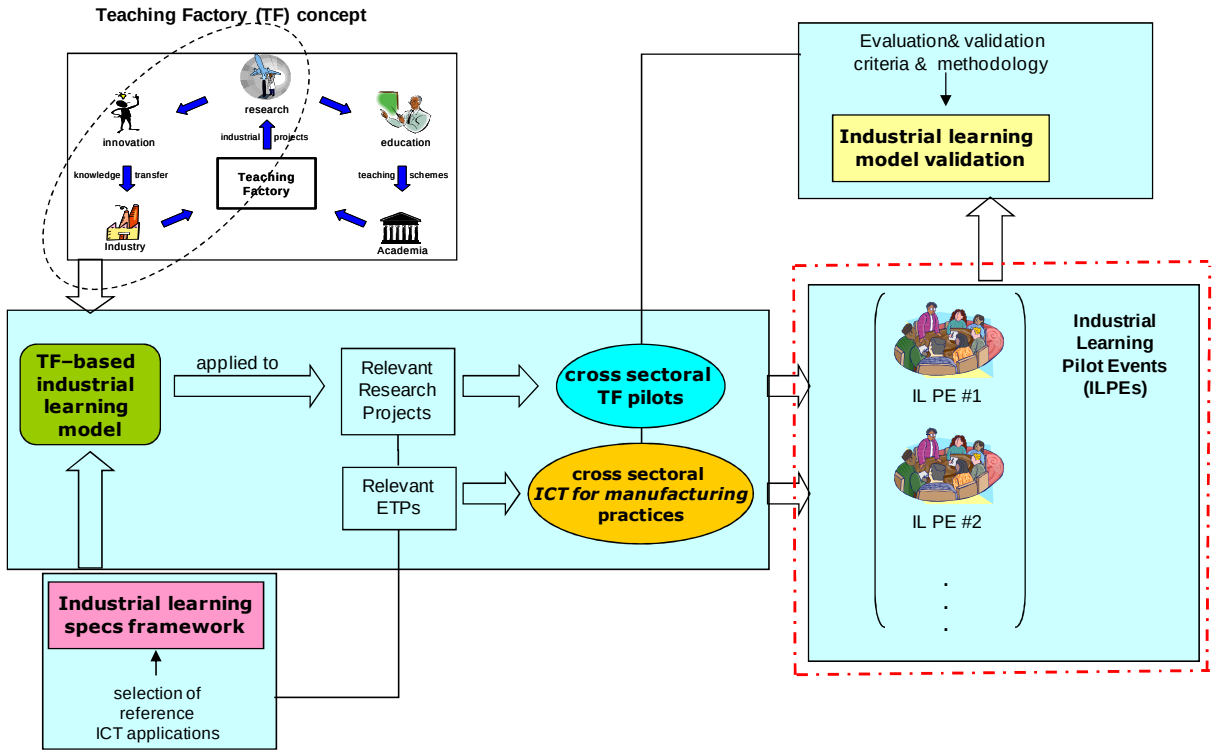

Figure 3. Model based IL implementation

Each ActionPlanT ILPE involves 3 main elements: learning theme, delivery mechanism and target group in addition to the learning process where all the three elements are considered together.

The content of the training is designed to cover inter-disciplinary topics of ICT matters and their application in manufacturing. Knowledge generated during the road mapping process is transformed to learning content to be used to IL webinars and workshops and transferred to professional, primarily, and to other identified audiences.

For the delivery of the training programmes, various instruments are proposed in order to suit the different learning styles of trainees and the requirements of the learning topics. Emerging and promising delivery mechanisms are particularly tested in ActionPlanT ILPEs.

The list of the delivery methods planned to be used for the different learning topics considered in the ILPEs includes both traditional and recent methods such as onsite: seminar / workshop / conference, synchronized/non-synchronized virtual classroom, Internet-based training, webinar, serious games, mid and long term course, workshops at future factory, etc.

A special attention is given to human oriented approaches, employing ICT tools to support human interaction with the “real” environment and application, and human-to-human interaction (e.g. collaborative environments, etc.).

The ActionPlanT IL model is competence-based and is suitable for creating new knowledge assets related to “cutting edge” ICT for manufacturing, identifying corresponding new professional competencies, and defining relevant learning programs and actions to train workers and engineers to develop these competencies.

In ActionPlanT IL model, the learning content for ICT for manufacturing is to be created from various sources such as R&D projects, best practices, business successes, etc. For example, two learning topics “PROMISE Messaging Interface for Quantum Lifecycle Management” and “PROMISE Data and Knowledge Management for Quantum Lifecycle Management” were created from PROMISE project and used in ILPE#3.

As reported in Deliverable D4.2, the main steps for the instantiation of the ActionPlanT IL model in piloting events are:

- Identification of target groups
- Definition of learning needs of target groups
- Analysis and classification of learning needs
- Definition of learning content
- Definition of IL action type and delivery mechanisms

An example of the way in which the ActionPlanT IL model is used to establish an ILPE is shown in Table 1.

Table 1: Example of using ActionPlanT IL model for ILPEs

Source	**Related ICT**	**Learning topic**	**Examples of related ICT skills/competencies**	**Training delivery mechanism**	**Learning action**
PROMISE research project	Closed Loop PLM	PROMISE Messaging Interface for Quantum Lifecycle Management	Web visualization of device data Data transfer with XML XML data analysis	Best Practice Tutorial	ILPE#3

As only a limited number of ILPEs can be organised during a short period as that of ActionPlanT project, it is not possible to consider all ICT for manufacturing topics and delivery mechanisms selected in the initial plan of ILPEs.

However, the organized ILPEs provided valuable insights about various aspects of IL regarding the suitability of delivery mechanisms to the learning topics, the interaction between the trainees in the target groups, etc.

Based on the evaluation of the organized ILPEs, we were able to formulate some recommendations about the way to make effective the use of IL to develop ICT for manufacturing skills.

4 Planning of ILPEs

The initial schedule for the realisation of ActionPlanT ILPEs was defined in Deliverable D4.2 and shown in Figure 4. It comprises a list of learning themes related to ICT for manufacturing, delivery mechanisms and a delivery plan with selected dates and places.

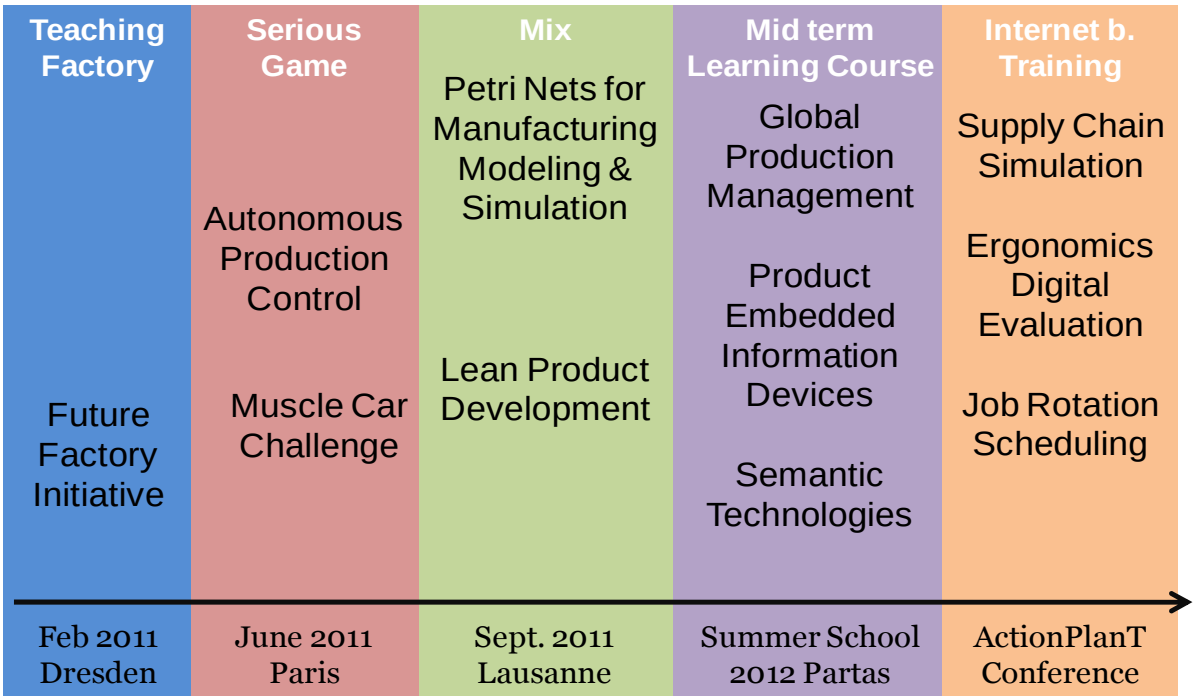

Figure 4. Initial Schedule of ILPEs

An important component of ILPEs which is not included in Figure 4 is the target group to which the ILPE is dedicated.

For each ICT for manufacturing theme identified in Task 4.2, a list of potential categories of trainees based on their role in the company is provided.

The identification of target groups to benefit from the training programs on ICT for manufacturing is addressed in deliverable D4.2 where 3 criteria: ICT competencies, processes along product life cycle and role are used for this identification.

In D4.2, twelve learning topics, from embedded information devices to semantic technologies, are derived from the core components of the FoF paradigm (smart, digital and virtual). For these topics, it is not only indicated which target groups are potential candidates but also which aspects among knowledge, skills and competency are aimed for each target group.

The learning potential learning topics identified in deliverable D4.2 were described with respect to the following aspects:

- FoF Type (Smart Factory, Digital Factory, Virtual Factory, Cross-over)
- Key Audience:
  - Role (Technology Planner, Production Controller, etc.)
  - ICT Competency (Strong, Medium, Weak)
  - Process (Production Planning, Quality Control, etc.)
- Objectives:
  - Improving Attitude,
  - Transfer of Knowledge,
  - Development of Skills,

- Development of Competences.

While selecting the ILPE themes in deliverable D4.2, 4 objectives have been targeted:

- Foresee topics representing the entire product life cycle – means from product development to service
- Application of almost all identified learning instruments and knowledge delivery mechanisms (from serious games to class lectures)
- Address a wide spread set of potential roles affected to ICT in factories
- Take into account all aspects of ActionPlanT: Smart, Digital, Virtual Factory

Some changes occurred in the original plan due to changes in the priorities in the ActionPlanT project. Indeed, the Summer School that was scheduled for 2012 in Patras is replaced by the validation workshop.

The distribution of learning topics among the different ILPEs is based on the expertise and the learning infrastructure available at the organizing ActionPlanT consortium member in order to better use the available resources for ActionPlanT IL learning activities.

The assignment of the learning topics to the ILPEs during the workshops organized by the different ActionPlanT consortium members is made in such a way to cover as much ICT for manufacturing topics as possible and use most of the emerging delivery instruments such as teaching factory and serious games which seem to have a promising potential for learning ICT for manufacturing issues.

The final list of ILPEs organized within ActionPlanT project is shown in Table2.

Table 2: Schedule for ActionPlanT ILPEs

ILPE	Learning theme	Delivery mechanism	Place	Date
ILPE#1	Shop floor data processing	Teaching Factory	Dresden	03.02.2011
ILPE#2	Lean Manufacturing	Serious Game	Paris	29.06.2011
ILPE#3	Closed Loop PLM	Best Practice Tutorial	Geneva	07.09.2011
ILPE#4	Lean Manufacturing	Serious Game	Paris	17.01.2012

Producing a baseline document about IL as a means to develop ICT for manufacturing skills emerged as a priority during the project. The main issues reported in this document are:

- a review of e-skills currently related to manufacturing and an identification of gaps with respect to the future needs for e-skills in manufacturing;
- a set of recommendations for an effective use of IL to develop ICT for manufacturing skills.

A validation workshop will be organized in Athens on the 14th and the 15th of Mai 2012 to validate the outcomes of this document. Due to the importance of this workshop, it will be presented in a separate section (Section 6).

5 Organization of ILPEs

As mentioned in the previous sections, 4 ILPEs were organized within ActionPlanT. The details about these ILPEs are given in the following subsections.
A common objective of all ActionPlanT ILPEs is to test and evaluate the Learning Process Building Blocks for Competence Development in Figure 5.

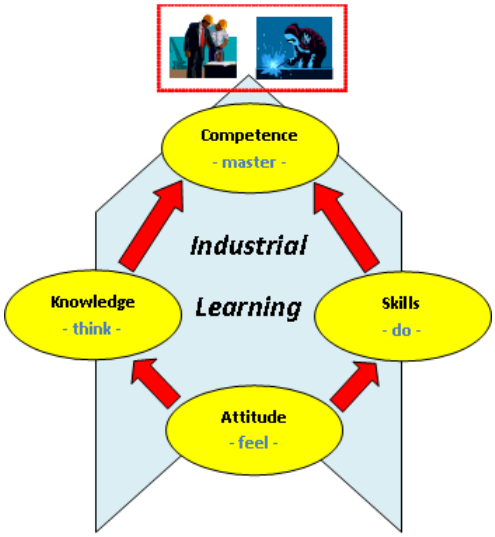

Figure 5. Learning building blocks of ActionPlanT IL

5.1 ILPE#1

The 1st ActionPlanT ILPE was organized in Dresden within the 1st ActionPlanT workshop. It considered the Teaching Factory Delivery Mechanism for IL where the participants were partitioned in heterogeneous groups to address the problem of building a visual dashboard which graphically displays data originating from devices on the shop floor by using specific software tools.

The main objectives of the 1st ActionPlanT ILPE were to test and evaluate the following aspects:

- The Learning Process Building Blocks for Competence Development:
  - Knowledge,
  - Skills,
  - Attitude.
- The Teaching Factory Delivery Mechanism
- Working in Heterogeneous Groups.

The main elements of the 1st ActionPlanT ILPE are summarized in Table 3.

Table 3: Main elements of the 1st ActionPlanT ILPE

1st **ActionPlanT ILPE**	
Training theme	Shop floor data processing
Delivery Mechanism	Teaching Factory
Target groups	Heterogeneous groups from both academia and industry

5.2 ILPE#2

The 2nd ActionPlanT ILPE was organized in Paris within the 2nd ActionPlanT ILPE workshop considered the Serious Games Delivery Mechanism for IL where the participants addressed the problem of assembling Lego cars within a traditional organization in the first round, a self optimized organization in the second round and a lean organization in the third round. The training theme addressed in this ILPE is related to Lean Manufacturing.

The main objectives of the 2nd ActionPlanT ILPE were to test and evaluate the following aspects:

- The Learning Process Building Blocks for Competence Development:
  - Knowledge,
  - Skills,
  - Attitude.
- The Serious Games Delivery Mechanism
- Working in Homogeneous Group.

The main elements of the 2nd ActionPlanT ILPE are summarized in Table 4.

Table 4: Main elements of the 2nd ActionPlanT ILPE

2nd ActionPlanT ILPE	
Training theme	Lean Manufacturing
Delivery Mechanism	Serious Games
Target groups	Homogeneous group with background in lean manufacturing

5.3 ILPE#3

The 3rd ActionPlanT ILPE was organized at CERN in Geneva considered the Best Practice Tutorial Delivery Mechanism for IL where the problems of PROMISE Data and Knowledge Management (PDKM) and PROMISE Messaging Interface (PMI) for Quantum Lifecycle Management were considered. The training theme addressed in this ILPE is related to Closed Loop PLM.

Since the learning topics considered for this ILPE are of high level quality from a theoretical viewpoint, the target group chosen for this ILPE comprises engineering researchers which have the necessary qualifications to follow and understand the concepts related to this type of topics.

The main objectives of the 3rd ActionPlanT ILPE were to test and evaluate the following aspects:

- The Learning Process Building Blocks for Competence Development:
  - Knowledge,
  - Skills,
  - Attitude.
- The Best Practice Tutorial Delivery Mechanism
- Working in Homogeneous Group.

The main elements of the 3rd ActionPlanT ILPE are summarized in Table 5.

Table 5: Main elements of the 3rd ActionPlanT ILPE

3rd ActionPlanT ILPE	
Training theme	Closed Loop PLM
Delivery Mechanism	Best Practice Tutorial
Target group	Homogeneous group of engineering researchers with different expertise levels in PLM

5.4 ILPE#4

The 4th ActionPlanT ILPE was organized at Altis Semiconductor Company in Paris on the 17th of January 2012. This ActionPlanT ILPE considered the Serious Games Delivery Mechanism for IL where the participants addressed the problem of assembling Lego cars within a traditional organization in the first round, a self optimized organization in the second round and a lean organization in the third round. The training theme addressed in this ILPE is related to Lean Manufacturing.

The main objectives of the 4th ActionPlanT ILPE were to test and evaluate the following aspects:

- The Learning Process Building Blocks for Competence Development in Lean Manufacturing:
  - Knowledge,
  - Skills,
  - Attitude.
- The Serious Games Delivery Mechanism
- Team work of participants from different functions in the same company.

The main elements of the 4th ActionPlanT ILPE are summarized in Table 6.

Table 6: Main elements of the 4th ActionPlanT ILPE

4th ActionPlanT ILPE	
Training theme	Lean Manufacturing
Delivery Mechanism	Serious Games
Target group	Participants with different roles from the same company

6 Evaluation of ILPEs

The evaluation of ILPEs is based on three sources:

- the feedback received from all trainees to the ILPE Questionnaire right after the end of the ILPE
- the assessment carried out by the professional training experts that participated in the ILPE as observers, and
- the comments of the rapporteurs that followed the activities of the three groups.

The evaluation approach is developed in Task 4.4 "Validation of the ActionPlanT industrial learning model". Its aim is to measure the impact of the industrial learning model and pilot events.

An ILPE Questionnaire has been developed and structured around the four major building blocks of the learning process, which are addressed by the ActionPlanT industrial learning model / methodology, i.e. attitude, knowledge, skills, and competence.

A set of metrics referring to the four building blocks of the learning process, i.e. attitude, knowledge, skills and competence are identified and used to define the ILPE Questionnaire. Each metric is associated with a specific question included in the Questionnaire used for ILPEs evaluation.

For each building block, the metrics help measuring in a quantified way the achievement of the respective goal. The metrics aim to capture the "contribution" of the ILPEs in improving the attitude, knowledge, skills and competence of the trainees with respect to the introduced ICT for manufacturing theme. Thus, they measure the "difference" in the levels of attitude, knowledge, skills and competence, before and after the ILPE as perceived by the trainees.

The general goals presented in Table 7 are customized to each ILPE case to suit to its specificities.

Table 7: General goals of ActionPlanT ILPEs

	Definition	**ILPE goals**
Attitude	"Attitude" is a hypothetical construct that represents an individual's degree of like or dislike for an item. Attitudes are generally positive or negative views of a person, place, thing, or event.	Create awareness, attract interest, increase motivation to learn & apply
Knowledge	"Knowledge" means the outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices that is related to a field of work or study.	Create a basic technology understanding (basics of relevant theory & SW) oriented to industrial practice, and acquaint with relevant ICT tools to search for further information
Skills	"Skills" means the ability to apply knowledge and use know-how to complete well defined tasks. Skills may be cognitive or practical	Acquaint with the use of dedicated software tools, complete a well defined task involving processing of data with the given tools
Competencies	"Competence" means the proven ability to use knowledge, skills and personal, social and/or methodological abilities. Competences may be considered as the interface between the learning and the innovation processes.	Build-up basic ability to combine different pieces of knowledge, developed skills and own understanding, to make decisions and address real life-like use cases

The trainees' responses in the Questionnaire of each ILPE are processed appropriately, so as to assign specific values to the metrics. Mean values are extracted on the basis of all trainees inputs. Standard techniques, i.e. normalization, weights assignment, multi-criteria weighted rating etc. are used to get overall impact assessment values.

Selected experts from the three activity levels (projects, ETPs and wide audience) will be involved in the validation process.

For each ILPE, training experts are invited to observe, assess and evaluate the different aspects of the learning activities.

Both the experts and the learners participate in the evaluation of the training activities organized in the framework of ActionPlanT ILPEs. Their answers to the evaluation questionnaires and their feedback in general are considered for the validation of ActionPlanT IL.

The experts evaluate the ILPEs mainly from the following viewpoints:

- adequacy of delivery methods,
- adequacy of grouping approaches and participants,
- identification of challenges regarding learning content and delivery methods to be taken into account for future research.

Existing approaches to learning evaluation are taken under consideration in the detailed definition of the evaluation methodology.

The trainees' feedbacks to the questionnaires have been statistically processed.

Qualitative assessment aims to draw conclusions, on the basis of the statistical analysis of the trainees' feedbacks, about:

- the improvement of the attitude, knowledge, skills and competence of the trainees with respect to the introduced learning module,
- the actual work flow and performance of the group, the difficulties encountered by the trainees, their actual involvement and co-operation level,
- the strong / weak aspects of the introduced training delivery mechanism and areas of possible improvement for the training delivery.

As soon as the evaluation methodology is fully defined, it will be applied to the ILPEs outputs, so as to deliver a quantified impact measurement of the ILPEs, as well.

An evaluation report is made for each ILPE. It includes the different elements of the ILPE: learning theme, delivery mechanism, participants, analysis of the questionnaires in addition to the evaluation of the event.

The evaluation reports of the four ILPEs are given in the annexes of this deliverable.

7 ActionPlanT IL validation workshop

The ActionPlanT IL validation workshop will be held on the 14th and 15th of Mai 2012 in Athens. The workshop is titled “e-skills in European manufacturing: A view to the future” to account for the main mission of IL which consists of providing the means for manufacturing workforce to acquire ICT for manufacturing skills needed by the European manufacturing companies in order to implement and apply advanced ICT in manufacturing.

The scope of the Workshop is to host a forum of major European IL stakeholders in order to:

- validate the findings of the study on IL for developing ICT for Manufacturing Skills, which has been undertaken in the framework of ActionPlanT project and reported in a baseline document, and
- elaborate a multi-perspective strategic outlook to the future developments on e-skills for manufacturing in Europe.

The main expectations of the ActionPlanT project are:

- elaboration of the assessment of the current status on e-skills for manufacturing to identify the current gaps and directions for future work,
- synthesis of a multi-perspective strategic view to IL on ICT for manufacturing,
- validation of a set of recommendations for the delivery of the future e-skills to manufacturing formulated in the baseline document,
- initiation of discussion with the European IL stakeholders for the future take-up of the project developments.

The experts participating in the workshop are expected to provide the following contributions:

- prior to the Workshop, all experts will be invited to provide a preliminary validation of the project study (e-skills review and recommendations) on the basis of a Questionnaire,
- during the Workshop, all experts will be encouraged to actively participate in validation work group sessions, which will focus on the assessment of the current status on e-skills for manufacturing, as synthesized by the project, and the validation / elaboration of the recommendations for the delivery of the future e-skills for manufacturing, as introduced by the project. A briefing will precede the validation session to familiarize the experts with the format of the exercise,
- representatives of the key stakeholders will be also invited to give, during the 1st Workshop day, a 15-20 minute key note presentation on their organization’s view to the future for IL on ICT for Manufacturing.

To prepare the workshop, the invited experts receive a ToR document introducing the workshop, the ActionPlanT IL baseline document and a Questionnaire to be completed by the participants before to attend the workshop.

The Questionnaire will be the main basis for the validation exercise as it will collect the views of the participating experts about the issues to be validated during the workshop.

8 Conclusion

In this deliverable we reported on the outputs of the main activities related to the implementation of the ActionPlanT IL model undertaken in Task 4.3.

The 4 ILPEs organized within ActionPlanT project were briefly described. The details about ILPEs mainly the evaluation reports are given in the annexes.

The ActionPlanT ILPEs covered various ICT for manufacturing themes and tested different promising delivery mechanisms.

3 learning themes were considered in these ILPEs: **Shop Floor Data Processing**, **Lean Manufacturing** and **Closed Loop PLM**.

Also 3 important delivery mechanisms were tested in these ILPEs: **Teaching Factory**, **Serious Game** and **Best Practice Tutorial**.

In addition of the evaluation of ILPEs by the trainees with respect to improvement in attitude, knowledge, skills and competence regarding the ICT for manufacturing theme addressed, the experts and trainees also evaluated the suitability of the delivery mechanism to the learning content. Based on the feedback from trainees and experts who participated in the ILPEs, the following conclusions were made:

- The **Teaching Factory** is a suitable delivery mechanism for topics such as **Shop Floor Data Processing**,
- The **Serious Game** is a suitable delivery mechanism for topics such as **Lean Manufacturing**,
- The **Best Practice Tutorial** is a suitable delivery mechanism for topics such **Closed Loop PLM**.

Globally the 4 ILPEs were positively evaluated by both the trainees and the experts even though recommendations about further improvement of certain aspects of the ILPEs were provided and reported in the corresponding evaluation reports. Some of these recommendations were taken into account while organizing the subsequent ILPEs.

The ActionPlanT IL validation workshop to be held on the 14th and 15th of Mai 2012 in Athens aims to account for the best way to use IL as a means for developing ICT for manufacturing skills needed for the use of advanced ICT in manufacturing.

9 References

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- Mavrikios, D., Papakostas, N., Mourtzis, D., and Chryssolouris G. (2011). On industrial learning & training for the Factories of the Future: A conceptual, cognitive & technology framework. Journal of Intelligent Manufacturing, Special Issue on Engineering Education, DOI 10.1007/s10845-011-0590-9.

10 Annexes

10.1 Annex 1: ILPE#1

10.1.1 Description of the 1st ActionPlanT ILPE exercise

The purpose of the exercise of the 1st ActionPlanT ILPE was to ***build a visual dashboard*** which graphically ***displays data*** originating from ***devices on the shop floor*** using specific **SAP software tools** (Figure 6).

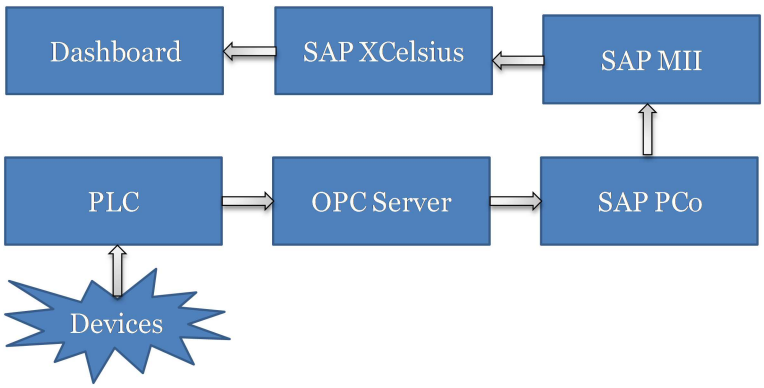


Figure 6. 1st ActionPlanT ILPE exercise

The exercise involves two main learning abilities:

- understanding of the process of vertical integration of different manufacturing software,
- demonstrating a sound ability to logically analyze the different steps involved in the processing the raw data into a meaningful format.

To build the visual dashboard, the trainees need to use of the following SAP software tools:

- **SAP Plant Connectivity (PCo)** which is used for connecting devices to backend business systems,
- **SAP Manufacturing Integration and Intelligence (MII)** which is used for expressing business logic which filters and marshals relevant data,
- **SAP Xcelsius** which is used for creating intuitive visualization interfaces.

The main ICT topics related to this exercise are: data formats, business logic writing, OPC, and PLC.

The main tasks of the participants in this exercise are the following:

- access and filter data,
- create business logic for triggering alerts based on certain predefined thresholds,
- build an intuitive dashboard which would help plant managers in assessing the status of their factory.

To provide guidance for the trainees about the exercise, a presentation about the different tools and steps required to realize the exercise was given before the beginning of the training sessions.

The complete script of the exercise is presented in Annex 3.

10.1.2 Goals of the 1st ActionPlanT ILPE

The goals of the 1st ActionPlanT ILPE regarding the improvement of attitude, knowledge skills and competencies are presented in Table 8.

Table 8: 1st ActionPlanT ILPE regarding attitude, knowledge skills and competencies

	Definition	**General ILPE goals**	**1st ILPE goals**
Attitude	"Attitude" is a hypothetical construct that represents an individual's degree of like or dislike for an item. Attitudes are generally positive or negative views of a person, place, thing, or event.	Create awareness, attract interest, increase motivation to learn & apply	Create awareness and attract interest with respect to the introduced engineering process and software tools
Knowledge	"Knowledge" means the outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices that is related to a field of work or study.	Create a basic technology understanding (basics of relevant theory & SW) oriented to industrial practice, and acquaint with relevant ICT tools to search for further information	Understanding of the process of vertical integration of different manufacturing software and of the different steps involved in the processing of raw data into meaningful formats
Skills	"Skills" means the ability to apply knowledge and use know-how to complete well defined tasks. Skills may be cognitive or practical	Acquaint with the use of dedicated software tools, complete a well defined task involving processing of data with the given tools	Acquaint with the use of SAP Plant Connectivity (PCo), SAP Manufacturing Integration and Intelligence (MII),
Competencies	"Competence" means the proven ability to use knowledge, skills and personal, social and/or methodological abilities. Competences may be considered as the interface between the learning and the innovation processes.	Build-up basic ability to combine different pieces of knowledge, developed skills and own understanding, to make decisions and address real life-like use cases	Build a visual dashboard which graphically displays data originating from devices on the shop floor

The overall objective of the 1st ActionPlanT ILPE was the assessment of the "Teaching Factory" paradigm as a knowledge delivery mechanism for industrial learning.

Another characteristic of the 1st ActionPlanT ILPE was the consideration of heterogeneous groups involving participants with various backgrounds and different interests from both academia and industry.

The evaluation of the 1st ActionPlanT ILPE takes into account all these viewpoints and assesses to what extent the different objectives have been achieved.

10.1.3 Participants in the 1st ActionPlanT ILPE

The participants in the 1st ILPE in Dresden, from both academia and industry were partitioned into 3 heterogeneous groups as in Tables 9-11.

For each group of trainees was assigned a rapporteur. The main tasks of the rapporteurs were to observe and report on various aspects of the training sessions, such as the actual work flow and performance of the group, the difficulties encountered by the trainees, their actual involvement, their

co-operation level etc. Their comments are taken into account in the evaluation of ILPEs addressed in Task 4.4 “Validation of the ActionPlanT industrial learning model”.

Table 9: Composition of group # 1 of the 1st ActionPlanT ILPE

Group #1	
Dr Pär Erik MARTINSSON	Luleå University
Mr Eric BOURGUIGNON	TUM
Dr Christoph HANISCH	Festo
Mr Thomas KNOTHE	IPK (Rapporteur)

Table 10: Composition of group # 2 of the 1st ActionPlanT ILPE

Group #2	
Mr Rainer BISCHOFF	KUKA
Dr Nenad IVEZIC	NIST
Dr Marcello COLLEDANI	POLIMI
Dr Dimitris MAVRIKIOS	U. Patras (Rapporteur)

Table 11: Composition of group # 3 of the 1st ActionPlanT ILPE

Group #3	
Mr Manuel LAI	CRF
Mr Hadrien SZIGETI	INTERCIM
Dr Jose Carlos CALDEIRA	INESC Porto
Dr Jacopo CASSINA	POLIMI (Rapporteur)

Two IL experts participated in the 1st ILPE as observers (Table 12). Their role was to observe and assess the training activities of the ILPE from different viewpoints: content, structure, delivery mechanism, etc. and make suggestions for the overall improvement of the industrial learning methodology and pilot events.

Table 12: IL experts that participated in the 1st ILPE

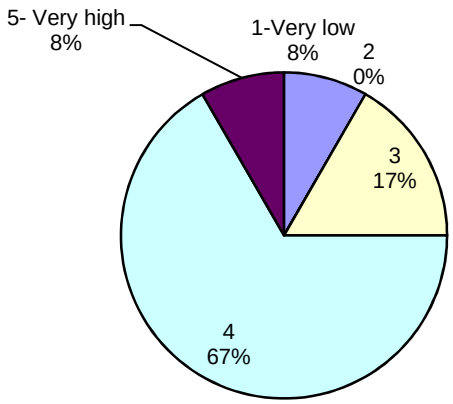
Observers

Dr Holger KOHL	IPK
Mr Heiko WEINAUG	IPK

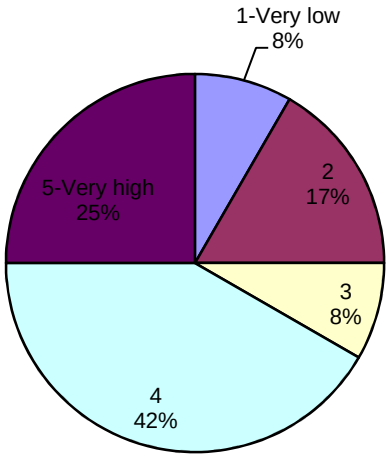
10.1.4 Analysis of the ILPE#1 questionnaires

Attitude

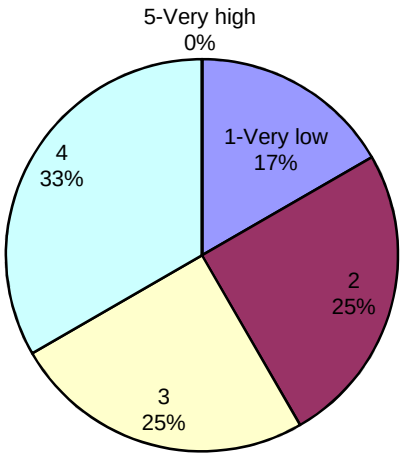
A1 – Indicate your interest in the introduced technology(ies) after this ILPE.



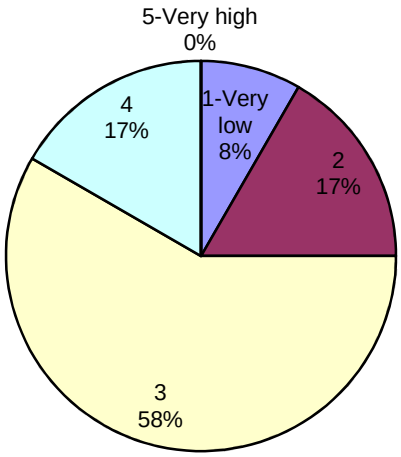
A2 – How would you rate the business potential of the introduced technology(ies) after this ILPE ?



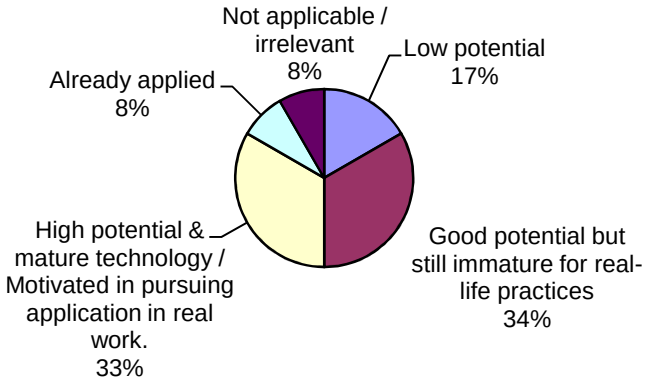
A3 – How would you rate the environmental impact of the introduced technology(ies) after this ILPE ?



A4 – How would you rate the societal impact of the introduced technology(ies) after this ILPE ?

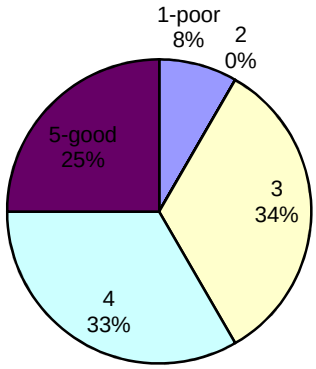


A5 – Indicate the potential (as you perceive that after the ILPE) of applying / integrating the introduced technology(ies) in the working practices of your company/institute

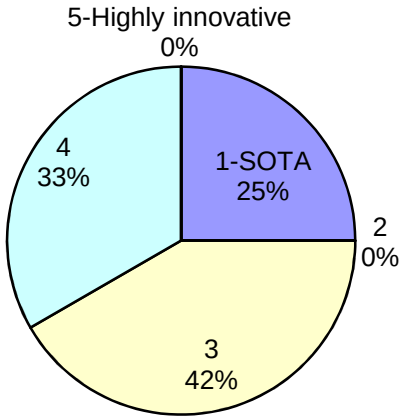


Knowledge

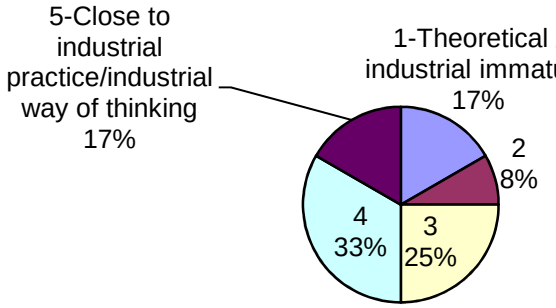
K1 – Indicate your understanding of the introduced technology(ies) after this ILPE.



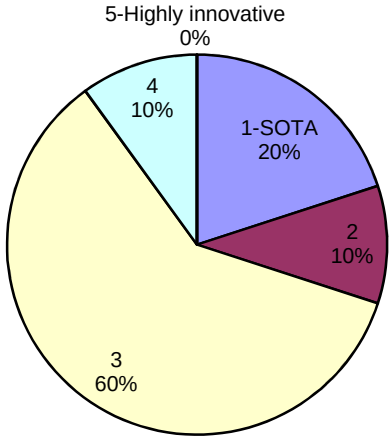
K2 – How would you rate the maturity of the ICT knowledge you got?



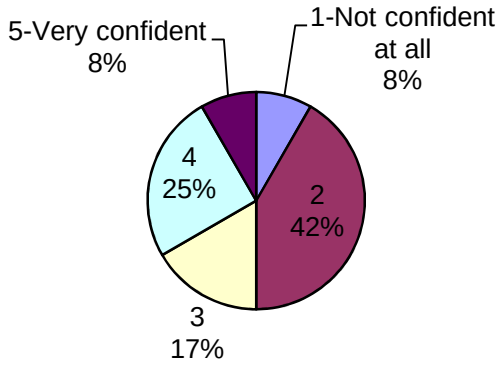
K3 – How would you rate the applicability of the ICT knowledge you got?



K4 - How would you rate the knowledge "delivery mechanism" used in the ILPE?-Innovative?

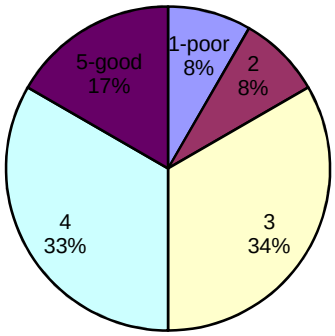


K5 – Do you feel confident that you can easily access, if you wish, more information / knowledge on the introduced technology(ies) after this ILPE ?

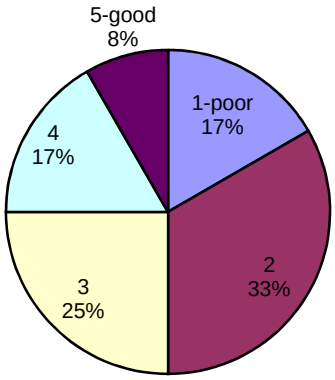


Skills

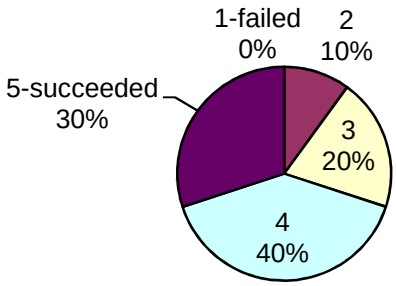
S1 – How would you rate your cognitive skills (e.g. data manipulation, logical thinking, understanding of task work flows etc.) with respect to the introduced technology(ies) before this ILPE ?



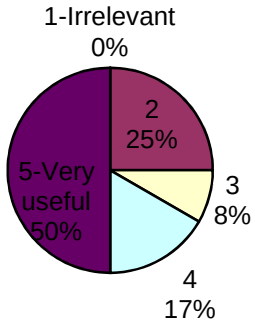
S2 – How would you rate your practical skills (e.g. good command of data input/output procedures, SW basic functions etc.) with respect to the introduced technology(ies) before this ILPE ?



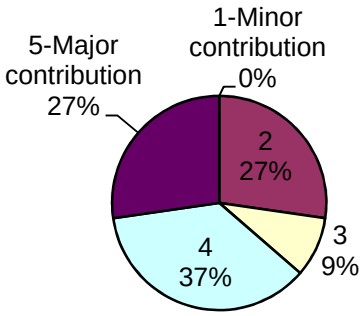
S3 - To what extent have you been able to complete well defined tasks (e.g. typical data processing et.) using the given software & hardware tools ?

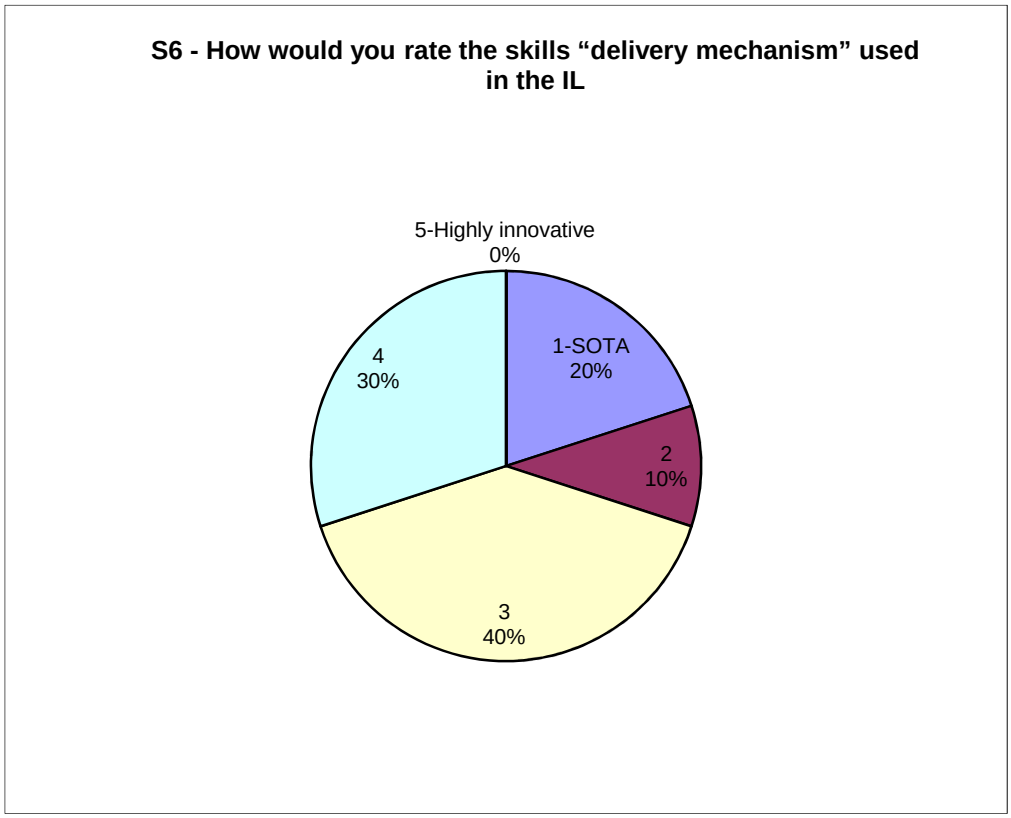


S4 – To what extent do you consider the offered hands-on practice useful for a better comprehension of the delivered knowledge?



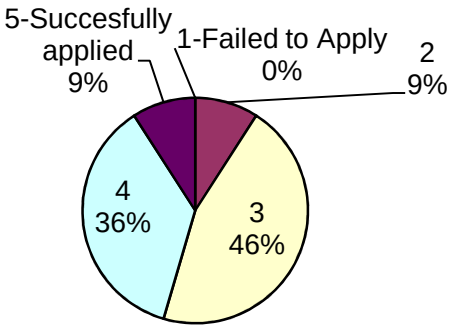
S5 - To what extent has collaboration and team work helped you in reaching a good level of skills in using the software tools?



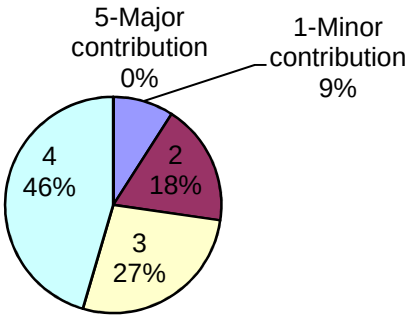

S6 - How would you rate the skills “delivery mechanism” used in the IL
5-Highly innovative
0%
1-SOTA
20%
2
10%
3
40%
4
30%

Competence

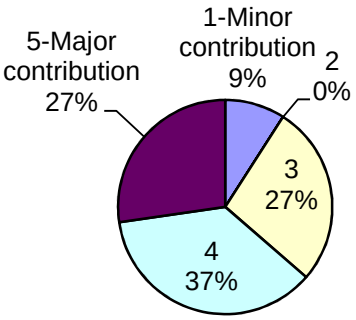
C1 – To what extent have you been able to apply the acquired knowledge and skills on the real life-like use case / exercise?



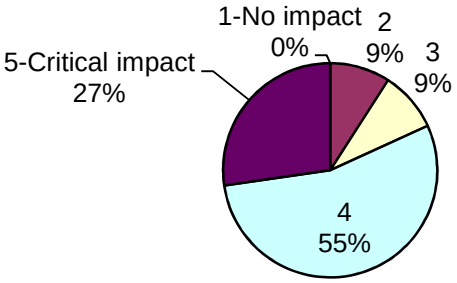
C2 - To what extent has the acquired knowledge and skills helped you in making correct decisions and reaching a solution to the real life-like use case / exercise?



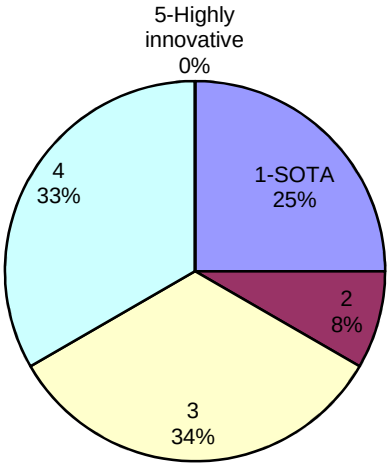
C3 - To what extent has collaboration and team work helped in making correct decisions and reaching a solution to the real life-like use case / exercise?



C4 – To what extent do you think that competence development using such training paradigms could help bridging the gap between new ICT knowledge and product / process innovation?

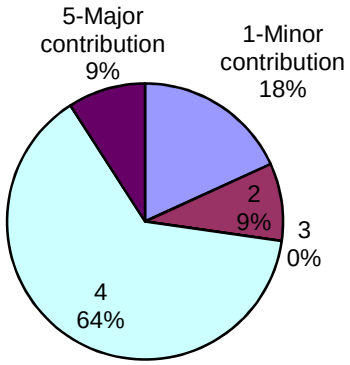


C5 - How would you rate the "Teaching Factory" used in the ILPE as a "mechanism" for competence development?

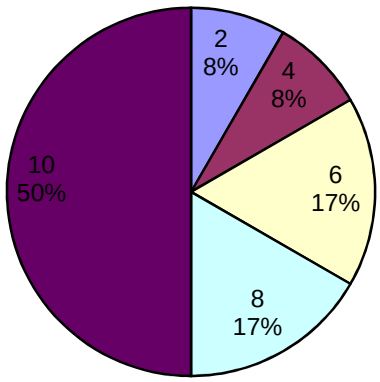


Overall ILPE

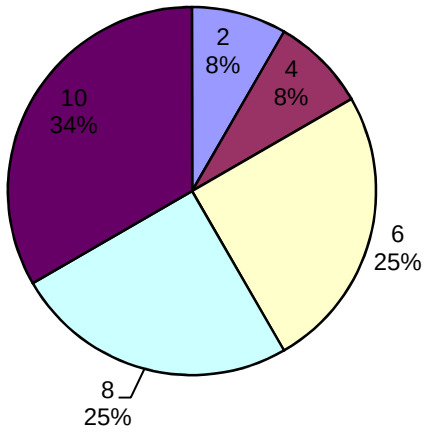
O5 - To what extent do you think the Teaching Factory concept demonstrated during the ILPE can help in making a sales/business decision ?



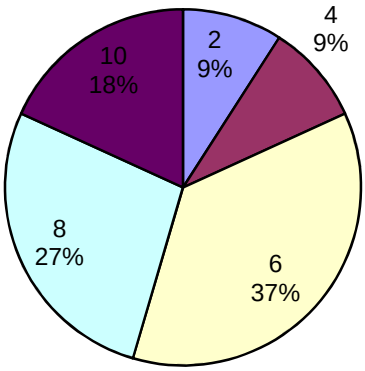
O1 - How would you rate the following aspects of this ILPE? Overall Organization



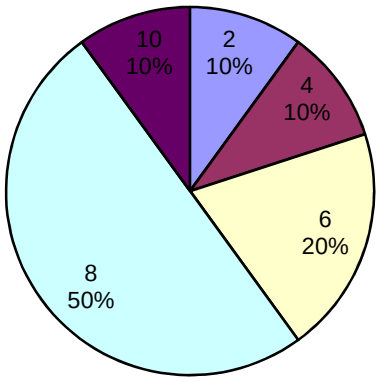
O1 - How would you rate the following aspects of this ILPE?- Structure



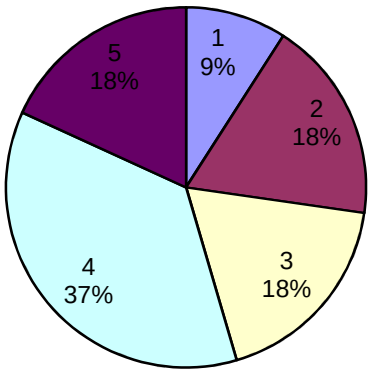
O1 - How would you rate the following aspects of this ILPE?- Supporting documentation



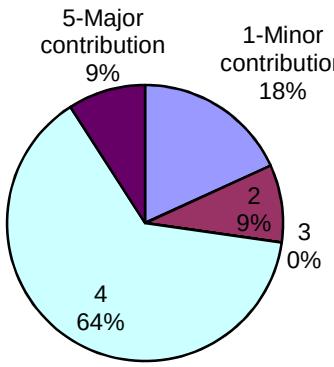
O1 - How would you rate the following aspects of this ILPE?
Knowledge content



O1 - How would you rate the following aspects of this ILPE?
Training aids, delivery mechanisms

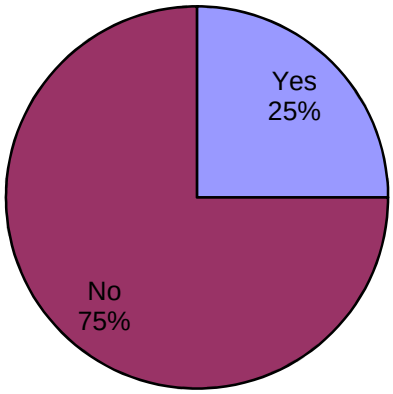


O5 - To what extent do you think the Teaching Factory concept demonstrated during the ILPE can help in making a sales/business decision ?

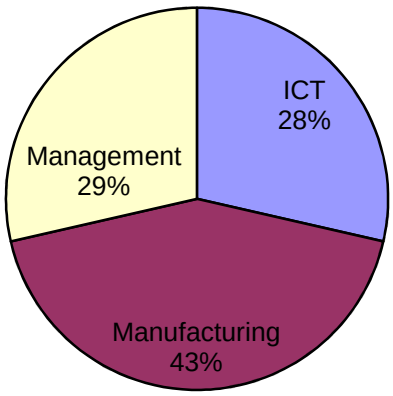


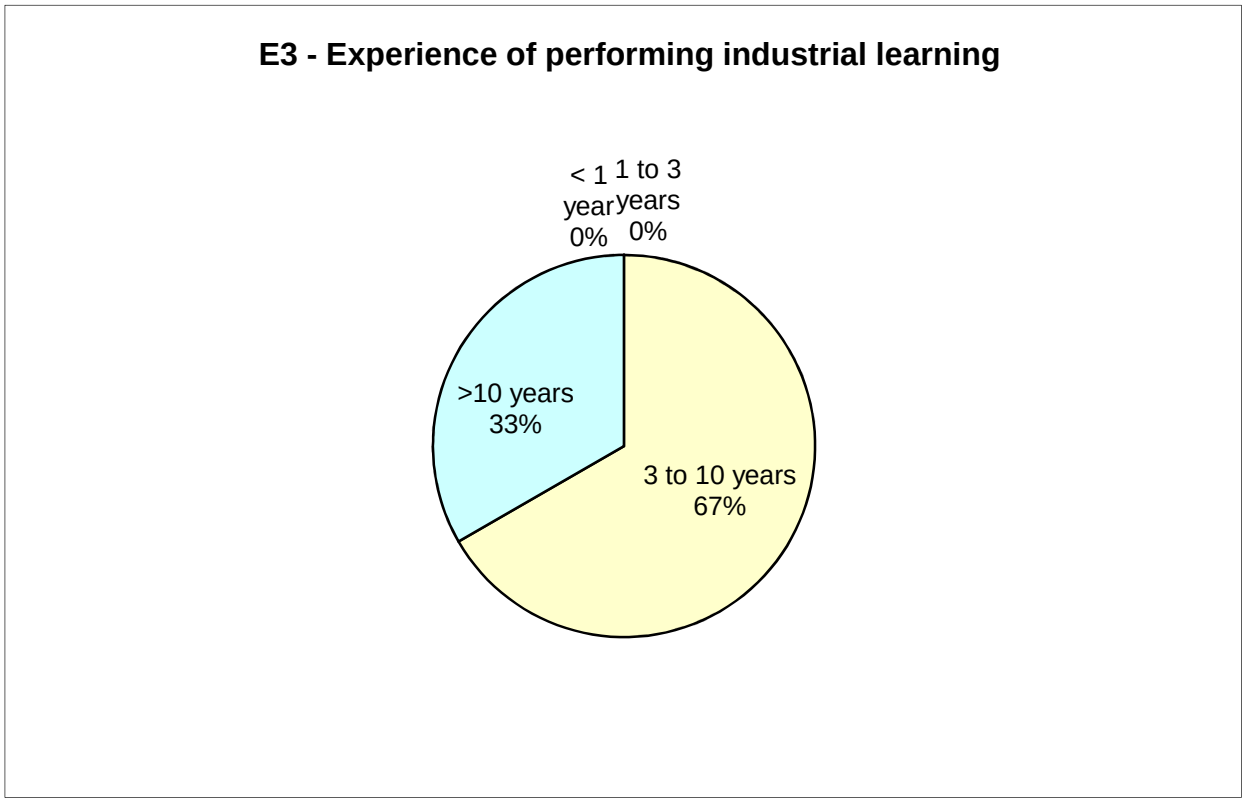
Exp in Industrial Learning

E1 - Do you perform industrial learning courses as a trainer?



E2 – Disciplines





10.1.5 Evaluation of learning process

This paragraph includes the qualitative assessment of the "contribution" of the 1st ILPE in improving the attitude, knowledge, skills and competence of the trainees with respect to the introduced learning module. The assessment is only based on the trainees responses to the ILPE Questionnaire, which was filled-in just after the end of the "exercise".

10.1.5.1 Attitude

- The trainees clearly indicated an increase of their interest in the introduced technology(ies) after this ILPE.
- The ILPE did not have a significant impact on the way the trainees perceived the business potential of the introduced technology(ies).
- A balanced attitude has been indicated concerning the maturity or not of the introduced technology(ies) for integration in industrial working practices
- The ILPE did not have a significant impact on the way the trainees perceived the environmental potential of the introduced technology(ies).
- The ILPE did not have a significant impact on the way the trainees perceived the societal potential of the introduced technology(ies).

10.1.5.2 Knowledge

- The trainees reported a significant improvement of their overall understanding of the introduced technology(ies) as an output of this ILPE

- The trainees generally considered the ICT knowledge communicated to them during the ILPE to be innovative
- The trainees generally considered the ICT knowledge communicated to them during the ILPE to be applicable to industrial practices
- The knowledge “delivery mechanism” used in the ILPE has been generally considered innovative but a significant number of trainees still questioned its appropriateness and efficiency for this knowledge transfer
- A balanced opinion has been recorded concerning the confidence that more information / knowledge on the introduced technology(ies) may be easily accessed after this ILPE

10.1.5.3 Skills

- The ILPE generally resulted in some increase of the trainees cognitive skills (e.g. data manipulation, logical thinking, understanding of task work flows etc.) with respect to the introduced technology(ies)
- The ILPE generally resulted in some increase of the trainees practical skills (e.g. good command of data input/output procedures, SW basic functions etc.) with respect to the introduced technology(ies). A significant number of trainees indicated though that their practical skills still remained poor.
- The trainees have been able to complete well defined tasks (e.g. typical data processing etc.) using the given software tools
- The trainees considered the offered hands-on practice useful for a better comprehension of the delivered knowledge
- Collaboration and team work has been reported as being generally helpful for reaching a good level of skills in using the software tools
- The skills “delivery mechanism” used in the ILPE has been generally considered to be appropriate and efficient, as well as rather innovative.

10.1.5.4 Competence

- The trainees have been able to apply quite well the acquired knowledge and skills on the real life-like use case / exercise
- The acquired knowledge and skills have been indicated as quite helpful in making correct decisions and reaching a solution to the real life-like use case / exercise
- Collaboration and team work helped in making correct decisions and reaching a solution to the real life-like use case / exercise
- The trainees confirmed that competence development using such training paradigms can help bridging the gap between new ICT knowledge and product / process innovation
- The “Teaching Factory” used in the ILPE has been generally considered as an appropriate / efficient and rather innovative “mechanism” for competence development. A significant number of trainees though considered that as SOTA.

10.1.6 General observations

Three Rapporteurs followed the activities of the three trainees groups, in order to comment on qualitative issues, such as the actual work flow and performance of the group, the difficulties encountered by the trainees, their actual involvement, their co-operation level etc.

The major general observations of the Rapporteurs have been the following:

- The interest and actual involvement of the trainees have been dependent on their familiarity with the introduced technologies and the underlying engineering process. Generally, only the trainees being familiar with these technologies showed active involvement.
- The trainees raised several questions for clarifying several issues with respect to the process and the SW tools. They initiated discussions bringing in ideas and suggestions about alternative options and/or improvements in user interfaces and/or process steps.
- The trainees were generally capable of carrying out the different steps of the exercise addressing only a few technical problems
- Not all trainees actually "touched" the software. Either one participant of each group, or even the group instructor himself, actually carried out all the relevant operations. That in fact limited the acquaintance of the trainees with the use of the SW tools.
- Due to the different levels of familiarity and nature of the task, co-operation was limited to discussions concerning the content of the exercise
- Trainees were not involved in a decision making process. The exercise was based on a well-defined series of steps / software operations, which the trainees had to follow without any deviation. Thus, there was no real need to make any "critical" decisions during the exercise execution.
- The overall understanding is that most trainees have reached a good basic understanding about the background concepts, the workflow logic and the functionalities of the software tools. Nevertheless, the general feeling of the trainees was that there was no "new engineering / ICT knowledge" transferred to them.
- There was also some feeling that the participants did not perceive the activity as a learning process, but rather as a predefined task they had to carry out

10.1.7 Overall impression

Based on their responses to the ILPE Questionnaire, the overall impression indicated by the trainees about the 1st ILPE, may be summarized in the following points:

- The trainees considered the overall ILPE organization being very good
- The structure, the knowledge content, the training aids and delivery mechanisms have been well received from the trainees. A less favorable, but still good, rate was given to the supporting documentation.
- The trainees consider that the Teaching Factory concept, which was demonstrated during the ILPE, can significantly help in making a sales/business decision

The trainees have considered the following points as the *strengths* of the 1st ILPE:

- The Future Factory itself and the concept of learning through the demonstration of realistic situations in factory settings
- The dedicated / active trainers with high technical competences
- The use of real software and data, the step-by-step approach and the repetition of the scenario, which greatly facilitated understanding
- The level of integration and diversity of the ICT solutions and demonstrated systems

The trainees have considered the following points as the *weaknesses* of the 1st ILPE:

- Background information not very well structured and communicated
- There was no great knowledge content in the exercise (i.e. just copy and paste of pre-defined steps etc.).
- There was lack of concrete application examples (e.g. at customer level) and no clear link with the benefits of this technology, e.g. what benefits compared with other SW
- Poor involvement of the trainees during both the knowledge transfer phase and the exercise

10.1.8 Recommendations

This paragraph includes the recommendations of the trainees and the expert trainers / observers for further improving the industrial learning methodology & knowledge delivery mechanisms used in the ActionPlanT ILPEs.

10.1.8.1 Trainees' suggestions

Based on their responses to the ILPE Questionnaire, the suggestions of the trainees may be summarized as follows:

- The "knowledge transfer" session, as well as the practical exercise, may be structured in smaller sub-sessions to make simpler
- A content-related questionnaire could be added to rate participant understanding
- A certificate of attendance could be given to the trainees / ILPE participants
- The manufacturing problem addressed in the exercise should allow a more active involvement of the trainees in identifying possible solutions, including discussion and collaborative decisions, using the provided SW or HW tools

10.1.8.2 Expert trainers' suggestions

The two expert trainers, which participated as observers in the 1st ILPE, suggested measures for the overall improvement of the industrial learning methodology and pilot events. Their suggestions took under consideration the structure and content of the 1st ILPE, as well as the applied and tested knowledge delivery mechanisms.

As per their suggestions, improvement potentials can be found in:

- Rising motivation
  - Create fast and easy feelings of success: Involving the participants as early as possible in practical application (better 5 small exercise distributed over the event than one long presentation followed by one big exercise)
  - Avoid comments like " Simple to understand", "This is easy" or "This is all what you have to do" (in correlation with long procedures and complex content, such comments discourage the trainees)
  - Create more dynamic events in the knowledge transfer process
- Learning structure
  - To increase the overall "knowledge transfer" within industrial learning it is recommended to develop a learning structure addressing the particular educational needs of the trainees.
- Knowledge content & presentation techniques
  - The complexity of the presented content needs to be adjusted to the knowledge and experiences of the trainees.
  - Use of readable font sizes
  - Reduce the complexity of graphics (e.g. concentrate to the important facts; use of animation to stepwise explain the content). The presentation should include easy understanding images and graphs to be remembered by audience.
  - Clear structure of the presentation that gives orientation to the auditorium (e.g. with content per bullets no longer than 10 minutes)
  - The presenters should be trained as "trainers" – it is always difficult for trainees to be trained by "developers".
- Hands-on practise / Group exercise
  - A larger group of participants were able to have access to the software directly; nevertheless there were still many trainees left who were only able to watch the exercise. Hence, it is recommended to allow more participants getting direct access to the application.

  - Due to the limited access to the application, the “knowledge transfer” within the ILPE has to be seen as limited.
  - Most of the work of the trainees was related to transfer the information given in the guideline to the software. Hence, the overall “knowledge transfer” related to the use of such software has to be stated as limited.
  - The “Teaching Factory” should identify other innovative learning mechanisms for involving more trainees in the actual exercise, also by reducing the complexity of the case study.
- Heterogeneous group approach
  - Different experiences and domains of the participants create different point of views and therefore different questions, which is an advantage. On the other hand, the different background level of the participants of the exercise leads to practically different level of attentiveness. Thus, a mechanism, or clearly defined constraints, are required to specify when and under which condition the heterogeneous group approach is a success factor or should be avoided

The expert trainers have also indicated a number of relevant European approaches and future challenges / research topics for industrial learning, which could be taken under consideration in the ActionPlanT methodology and pilot events.

Relevant approaches include:

- The European approach of “Corporate Universities for VET”.
- The European approach for measuring the Intellectual Capital of organizations (Intellectual Capital Statements) to easily identify specific needs in terms of Industrial Learning.
- A European Benchmarking Study for identifying available Best Practices in the area of Industrial Learning to be transferred within the European Industrial Community.

Relevant future challenges / research topics include:

- *Enabling methods* to efficiently transfer of didactical and vocational training capabilities as well as presentation competencies to the professional experienced persons that shall teach their knowledge (e.g. experts, technicians, etc.) as pre-condition for a motivating and sustainable industrial learning process
- *Innovative learning concepts* that take care of the often brought set of experiences of the people to be trained as well as their age (teaching concepts from school or university are often less effective applicable in industrial environment)
- *Mechanisms for the automated knowledge capturing* (e.g. capturing of efficient and constitutional work motion; automated capturing of best practise procedures)
- *Learning by doing-approaches* that assist the knowledge transfer embedded in the daily work (e.g. assistant systems that motivating guide the worker or clerk at their workplaces)
- *Cross-domain oriented transfer approaches of learning* (e.g. management and technicians learn together and share their experiences; technicians from different domains learn together)

10.1.9 Conclusion

The ILPE#1 took place on the 3rd of February 2011, at SAP Research premises in Dresden.
The learning paradigm chosen to be used and evaluated was based on the parading of “Teaching Factory”.
The participants of ILPE#1 were selected among the experts of WS1 of ActionPlanT participating also on the activities of days 1 and 2 of the workshop.
They have been distributed in heterogeneous groups together with SAP Research staff and students and selected project partners with the idea to test the level of collaboration and specific knowledge transfer among the participants of each group.
The learning content was extracted from the ICT developments done in the Future Factory Lab of SAP Research in Dresden and designed following the IL model and approach of ActionPlanT.

Based on the observations and recommendations from the participants and the expert observers given in the previous sections, the following further observations would be considered for the following ILPEs:

- Consider inviting local audience in ILPEs independently of the experts of ActionPlanT workshops
- In relation to point 10.1 above, consider collaborations with local training organisations.
- Rethink the model of heterogeneous groups and try also the model of homogeneous groups considering collaboration with industrial companies
- In relation with point 10.3 above and the observations of participants and observers of ILPE#1 consider the redesign of the exercise of ILPE#1 so that it would be given to an appropriate group of trainees selected in collaboration of local industry from the region of Dresden. This point must be checked for feasibility etc, with the SAP Future Factory Lab responsible colleagues.

10.2 Annex 2: ILPE#2

10.2.1 Description of the 2nd ActionPlanT ILPE exercise

The purpose of the exercise of the 2nd ActionPlanT ILPE was ***the simulation of car's assembly line*** by playing ***Muscle Car*** based on ***LEGO® car models*** where the participants should assemble as much cars as possible testing different types of organization: traditional, self optimized and lean.

The exercise involves 3 main rounds described as follows:

In the first round of the game, the participants manufacture cars according to a specific organization described by game rules.

In the second round, the participants propose their own organization in order to fix problems identified in the first round.

Then in the 3rd round, the participants experience some Lean principles in action in order to make production more efficient (Figure 7).

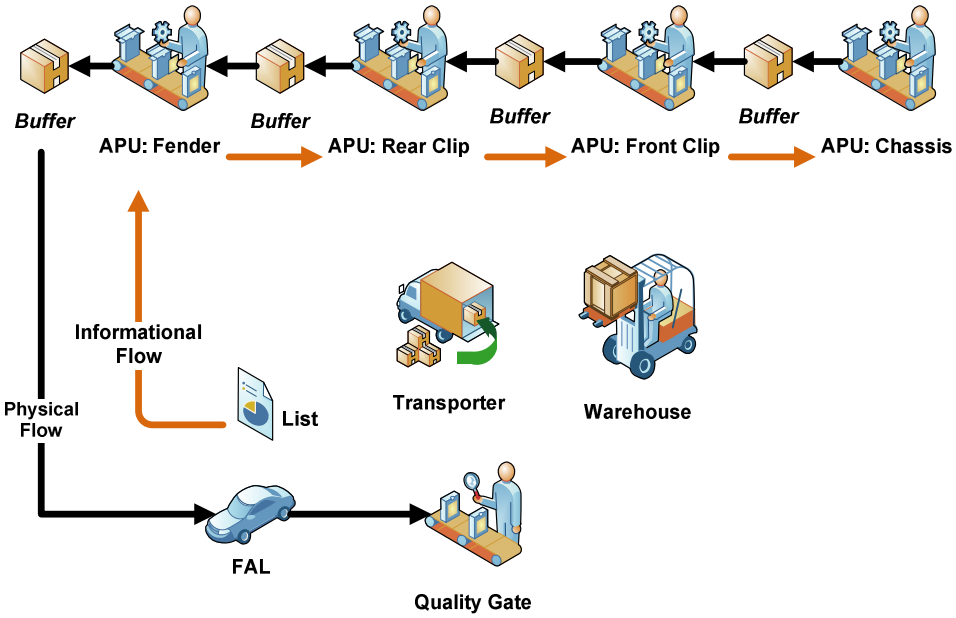


Figure 7. Organization using lean principles

At the end of the three rounds of the game, participants will have an overview (Debrief) of the impact of their choices on results and "lean Manufacturing, followed by a more formal presentation on Lean principles and the kind of ICT systems that are needed to implement them in modern production organizations.

The structure and timing of the 3 rounds of the serious game are shown in Table 13.

Table 13: Structure and timing of Muscle Car Serious Game

Round I	Initial rules of the game (role distribution and setup)	20'
	3 simulated weeks of work: | 10 minutes equal to one week (5 days) | + a break of 2 minutes for week-ends	45'
Round II	Team's own organization preparation	10'
	3 simulated weeks of work: | 10 minutes equal to one week (5 days)	45'

	| + a break of 2 minutes for week-ends	
Round III	New rules of the game (document to read)	15'
	3 simulated weeks of work: | 10 minutes equal to one week (5 days) | + a break of 2 minutes for week-ends	45'
	Debrief	15'

10.2.2 Goals of the 2nd ActionPlanT ILPE

The goals of the 2nd ActionPlanT ILPE regarding the improvement of attitude, knowledge skills and competencies are presented in Table 14.

Table 14: 2nd ActionPlanT ILPE goals regarding attitude, knowledge skills and competencies

	Definition	**ILPE goals**	**2nd ILPE Goals**
Attitude	"Attitude" is a hypothetical construct that represents an individual's degree of like or dislike for an item. Attitudes are generally positive or negative views of a person, place, thing, or event.	Create awareness, attract interest, increase motivation to learn & apply	Create awareness and attract interest with respect to Lean Manufacturing and the supporting ICTs
Knowledge	"Knowledge" means the outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices that is related to a field of work or study.	Create a basic understanding on business principles & supporting ICTs (basics of relevant theory & SW) oriented to industrial practice.	Create a basic understanding about the major principles, pillars and limitations of Lean Manufacturing, as well as about the manufacturing ICTs (e.g. MES, ERP, RFID etc.) implementing the underlying principles and enabling lean production
Skills	"Skills" means the ability to apply knowledge and use know-how to complete well defined tasks. Skills may be cognitive or practical	Acquaint with functions of software tools, information processing, workflows and organization schemes, and complete a well defined series of tasks applying the given knowledge	Apply different schemes for team work organization and information processing in assembly operations, including traditional schemes, self-organization and lean principles
Competencies	"Competence" means the proven ability to use knowledge, skills and personal, social and/or methodological abilities. Competences may be considered as the interface between the learning and the innovation processes.	Build-up basic ability to combine different pieces of knowledge, developed skills and own understanding, to make decisions, optimize operations and address real life-like use cases	Develop the capability of addressing realistic use cases involved in car assembly operations, requiring decision making and optimization of teamwork organization and information processing

The overall objective of the 2nd ActionPlanT ILPE was the assessment of the "Serious Games"

paradigm as a knowledge delivery mechanism for industrial learning.

Another characteristic of the 2nd ActionPlanT ILPE was the consideration of homogeneous group involving participants with background in lean manufacturing.

The evaluation of the 2nd ActionPlanT ILPE takes into account all these viewpoints and assesses to what extent the different objectives have been achieved.

10.2.3 Participants in the 2nd ActionPlanT ILPE

The participants in the 2nd ILPE in Paris are given in Table 15.

Table 15: List of trainees in the 2nd ActionPlanT ILPE

List of trainees	
Yann BEAXIS	Altis
Farouk BELKADI	UTC
Anne-Marie CHATELET	Danisco
Christophe DANJOU	IJTC
Djea DJEA-PRAGACHE	CETIM
Yuan LI	UTC
Gregory LEBRUN	Storengy GDF Suez
Vivien LECOQ	Panhard
Belkadi SAHLI	UTC
Jonathan TAHIATOHIUPOKO	UTC

All the participants have at least some basic background in lean manufacturing and the group is considered to be homogeneous regarding the required background.

Two rapporteurs (Table 16) were assigned to the group. The main tasks of the rapporteurs were to observe and report on various aspects of the training sessions, such as the actual work flow and performance of the group, the difficulties encountered by the trainees, their actual involvement, their co-operation level etc. Their comments are taken into account in the evaluation of ILPEs addressed in Task 4.4 “Validation of the ActionPlanT industrial learning model”.

Table 16: Rapporteurs in the 2nd ActionPlanT ILPE

Rapporteurs	
Dr Julien LEDUIGOU	UTC
Dr Ahmed BUFARDI	EPFL

Two IL experts participated in the 2nd ILPE as observers (Table 17). Their role was to observe and assess the training activities of the ILPE from different viewpoints: content, structure, delivery mechanism, etc. and make suggestions for the overall improvement of the industrial learning methodology and pilot events.

Table 17: IL experts in the 2nd ILPE

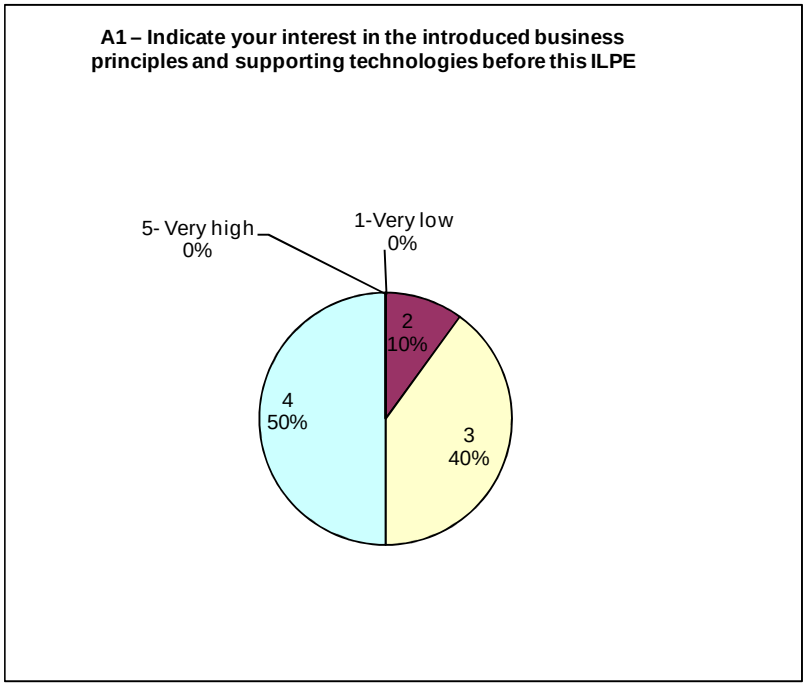
Observers	
Mr Marc ALVARADO	StoryMag
Mrs Annette LOCHER	I FSRM

Two instructors Hadrien SZIGETI and Mourad MESSAADIA supervised the learning process and intervened whenever the participants had a problem or a question about the exercise.

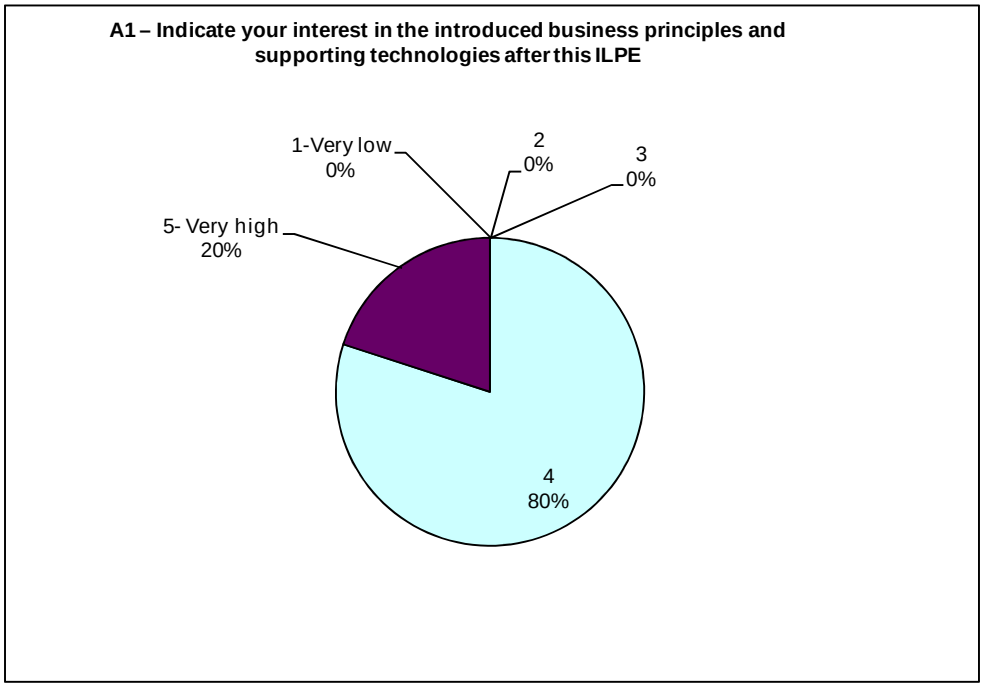
10.2.4 Analysis of the ILPE#2 questionnaires

Attitude

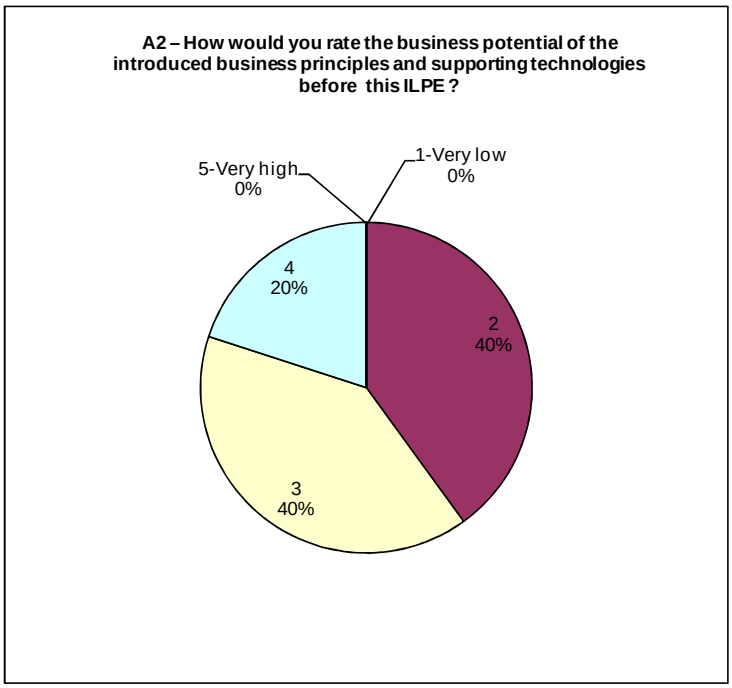
A1 – Indicate your interest in the introduced business principles and supporting technologies before this ILPE



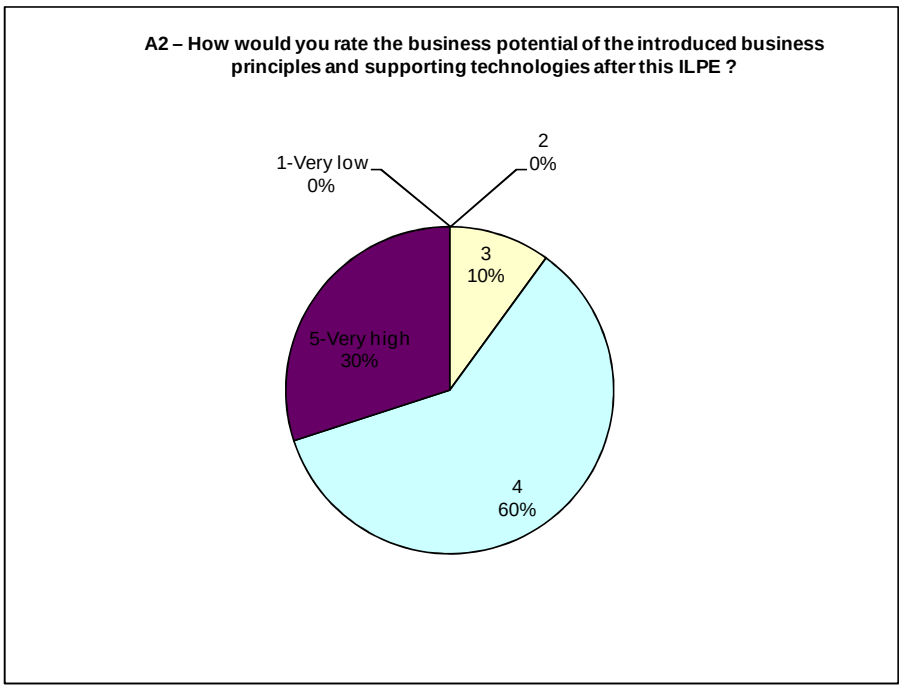
A1 – Indicate your interest in the introduced business principles and supporting technologies after this ILPE



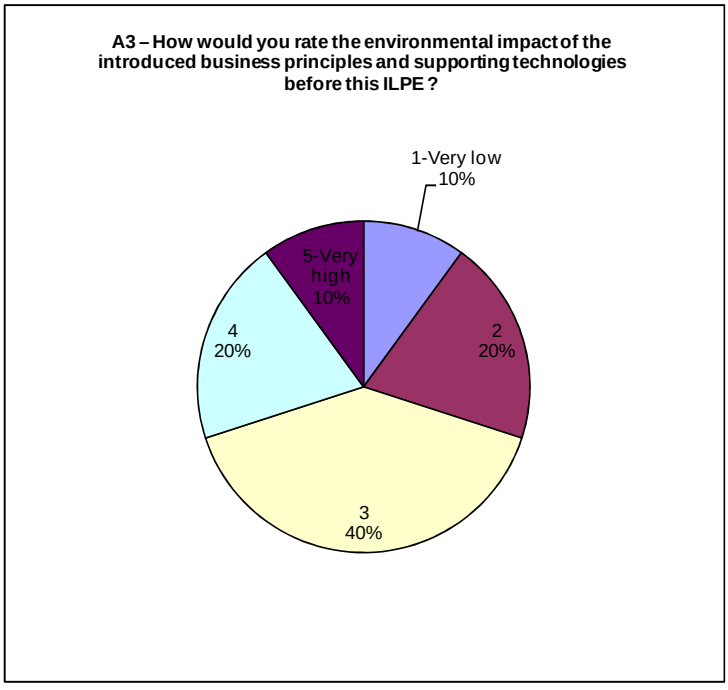
A2 – How would you rate the business potential of the introduced business principles and supporting technologies before this ILPE?



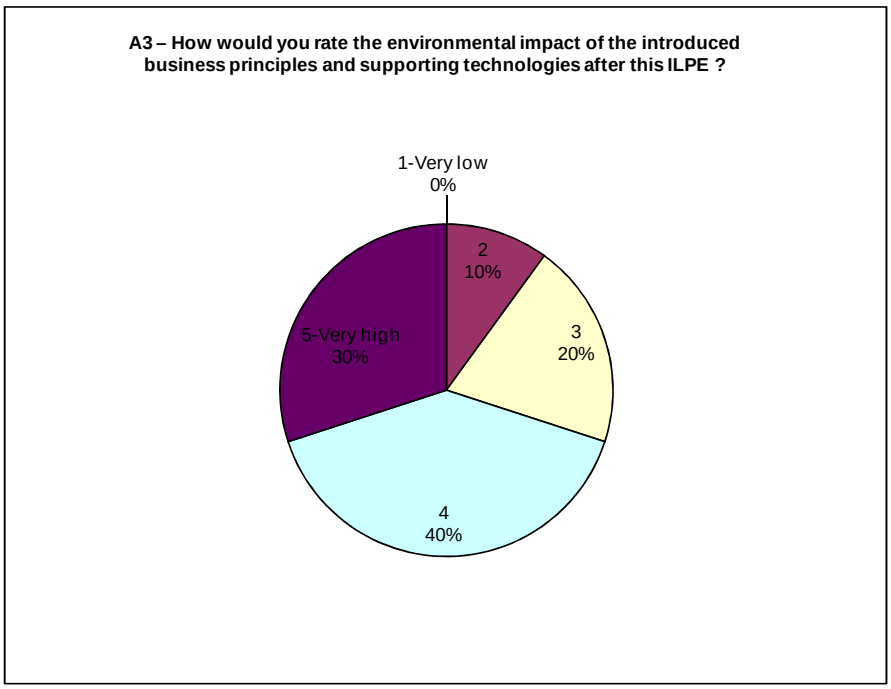
A2 – How would you rate the business potential of the introduced business principles and supporting technologies after this ILPE?



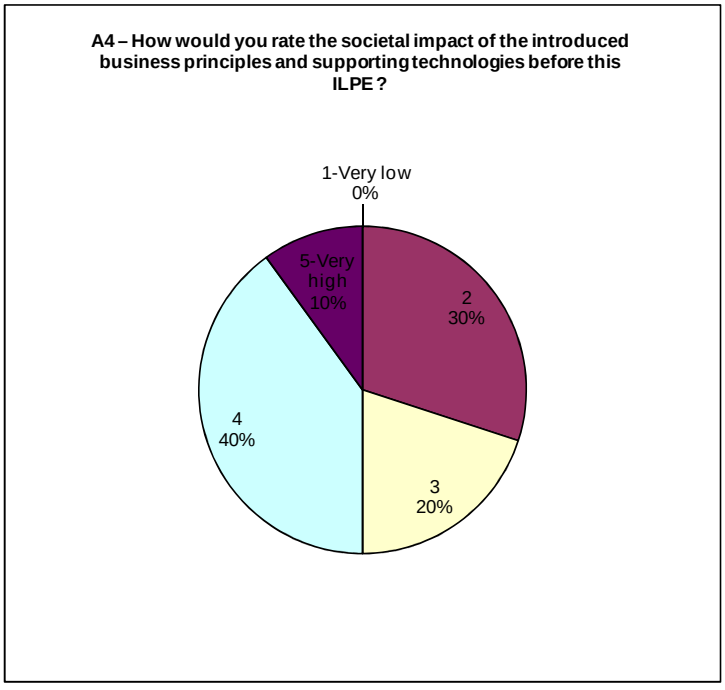
A3 – How would you rate the environmental impact of the introduced business principles and supporting technologies before this ILPE?



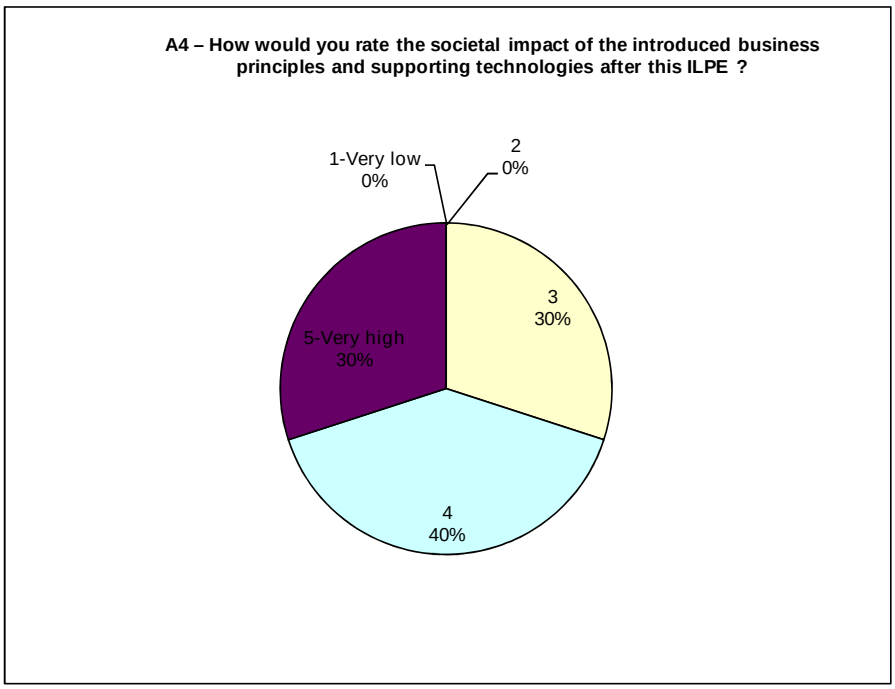
A3 – How would you rate the environmental impact of the introduced business principles and supporting technologies after this ILPE?



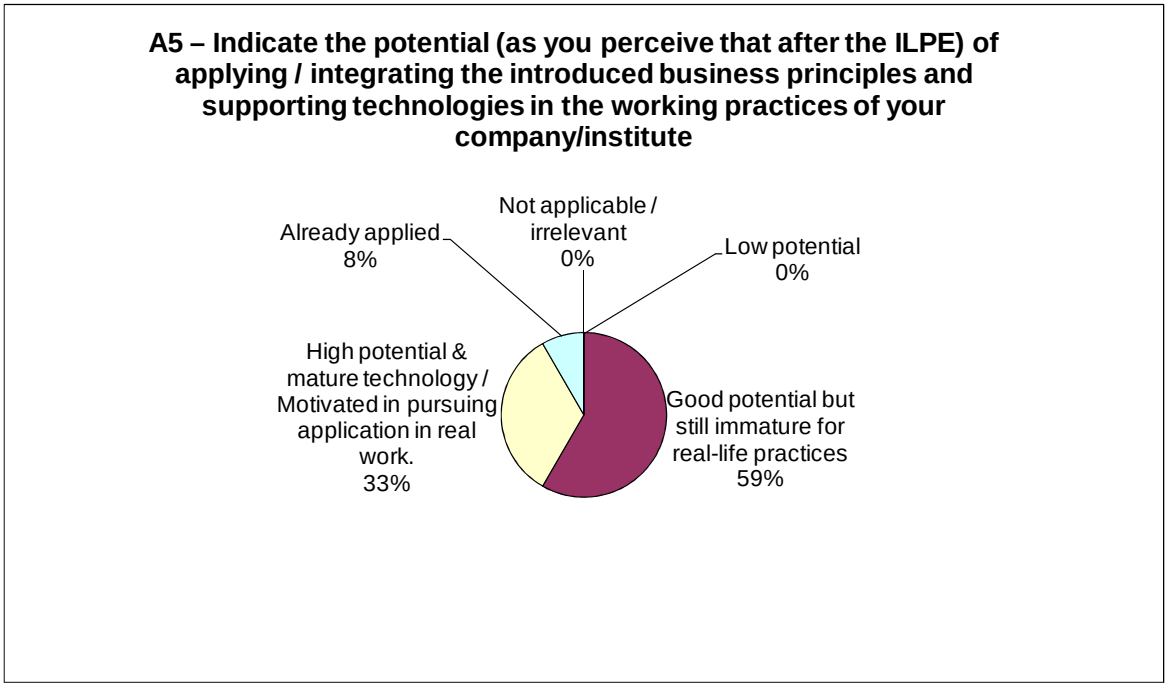
A4 – How would you rate the societal impact of the introduced business principles and supporting technologies before this ILPE?



A4 – How would you rate the societal impact of the introduced business principles and supporting technologies after this ILPE?

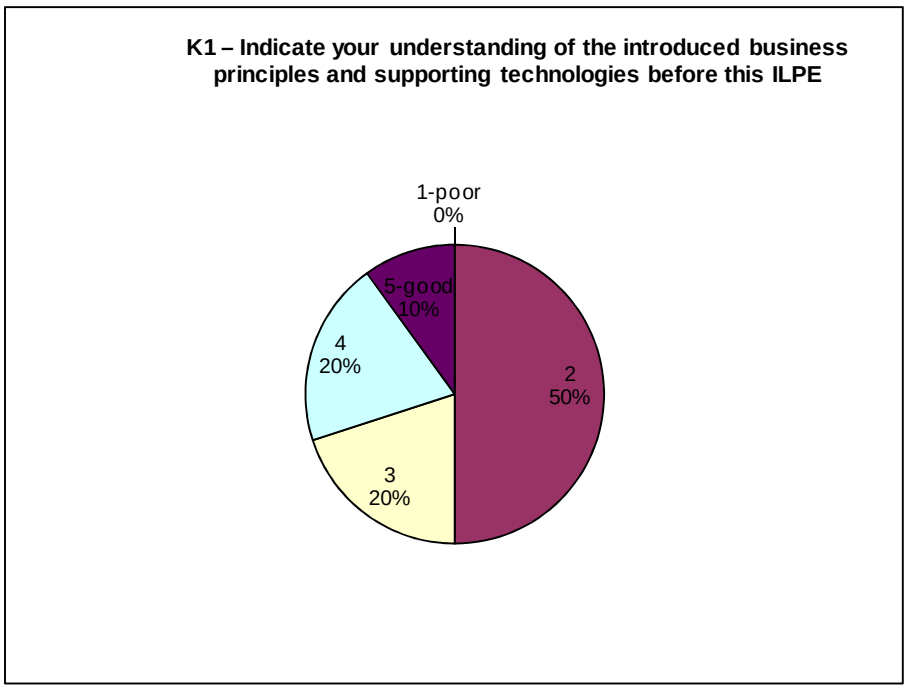


A5 – Indicate the potential (as you perceive that after the ILPE) of applying / integrating the introduced business principles and supporting technologies in the working practices of your company/institute



Knowledge

K1 – Indicate your understanding of the introduced business principles and supporting technologies before this ILPE.



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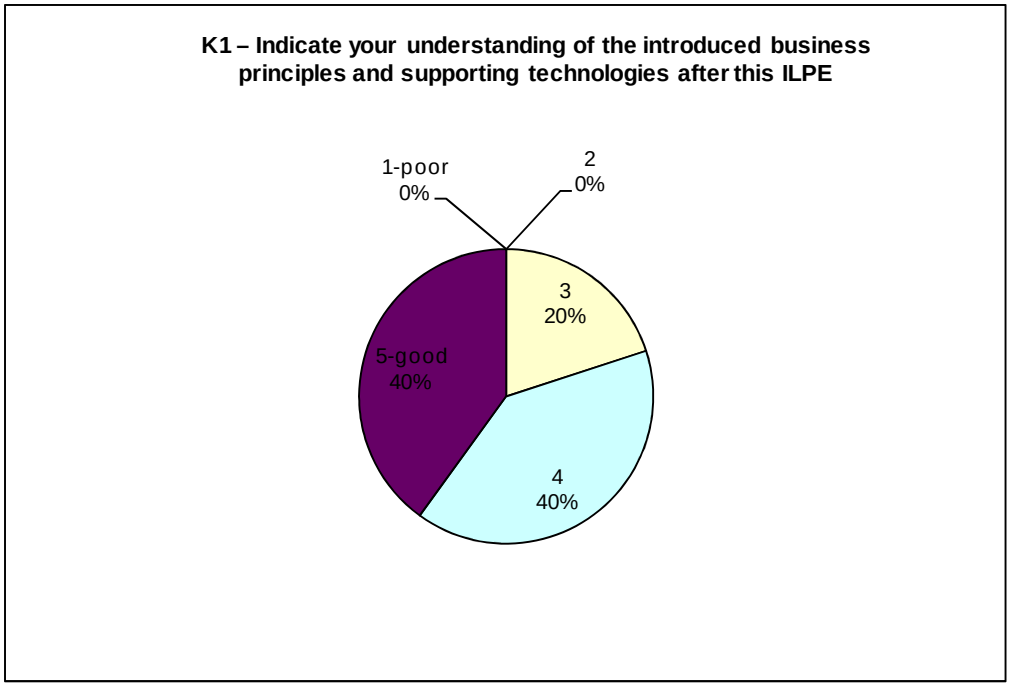
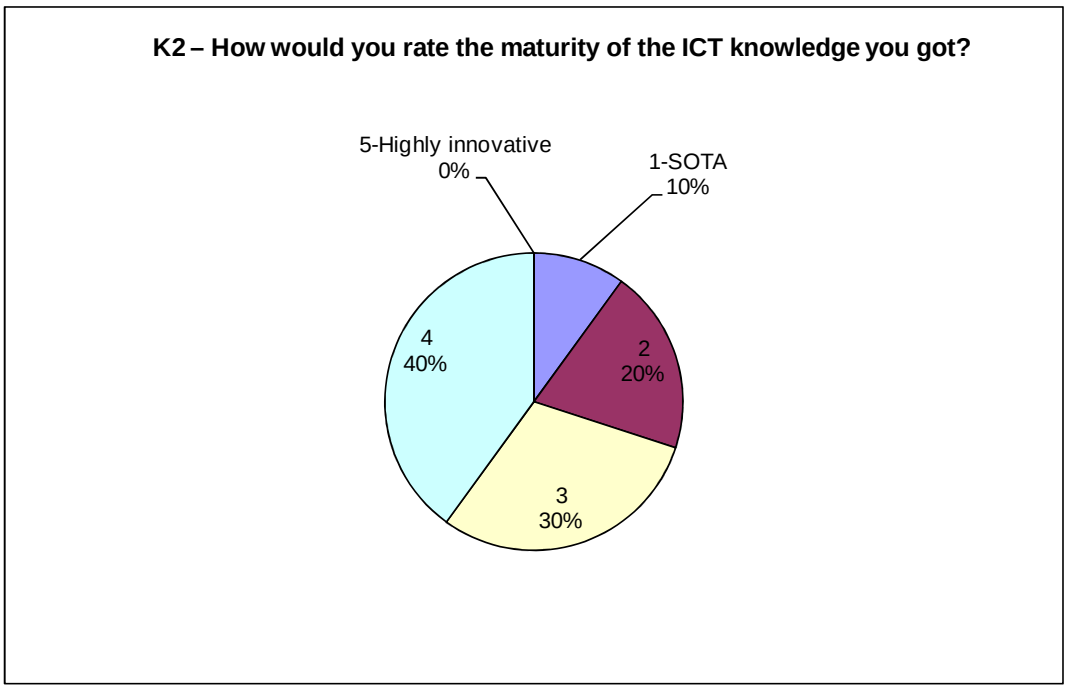
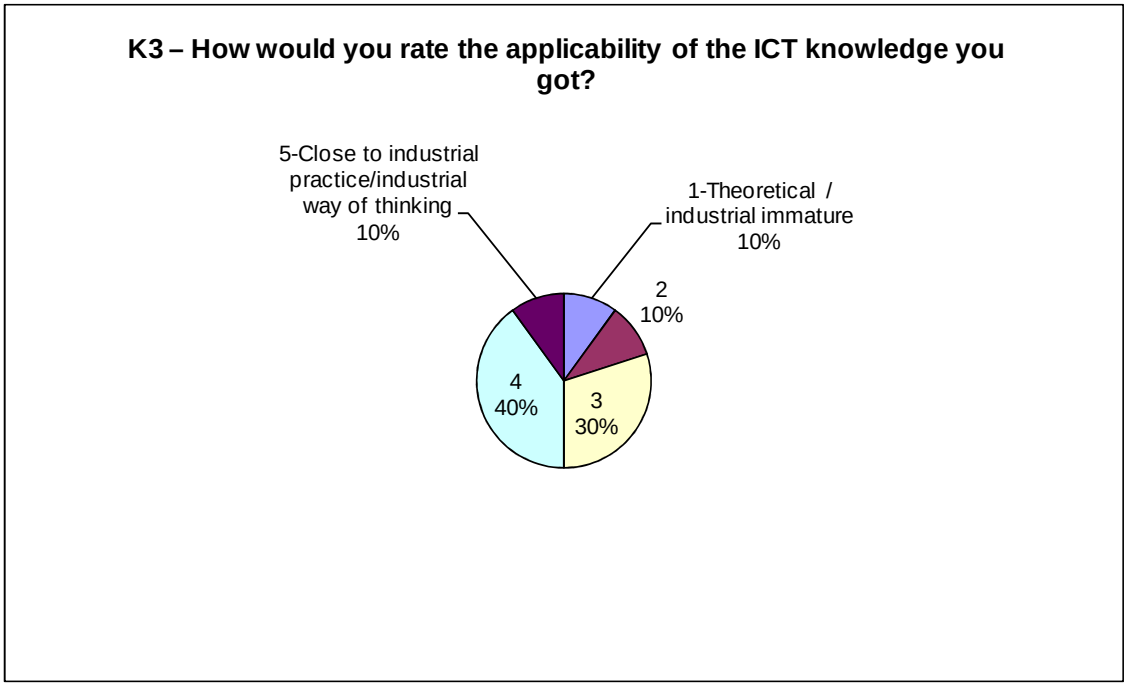


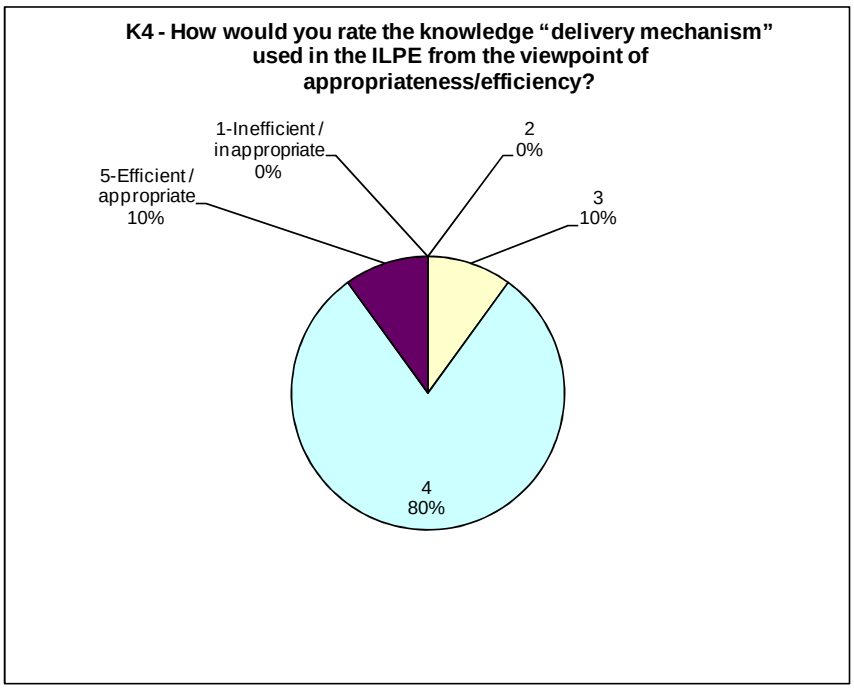
K2 – How would you rate the maturity of the ICT and business knowledge you got?



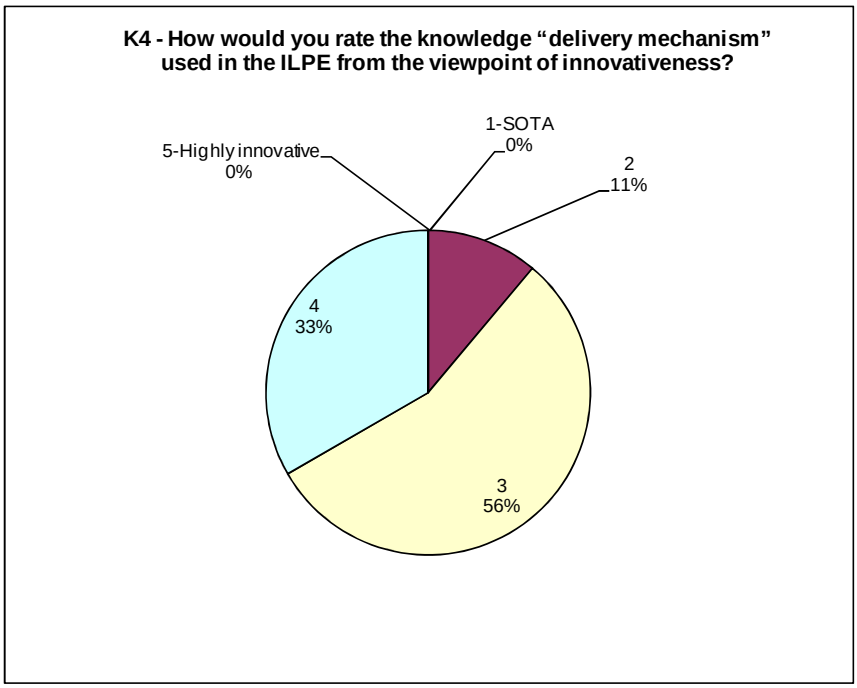
K3 – How would you rate the applicability of the ICT and business knowledge you got?



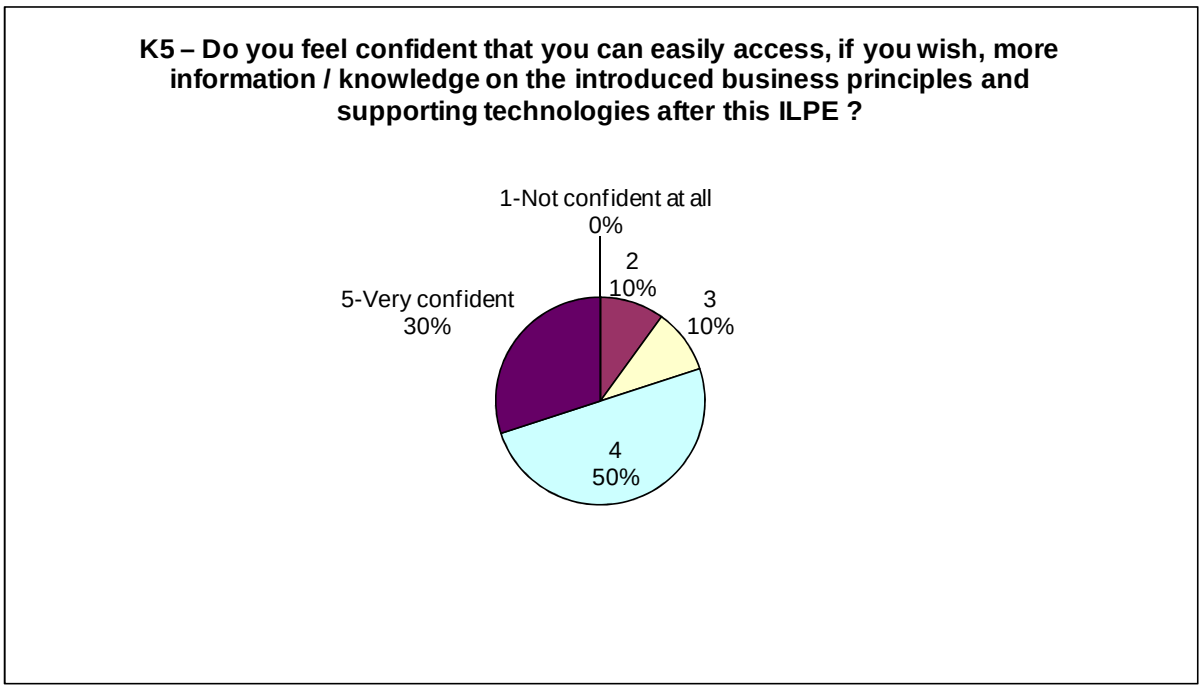
K4 - How would you rate the knowledge “delivery mechanism” used in the ILPE from the viewpoint of appropriateness/efficiency?



K4 - How would you rate the knowledge "delivery mechanism" used in the ILPE from the viewpoint of innovativeness?

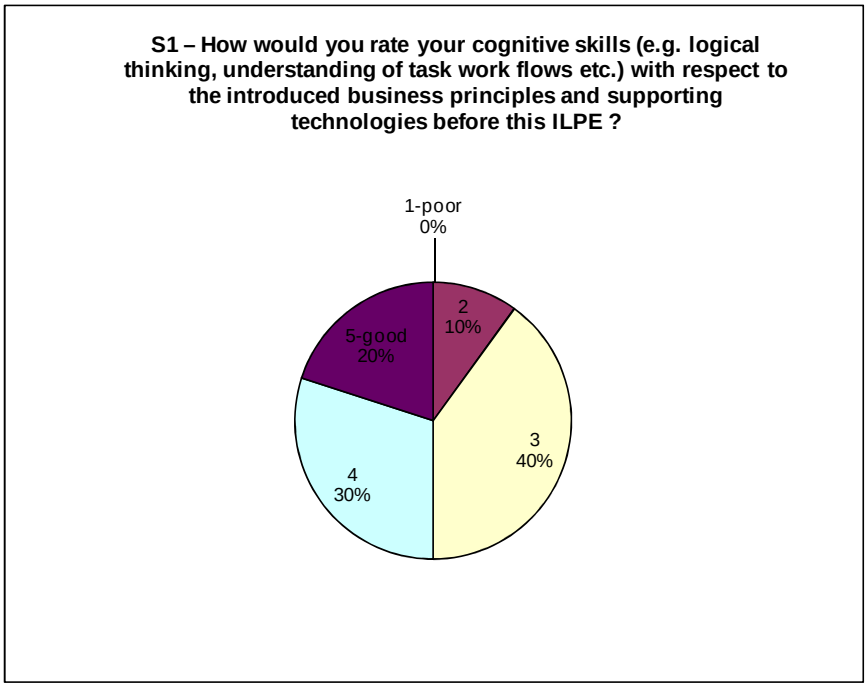


K5 – Do you feel confident that you can easily access, if you wish, more information / knowledge on the introduced business principles and supporting technologies after this ILPE?



Skills

S1 – How would you rate your cognitive skills (e.g. logical thinking, understanding of task work flows etc.) with respect to the business principles and supporting technologies before this ILPE?



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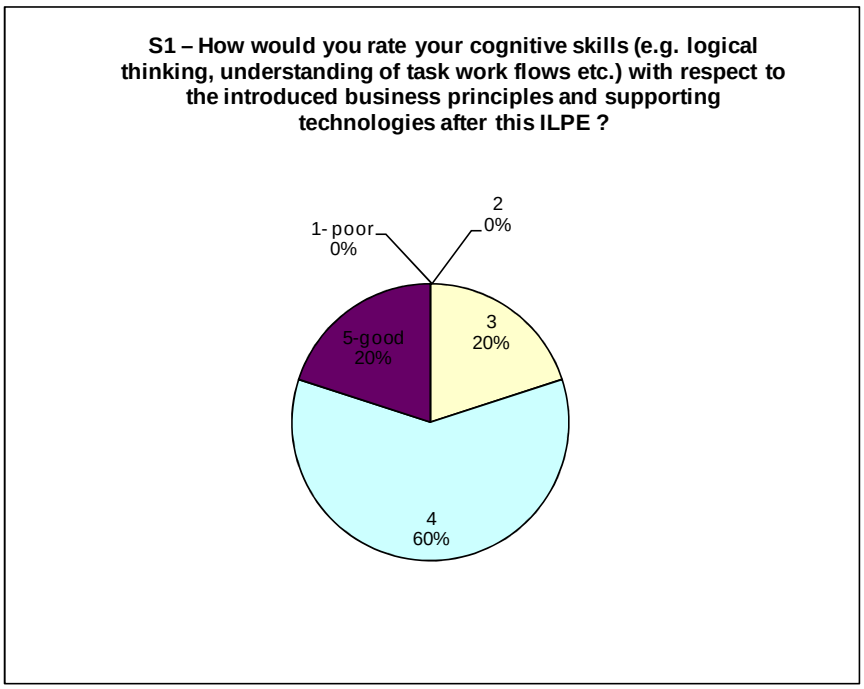
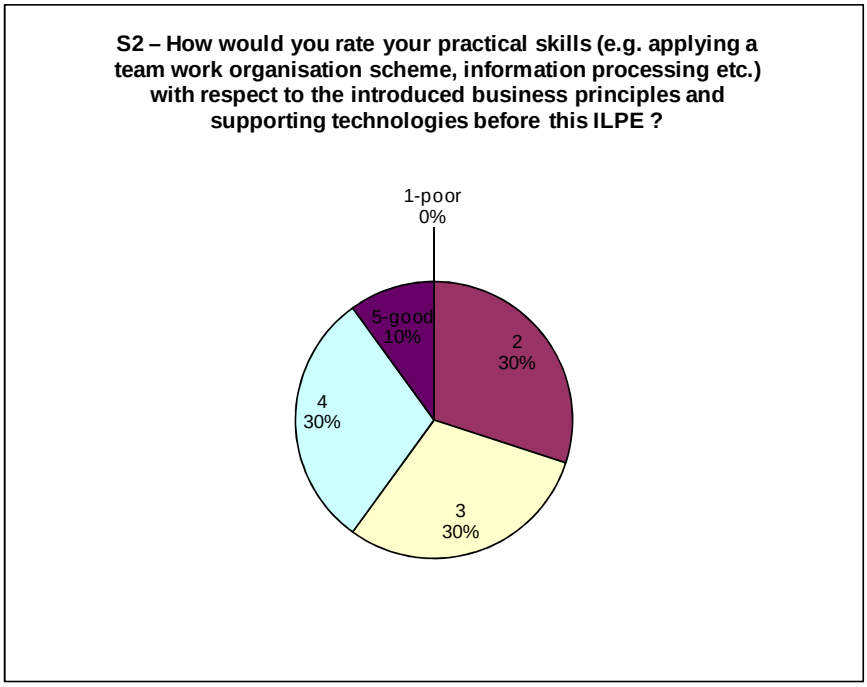


S2 – How would you rate your practical skills (e.g. applying a team work organization scheme, information processing etc.) with respect to the introduced business principles and supporting technologies before this ILPE?



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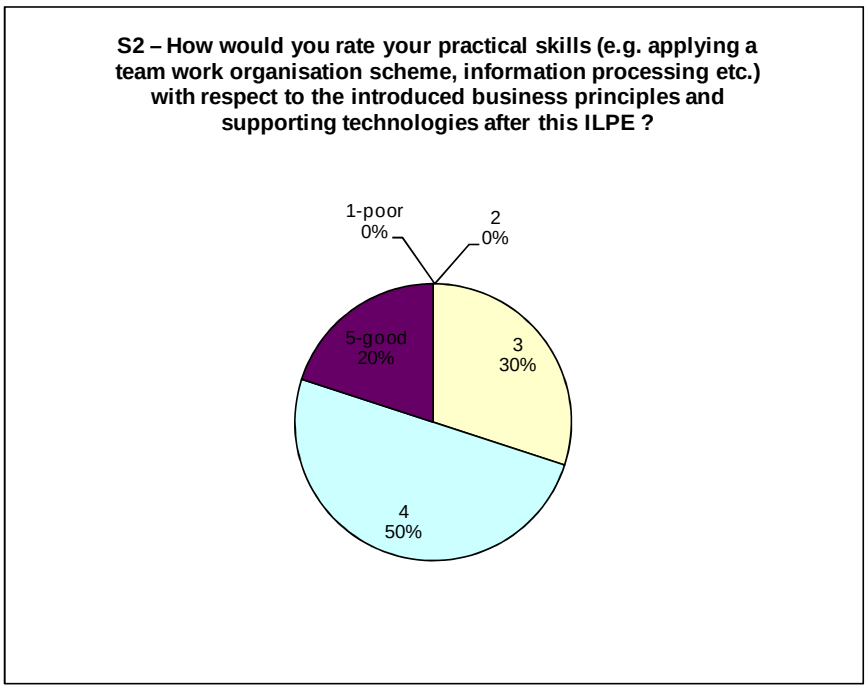
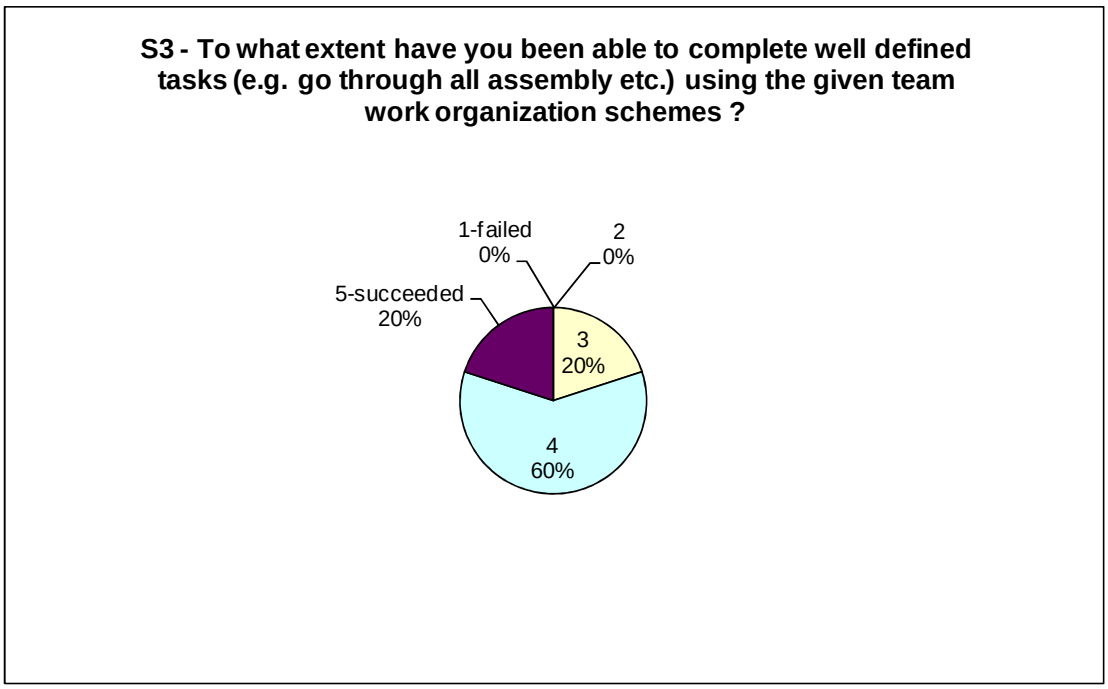


S3 - To what extent have you been able to complete well defined tasks (e.g. go through all assembly operation steps etc.) using the given team work organization schemes?



S4 – To what extent do you consider the offered hands-on practice useful for a better comprehension of the delivered business principles and supporting technologies?

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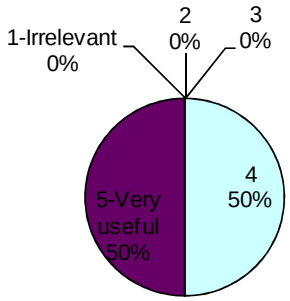

S5 - To what extent has collaboration with the other group members helped you in reaching a good level of skills in applying a team work organization and information processing scheme?

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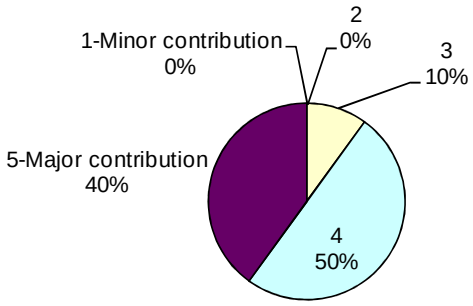
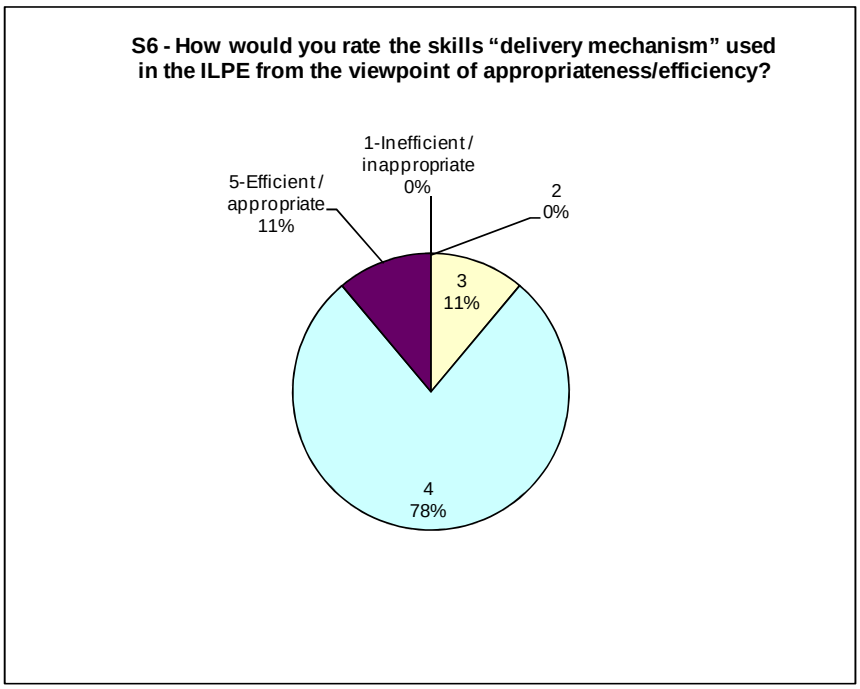
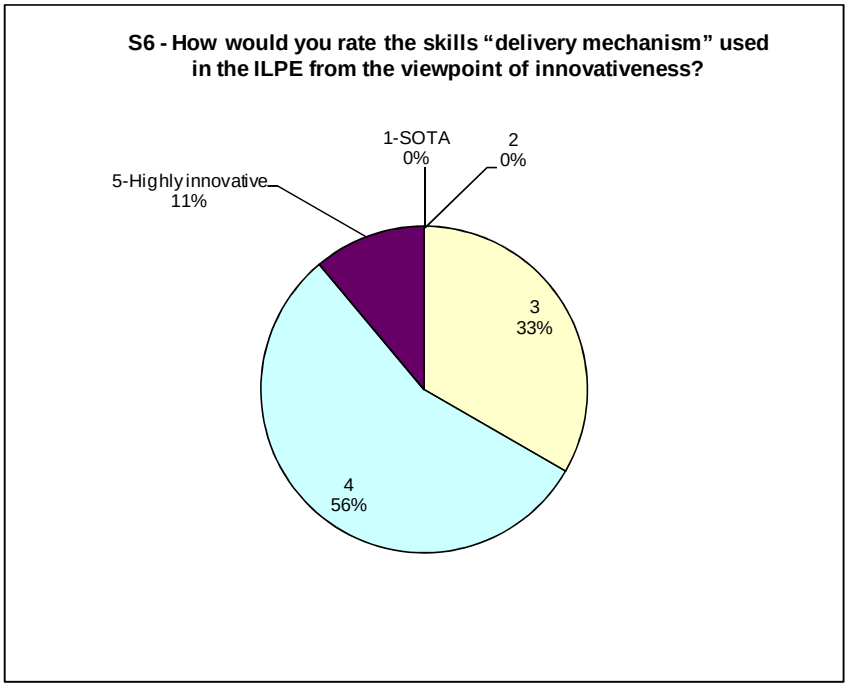


S6 - How would you rate the skills “delivery mechanism” used in the ILPE from the viewpoint of appropriateness/efficiency?

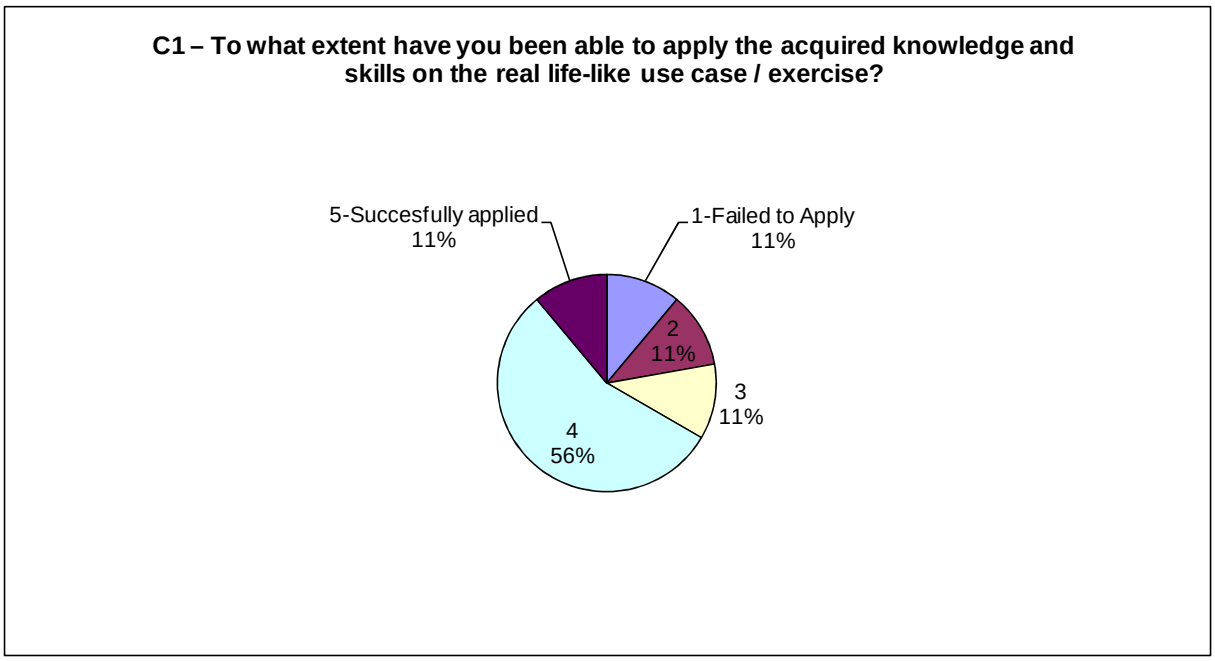


S6 - How would you rate the skills "delivery mechanism" used in the ILPE from the viewpoint of innovativeness?

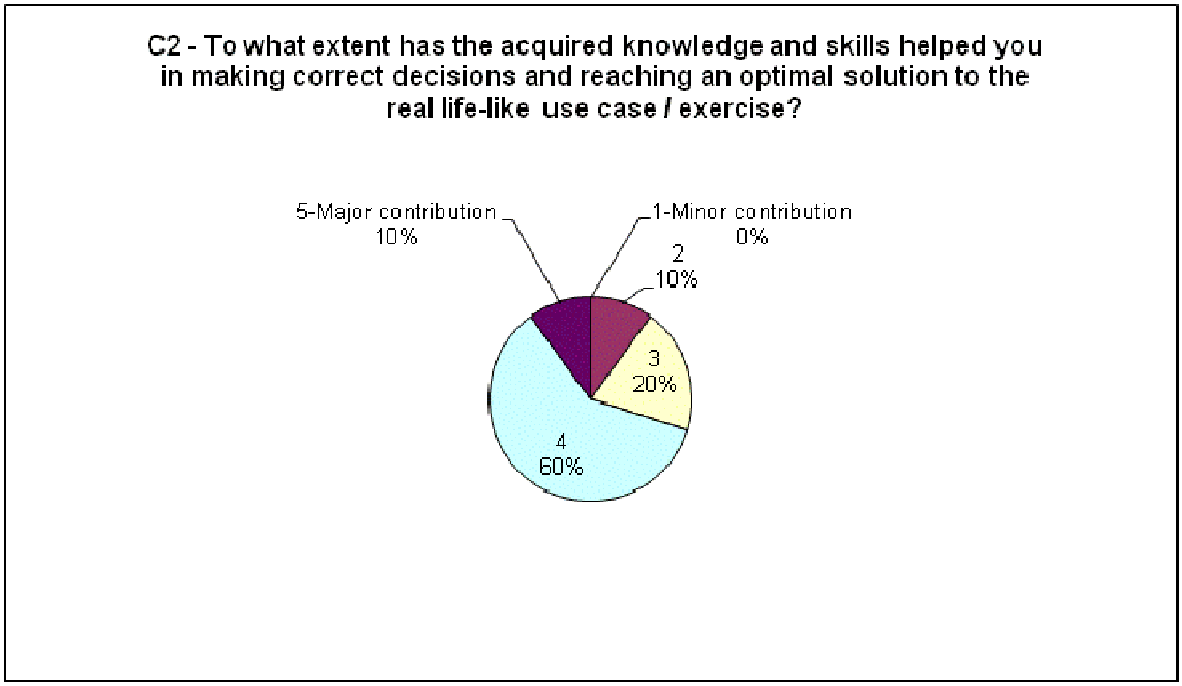


Competence

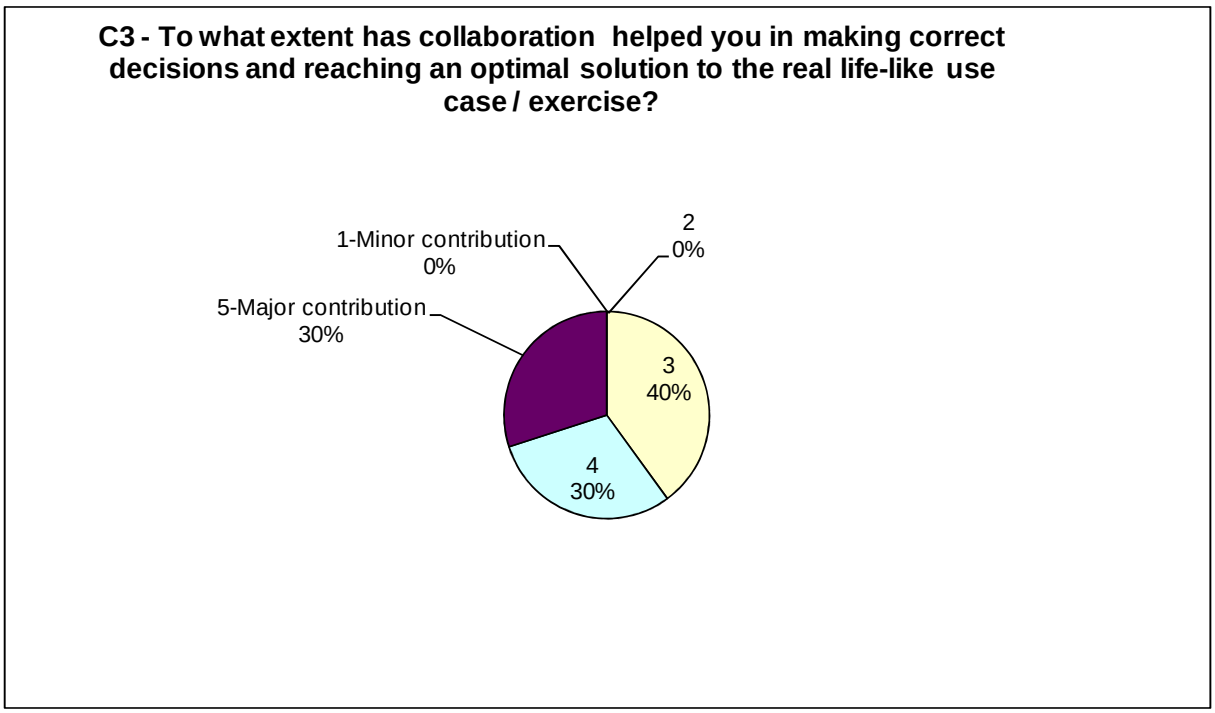
C1 – To what extent have you been able to apply the acquired knowledge and skills on the real life-like use case / exercise?



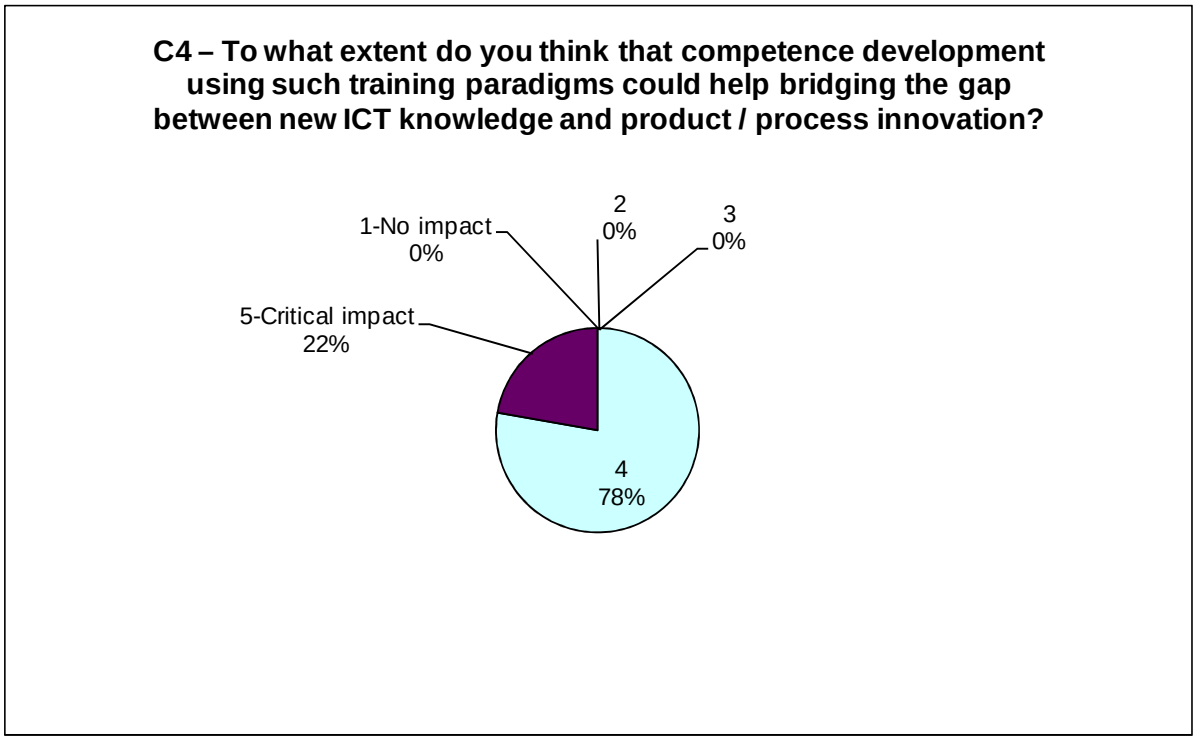
C2 - To what extent has the acquired knowledge and skills helped you in making correct decisions and reaching an optimal solution to the real life-like use case / exercise?



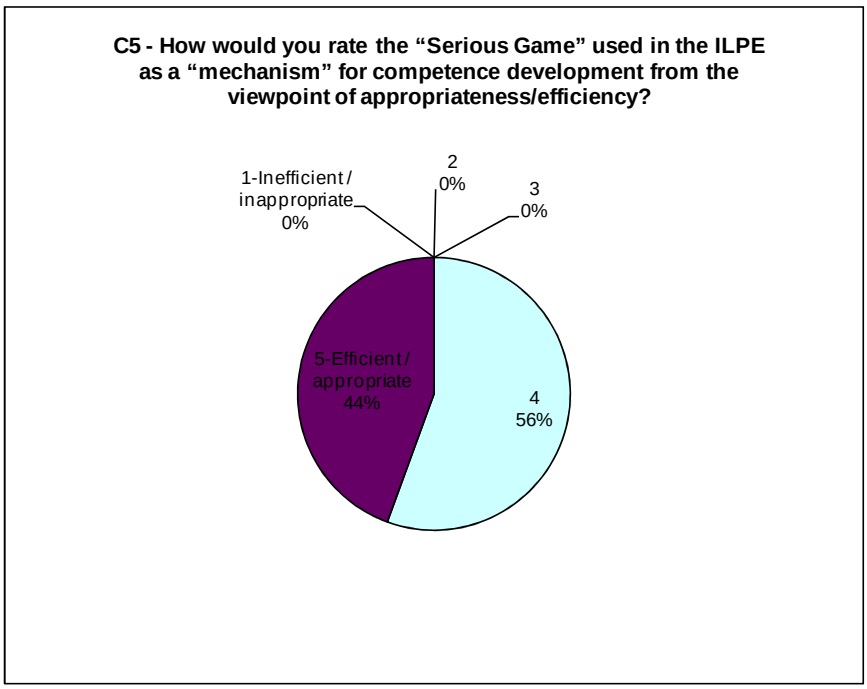
C3 - To what extent has collaboration helped in making correct decisions and reaching an optimal solution to the real life-like use case / exercise?



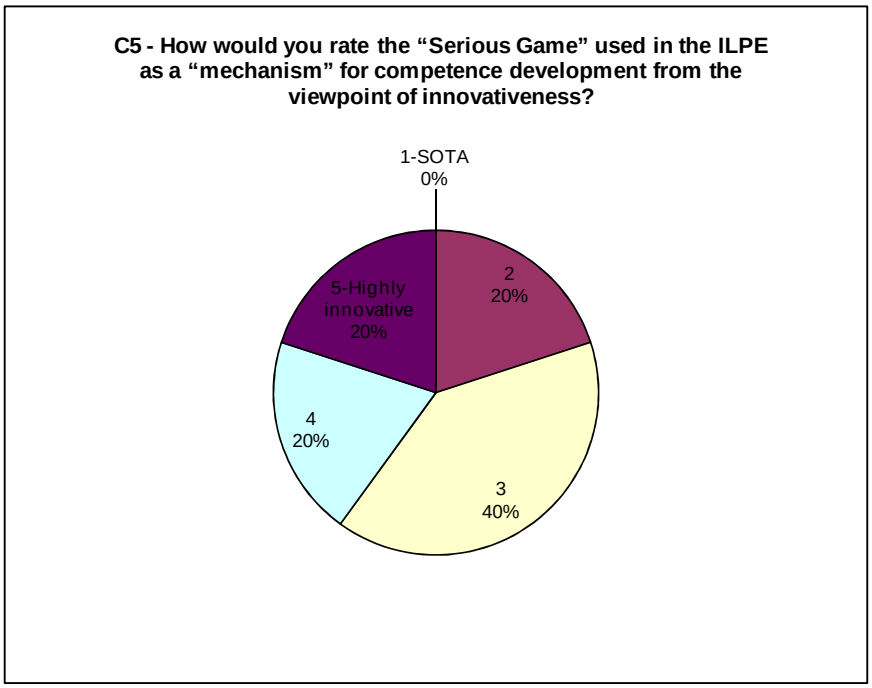
C4 – To what extent do you think that competence development using such training paradigms could help bridging the gap between new ICT / business knowledge and product / process innovation?



C5 - How would you rate the “Serious Game” used in the ILPE as a “mechanism” for competence development from the viewpoint of appropriateness/efficiency?

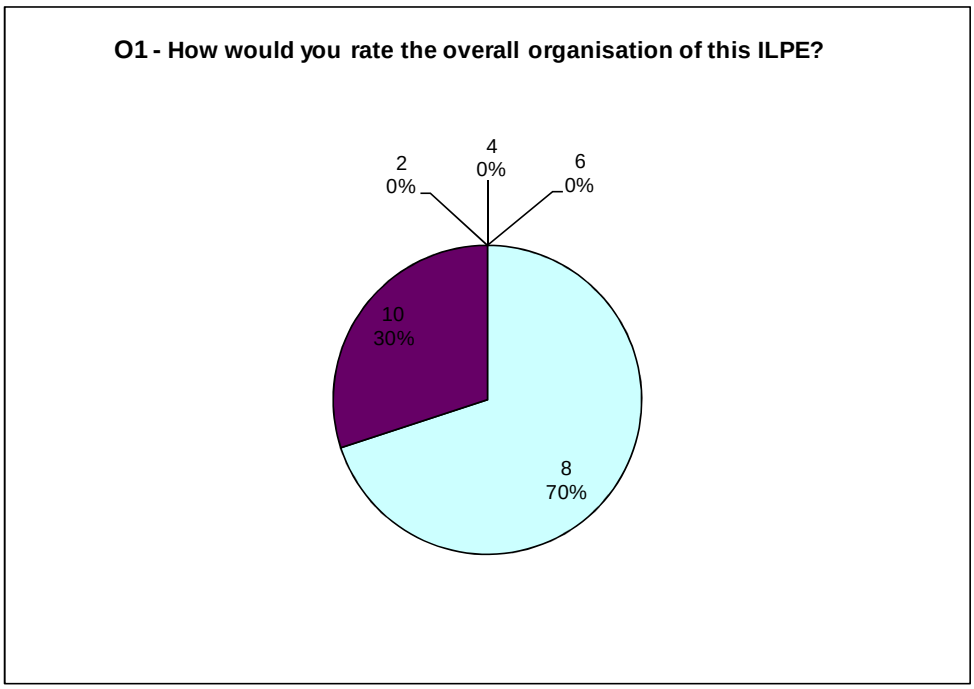


C5 - How would you rate the "Serious Game" used in the ILPE as a "mechanism" for competence development from the viewpoint of innovativeness?

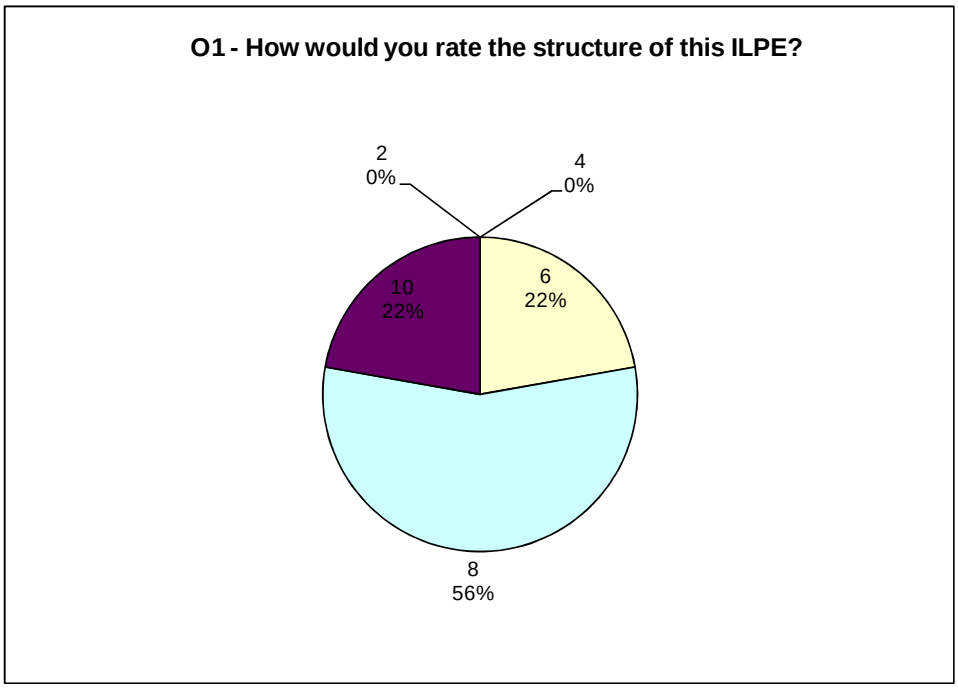


Overall ILPE

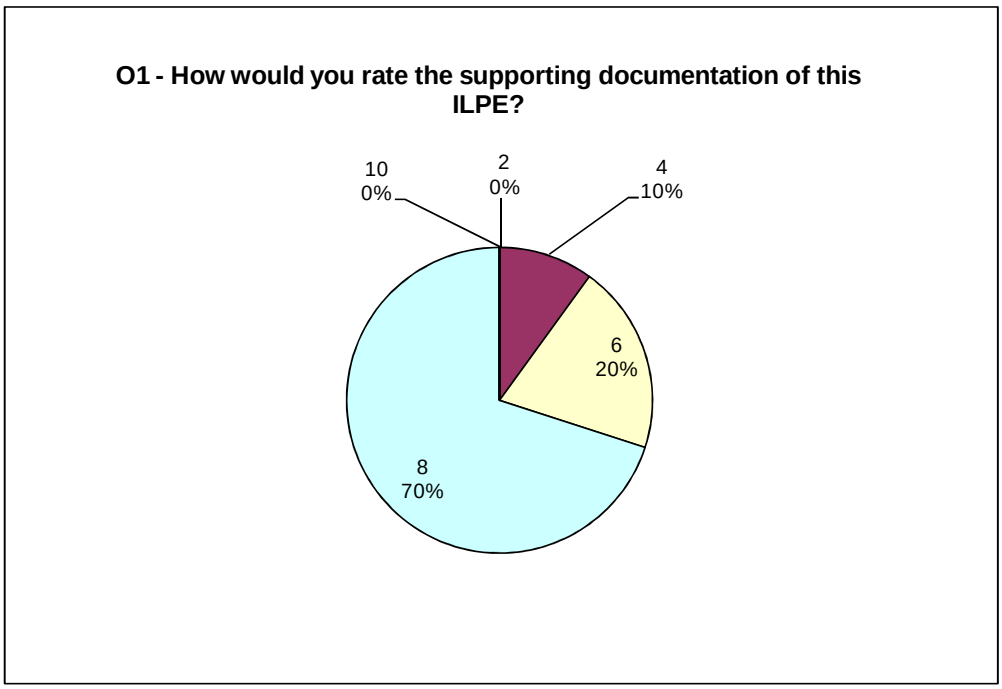
O1 - How would you rate the overall organisation of this ILPE?



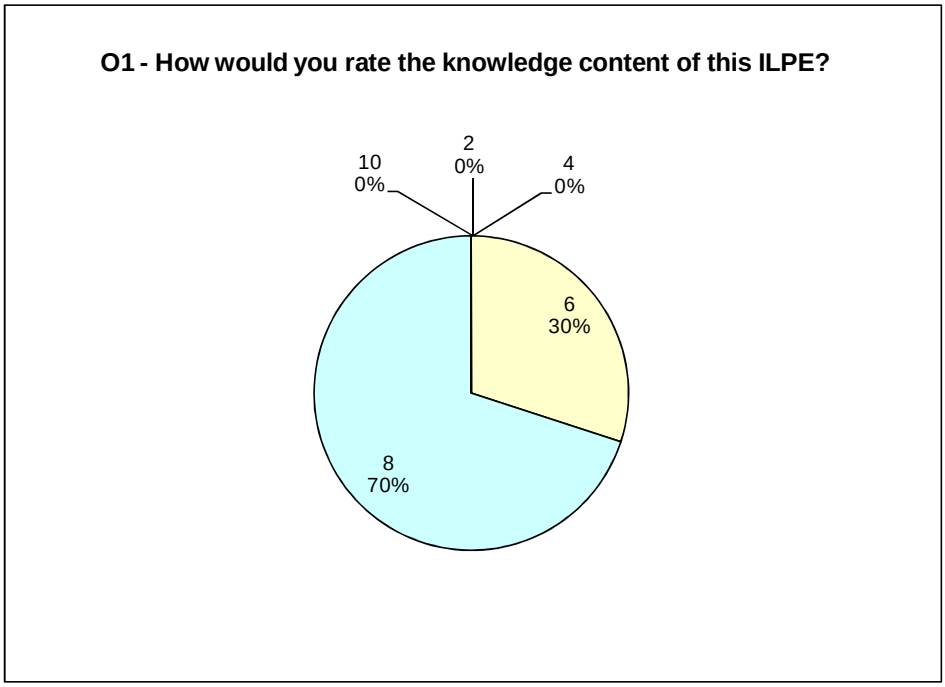
O1 - How would you rate the structure of this ILPE?



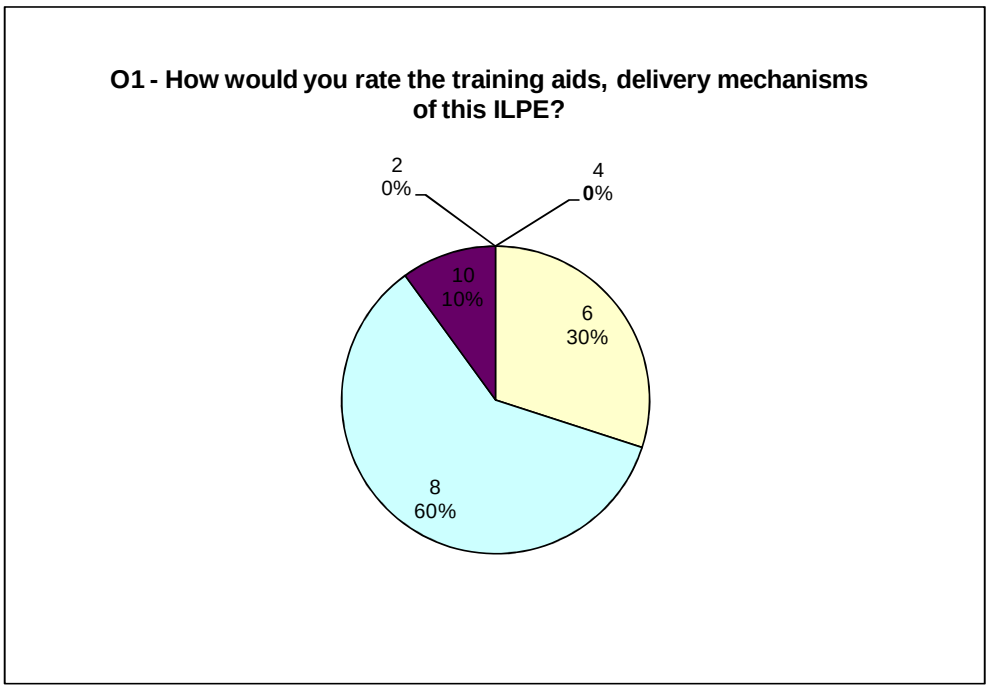
O1 - How would you rate the supporting documentation of this ILPE?



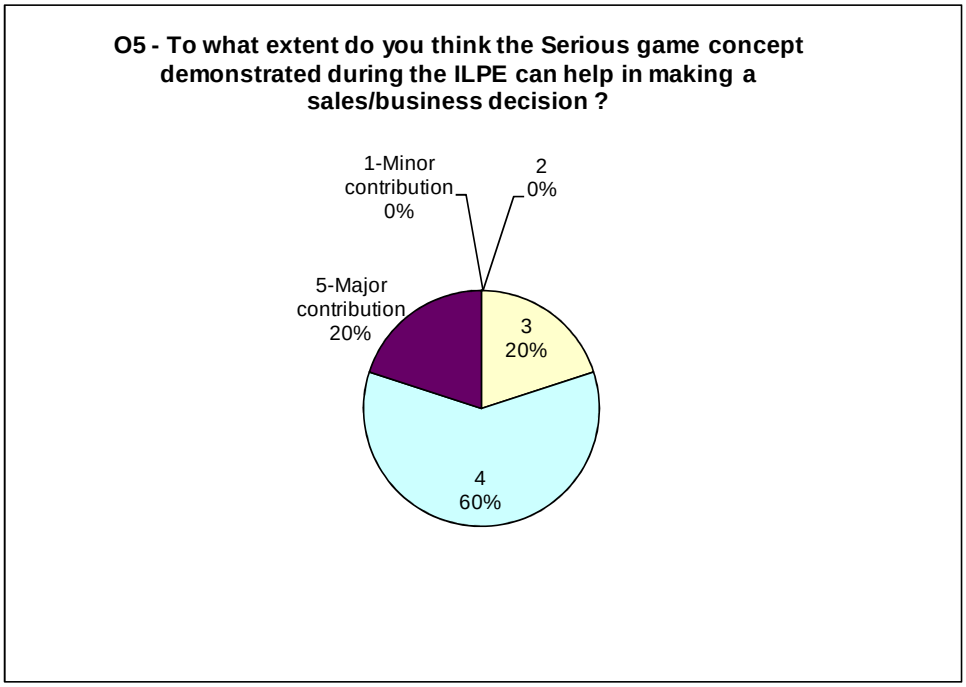
O1 - How would you rate the knowledge content of this ILPE?



O1 - How would you rate the training aids, delivery mechanisms of this ILPE?

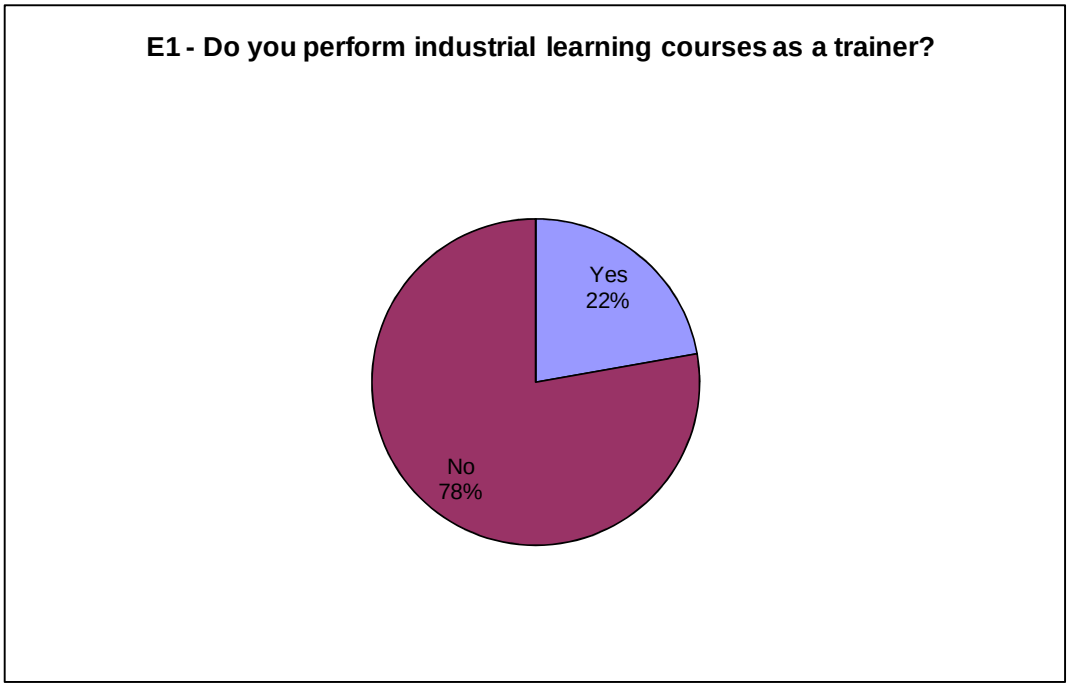


O5 - To what extent do you think the Serious Games concept demonstrated during the ILPE can help in making a sales/business decision?

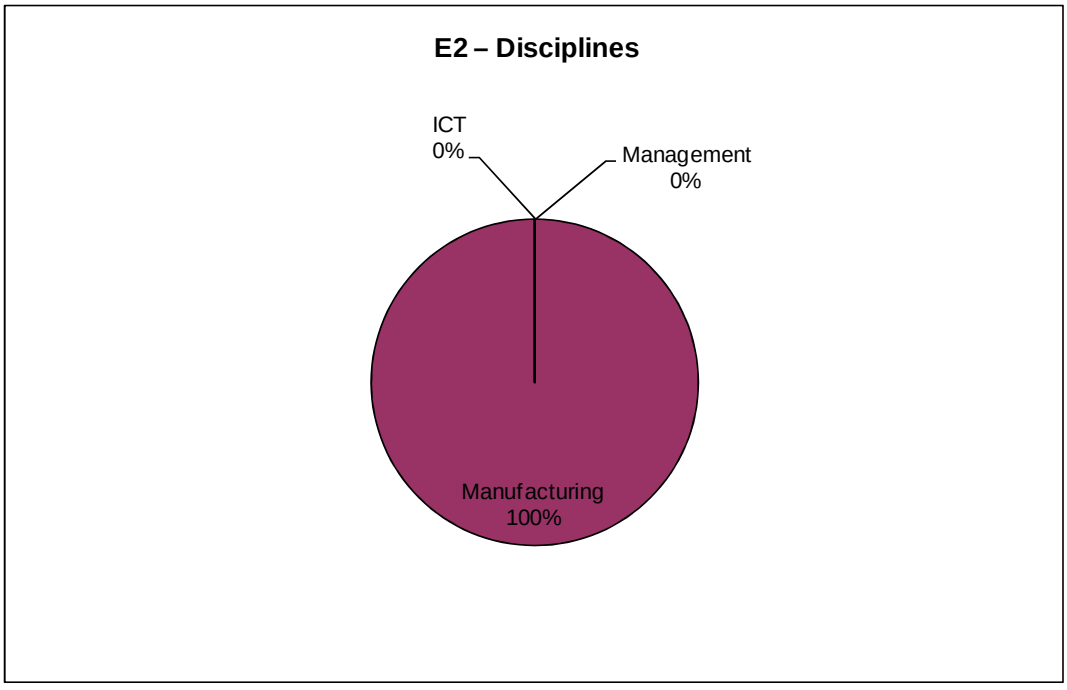


Experiences in performing Industrial Learning

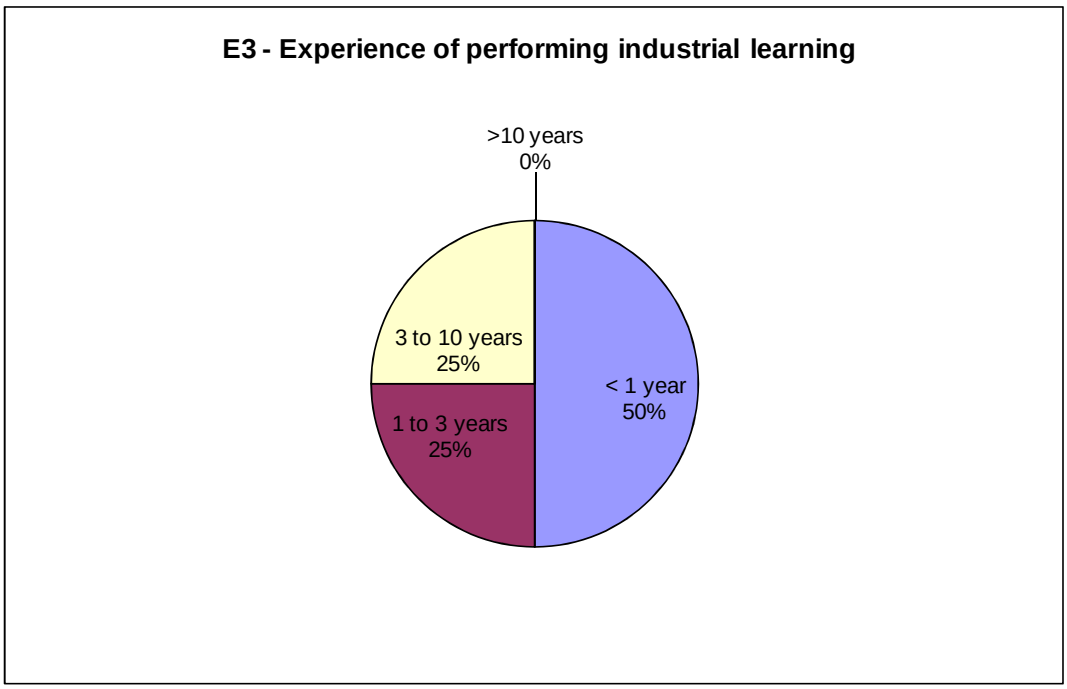
E1 - Do you perform industrial learning courses as a trainer?



E2 – Disciplines



E3 - Experience of performing industrial learning



10.2.5 Evaluation of learning process

The evaluation of the 2nd ILPE is based on three sources: the feedback received from all trainees to the questionnaire, the assessment carried out by the professional training experts that participated in the ILPE as observers, and the comments of the rapporteurs.

The questionnaire was distributed to all the trainees during the training sessions and has been filled-in right after the end of the event. The questionnaire has been structured around the four major building blocks of the learning process, which are addressed by the ActionPlanT industrial learning model / methodology, i.e. attitude, knowledge, skills, and competencies.

The trainees' feedbacks to the questionnaires have been statistically processed. Based on this processing, qualitative conclusions are drawn.

10.2.5.1 Attitude

- A major increase of the trainees' interest in the introduced business principles and supporting technologies has been reported, as a result of this ILPE.
- The trainees indicated a higher confidence in the business potential of the introduced business principles and supporting technologies, as a result of this ILPE.
- There has been a rather balanced response concerning the maturity or not of the introduced business principles and supporting technologies for integration in industrial working practices, with the majority of the trainees indicating that they have good potential but they are still immature for real-life practices
- The trainees indicated that the ILPE significantly helped in better understanding the environmental impact of the introduced business principles and supporting technologies.
- The trainees indicated that the ILPE significantly helped in better understanding the societal impact of the introduced business principles and supporting technologies.

10.2.5.2 Knowledge

- The trainees reported a major improvement of their overall understanding of the introduced business principles and supporting technologies, as a result of this ILPE.
- There has been a rather balanced response concerning the level of maturity ("SOTA" → "highly innovative") of the ICT and business knowledge delivered during the ILPE
- There has been a rather balanced response concerning the applicability ("theoretical" → "close to industrial practice") of the ICT and business knowledge delivered during the ILPE
- The knowledge "delivery mechanism" used in the ILPE has been considered highly appropriate / efficient. The majority of the trainees considered that moderately new.
- The trainees felt confident that they can easily access more information / knowledge on the introduced business principles and supporting technologies after this ILPE

10.2.5.3 Skills

- The trainees indicated a significant improvement of their cognitive skills (e.g. logical thinking, understanding of task work flows etc.) with respect to the introduced business principles and supporting technologies, after this ILPE
- The trainees indicated a significant improvement of their practical skills (e.g. applying a team work organization scheme, information processing etc.) with respect to the introduced business principles and supporting technologies after this ILPE
- The trainees have succeeded in completing well defined tasks (e.g. go through all assembly operation steps etc.) using the given team work organization schemes
- The trainees considered the offered hands-on practice very useful for a better comprehension of the delivered business principles and supporting technologies
- The trainees indicated that collaboration with the other group members significantly helped in successfully applying a team work organization and information processing scheme
- The skills "delivery mechanism" used in the ILPE has been considered as appropriate / efficient and innovative.

10.2.5.4 Competence

- The trainees have been able to apply quite well the acquired knowledge and skills on the real life-like use case / exercise
- The trainees indicated that the acquired knowledge and skills significantly contributed in making correct decisions and reaching an optimal solution to the real life-like use case / exercise
- Collaboration and team work helped in making correct decisions and reaching an optimal solution to the real life-like use case / exercise
- The trainees indicated that competence development using such training paradigms can have a major impact in bridging the gap between new ICT / business knowledge and product / process innovation
- The "mechanism" for competence development used in the ILPE, i.e. "Serious Game", has been considered by the trainees highly appropriate / efficient. The majority of the trainees considered that moderately new.

10.2.6 General observations

10.2.6.1 General observations by the Rapporteurs

Two Rapporteurs followed the activities of the trainees group, in order to comment on qualitative issues, such as the actual work flow and performance of the group, the difficulties encountered by the trainees, their actual involvement, their co-operation level etc.

The major general observations of the Rapporteurs have been the following:

- The trainees were generally familiar with the concepts / theory of “lean manufacturing” but not with the practical aspects of their implementation etc.
- The participants showed high motivation and an active involvement especially in the second and third rounds. The coordination / cooperation (e.g. redistribution of roles etc.) was excellent especially in the second and third rounds.
- When required (e.g. second round) decision making has been collaborative and quite effective. It was mainly based on common sense.
- There has been no major problem addressed during the exercise. Only minor technical issues raised (e.g. difference between the 3D model and the final assembly picture, out of stock of some parts in the warehouse, 2 conveyers not use.
- The participants encountered a few difficulties related to understanding of procedures and roles (e.g. BoM, Manufacturing Order, Quality Manager, Plant Manager etc.) in the first round.
- The trainees have sometimes skipped some rules (e.g. about the material flow through the conveyer and the manufacturing order sequence etc.).
- The level of stress has been generally quite low during all the steps. A “team vs team” game play could improve this point. Setting quantified targets could be another way to increase stress.
- The ICT potential to support the application of “lean manufacturing” seems to have been well perceived. Some concerns have been raised about the difficulty of ICT implementation and the interoperability problems.

10.2.6.2 General observations by the Expert Trainers

Two expert trainers participated with an “observer” role in the 2nd ILPE. Their major general observations throughout the exercise execution are summarized hereafter.

General

- The game material was very well prepared.
- The game stimulated active involvement from all participants. Face to face contact enabled direct personal interaction. There was very good atmosphere.
- The participants of the game get an overview of the impact of their choices and lean manufacturing on results. They face basic problems and constraints of production and learn how to optimize operations.
- The participants could see very quickly the positive consequences of good decisions
- There was no simulation of real atmosphere of fabrication line.

Initiation

- The quite huge quantity of game material (lego blocks, boxes, lists, cards) brought some confusion at the beginning
- Difficulty of allocating certain roles whose perimeter is not well understood (manager, quality controller).
- No precise instructions about the aim of the game and the possible modes of organization. The participants looked quite confused at the end of the introduction.
- The implementation requires an important tutorial so that the game really starts
- The roles of supervision are rapidly converted into support roles to the conveyer or warehouse keeper

- Relatively little stress in the early stages of the game due to lack of challenge and loss of management

Second phase of the game

The continuation of the game enabled the organization to improve, and the objectives were focused on the number of vehicles to produce, to the detriment of the inventory optimization. Management did not play its role to remind the objectives of performance, which were specified at the beginning.

- Rules of implementing the changes between the first two phases (what is possible, what is not) were not clearly specified
- The objectives of the game were not re-explained (production + inventory optimization)
- The scenario remains identical, therefore not very capable to generate stress

Third phase of the game

The third phase of the game benefited from the experience gained from the two preceding phases. The mode of Lean organization, always on a smoothed scenario, quickly brought its fruits as regards production.

- In a context idealized and simplified to the extreme, the demonstration of the effectiveness of Lean seems a little bit simplistic
- The various anomalies observed during the previous phase have not really been addressed: lack of management, ill-defined role of quality control, lack of pressure on the objective “optimization of intermediate inventories...
- One does not learn in this phase how and to which level one can make improvements to a mode of Lean organization
- Again little stress

10.2.7 Overall impression

Based on their responses to the ILPE Questionnaire, the overall impression indicated by the trainees about the 2nd ILPE, may be summarized in the following points:

- The trainees considered the overall ILPE organization being very good
- The structure, the knowledge content, the training aids and delivery mechanisms have been very well received from the trainees
- The trainees consider that the “Serious Games” concept demonstrated during the ILPE can significantly contribute in making a sales/business decision

The trainees have considered the following points as the strengths of the 2nd ILPE:

- The “manufacturing” flavour of the “serious game”, including the very good demonstration of bottlenecks in production
- The evolution of the knowledge acquisition throughout the various stages of the game, based on the challenges and problems addressed
- The hands-on practice (“real” manufacturing), the ability to interact and collaborate with the group members
- The clear understanding of the lean methods efficiency through the assessment of different approaches
- The possibility to practise with tools and techniques of “lean” best practices and have a realistic demonstration of “lean” tools application
- Concrete application closer to the problems of enterprise
- The possibility to experiment different methods and not only the “lean” method and the discovery of the results of the different methods

The trainees have considered the following points as the weaknesses of the 2nd ILPE:

- Such games cannot really mimic the real-life in an industrial environment. There have been no variations in the game, e.g. lack of breakdowns etc.
- The preparation phase was not so explicit and did not provide enough time for "leaning" the task. The aural introduction has not been adequately explanatory
- There has been no actual use of IT (computers and software) in the game
- The result of the last round may be biased, since the participants get more "experienced" compared to the first stages
- Generally, there has been not enough time to perform, and this made the overall procedure not an easy one
- With respect to the time assigned, few knowledge can be approached

10.2.8 Recommendations

This paragraph includes the recommendations of the trainees and the expert trainers / observers for further improving the industrial learning methodology & knowledge delivery mechanisms used in the ActionPlanT ILPEs.

10.2.8.1 Trainees' suggestions

The trainees made just a few suggestions for improvements, which are listed hereafter:

- Introduction should rather include more visual means to explain the concepts and the game
- Some more realistic production problems may be included in the game, in order to be more close to reality
- Some more time should be allowed for the preparation and performance phases

10.2.8.2 Expert trainers' suggestions

The two expert trainers, which participated as observers in the 2nd ILPE, also suggested measures for the overall improvement of the knowledge delivery mechanism involved in this ILPE.

General

- Animator should give more clear guidelines for the discussion (indicate when the discussion time is finished and when decision making starts)
- The role of the game leader is extremely important. He has to explain the game, create the atmosphere and keep the game going on. The game leader could give the main information orally at the beginning in more details: show the different pieces, sheets and boxes on the table, distribute the people directly on their working places, explain them their tasks and the material. The written information could then be very short and only contain information the participants need after having started.

Sequences of the game

- Take apart at the beginning of the game the role of the manager to explain him the objectives of the team and the way in which he evaluates the performances of his team. It is then him who tutorates his team members.
- Same for the person in charge of quality in his field of responsibilities
- Induce an additional stress in the management of time by ringing at the end of days the alarm of exit of the factory
- Oblige the manufacture participants to stop their activities and to leave the table during the counts of the weekends, possibly by leaving the room.

- Give more meaning to the action of the plant, specifying the issues (customer orders, profitability expectations shareholders, etc ...)
- Make a complete synthesis of performances after each phase

Scenario of the game

- Impose changes of roles to simulate the arrival of new entrants or temporary replacements
- Practice the game with distant places (in two different rooms with the conveyor, the manager and the person in charge quality like buffers)
- Introduce ruptures into the course of the game: counter-orders, orders according to the market, temporary breakdown on one of the work stations… It is the responsible of the game who transmits this information to the manager who undertakes as well as possible to reflect them on the organization
- Reinforce the concept of competitiveness while considering several teams and while being clearer about the important indicators, otherwise only the objective “volume of production” is retained.

Projection using ICT

The game Muscle Car as it takes place on-site can benefit from the contribution of the ICT by allowing:

- Make the counts and publish the statistics at the end of every week (manager and quality controller)
- Give to the manager a memorandum which allows him to check the objectives
- Provide the manager with consultants on organization, according to the profile of the participants
- Use a messaging system which communicates to the manager the breaks of the scenario
- Use a simple tool of simulation of organization of the workshop which will be used between the Phase 1 and the Phase 2 of the game

The game as it is proposed seems to be difficult to virtualize, for the following reasons:
It is a game of "manufacturing" where the physical notion of construction is important

- It is a game which is essentially based on the spontaneous oral communication
- It is a game which did not plan during the development of its rules to be supported by ICT

On the other hand, with some adaptations, the principle of the game (set up a mode of organization of production then compare it with a Lean organization) can be very well reproduced on-line. For that, it would be necessary:

- Find an operational mode in the production chain which can be virtualized (it is with difficult for the case of car manufacturing, it would thus be necessary to consider another activity)
- Adopt a mode of communication which substitutes itself for the oral communication while keeping the immediate character and by being close to the available modes of communication in the company
- Set up systems of evaluation integrated into the game which allow by the analysis of the actions undertaken in the time and their effects on the game to deliver a personalized feedback post by post

10.2.9 Conclusion

The ILPE#2 took place on the 29th of June 2011, at the Dassault Systèmes’ premises in Paris.

The learning paradigm chosen to be used and evaluated in this ILPE was that of “Serious Game” which was used for learning the principles of lean manufacturing.

This ILPE has greatly benefited from the recommendations formulated by the trainees and the observers of the first ILPE hold in Dresden on the 3rd of February 2011. These recommendations were

implemented in ILPE#2 as far as possible. The excellent motivation and involvement of the participants in the exercise have also contributed to the achievement of ILPE#2.

The game was improved through the introduction of an intermediate round where the participants proposed their own organization in order to fix the problems encountered in the first round. The intermediate round allows the trainees to better follow the evolution from a traditional organization to a lean organization. This was appreciated by both the trainees and the expert trainers.

The ILPE also included a presentation about lean principles. This presentation made a link between the industrial learning and roadmap activities of ActionPlanT through listing the different research topics from the roadmap that provide potential solutions for dealing with the different challenges about applying ICTs in lean manufacturing emphasized in the presentation.

The recommendations from ILPE#2 of the trainees and the expert trainers will be investigated in order to identify those that can be implemented for each of the forthcoming ILPEs.

10.3 Annex 3: ILPE#3

10.3.1 Description of the 3rd ActionPlanT ILPE exercise

10.3.1.1 Exercise 1: Installation of Power Metering, data transfer with XML

1. Going through system setup
2. Visualising device data on the web
3. Installation of PowerMeter
4. Verifying that the PowerMeter turns up on web server, check power consumption
5. Analyze XML data
6. Group work: assessment of system. Things to think about and comment are e.g.:
   - 6.1 How did the router know where to send the data?
   - 6.2 What are the possibilities for other parties to subscribe to get the same information? From router directly or to server?
   - 6.3 How would you perform control (bi-directional communication)?
   - 6.4 What requirements/features of PMI can you see in this system?
   - 6.5 What are the advantages of having a standardized communication protocol/interface versus setting up a new one every time?
   - 6.6 Can you think of some similar case/scenario in your own business?
   - 6.7 Provide an estimation of immediate, mid-term and long-term benefits of such case

10.3.1.2 Exercise 2

The aim of this exercise is to show the applicability of a PDKM based application to very different areas.

The exercise involves two application domains:

- Chemical Production
- Assembly production

The participants were divided in two groups: one for chemical production and one for assembly production as shown in Tables 18 and 19.

Table 18: Participants in chemical production exercise

Chemical production	
Fatih KARAKOYUN	EPFL
Ana MILICIC	EPFL
Drazen NADOVEZA	EPFL
Apostolos PERDIKAKIS	EPFL

Table 19: Participants in assembly production exercise

Assembly production	
Saurabh AGGARWAL	EPFL
Kiran Bhat	EPFL
Yong Chan CHOI	EPFL
Andreas KOUKIAS	EPFL

10.3.2 Goals of the 3rd ActionPlanT ILPE

The goals of the 3rd ActionPlanT ILPE regarding the improvement of attitude, knowledge skills and competencies are presented in Table 20.

Table 20: 3rd ActionPlanT ILPE goals regarding attitude, knowledge skills and competencies

	Definition	**ILPE goals**	**3rd ILPE Goals**
Attitude	"Attitude" is a hypothetical construct that represents an individual's degree of like or dislike for an item. Attitudes are generally positive or negative views of a person, place, thing, or event.	Create awareness, attract interest, increase motivation to learn & apply	Create awareness and attract interest with respect to closed loop PLM and the supporting ICTs
Knowledge	"Knowledge" means the outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices that is related to a field of work or study.	Create a basic understanding on business principles & supporting ICTs (basics of relevant theory & SW) oriented to industrial practice.	Create a basic understanding about the major principles, pillars and limitations of closed loop PLM, as well as about related ICTs (e.g. CRM, SCM, ERP, SDLC, etc.) implementing the underlying principles and enabling closed loop PLM

Skills	"Skills" means the ability to apply knowledge and use know-how to complete well defined tasks. Skills may be cognitive or practical	Acquaint with functions of software tools, information processing, workflows and organization schemes, and complete a well defined series of tasks applying the given knowledge	Apply different methods and tools for closed loop PLM and related information processing
Competencies	"Competence" means the proven ability to use knowledge, skills and personal, social and/or methodological abilities. Competences may be considered as the interface between the learning and the innovation processes.	Build-up basic ability to combine different pieces of knowledge, developed skills and own understanding, to make decisions, optimize operations and address real life-like use cases	Develop the capability of addressing realistic use cases involved in product life cycle activities , requiring decision making and product life-cycle optimization and information processing

The overall objective of the 3rd ActionPlanT ILPE was the assessment of the "Best Practice Tutorial" paradigm as a knowledge delivery mechanism for industrial learning.

Another characteristic of the 3rd ActionPlanT ILPE was the consideration of homogeneous group of researchers involving participants which have different expertise levels in PLM.

The evaluation of the 3rd ActionPlanT ILPE takes into account all these viewpoints and assesses to what extent the different objectives have been achieved.

10.3.3 Participants in the 3rd ActionPlanT ILPE

The participants in the 3rd ILPE in CERN are given in Table 21.

Table 21: List of trainees in the 3rd ActionPlanT ILPE

List of trainees	
Saurabh AGGARWAL	EPFL
Kiran Bhat	EPFL
Yong Chan CHOI	EPFL
Fatih KARAKOYUN	EPFL
Andreas KOUKIAS	EPFL
Ana MILICIC	EPFL
Drazen NADOVEZA	EPFL
Apostolos PERDIKAKIS	EPFL

All the participants have at least some basic background in PLM and the group is considered to be homogeneous regarding the required background.

Two rapporteurs (Table 22) were assigned to the group. The main tasks of the rapporteurs were to observe and report on various aspects of the training sessions, such as the actual work flow and performance of the group, the difficulties encountered by the trainees, their actual involvement, their co-operation level etc. Their comments are taken into account in the evaluation of ILPEs addressed in Task 4.4 “Validation of the ActionPlanT industrial learning model”.

Table 22: Rapporteurs in the 3rd ActionPlanT ILPE at CERN in Geneva

Rapporteurs	
Soumaya El Kadiri	EPFL
Dr Ahmed BUFARDI	EPFL

Two IL experts participated in the 3rd ILPE as observers (Table 23). Their role was to observe and assess the training activities of the ILPE from different viewpoints: content, structure, delivery mechanism, etc. and make suggestions for the overall improvement of the industrial learning methodology and pilot events.

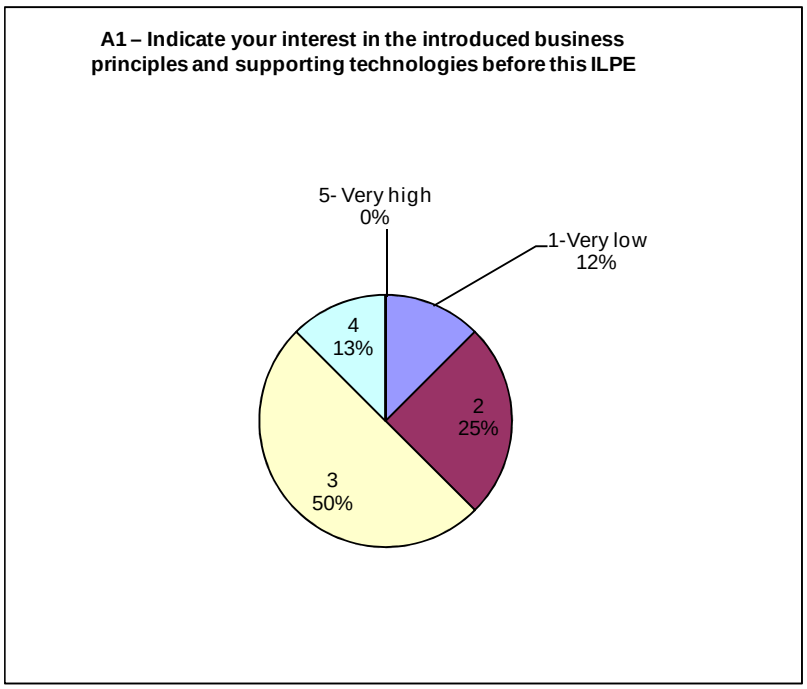
Table 23: IL experts in the 3rd ILPE at CERN in Geneva

Observers	
Mr Aristotelis ALEXOPOULOS	ALBA Graduate Business School, Athens
Mr Philippe FISCHER	FSRM

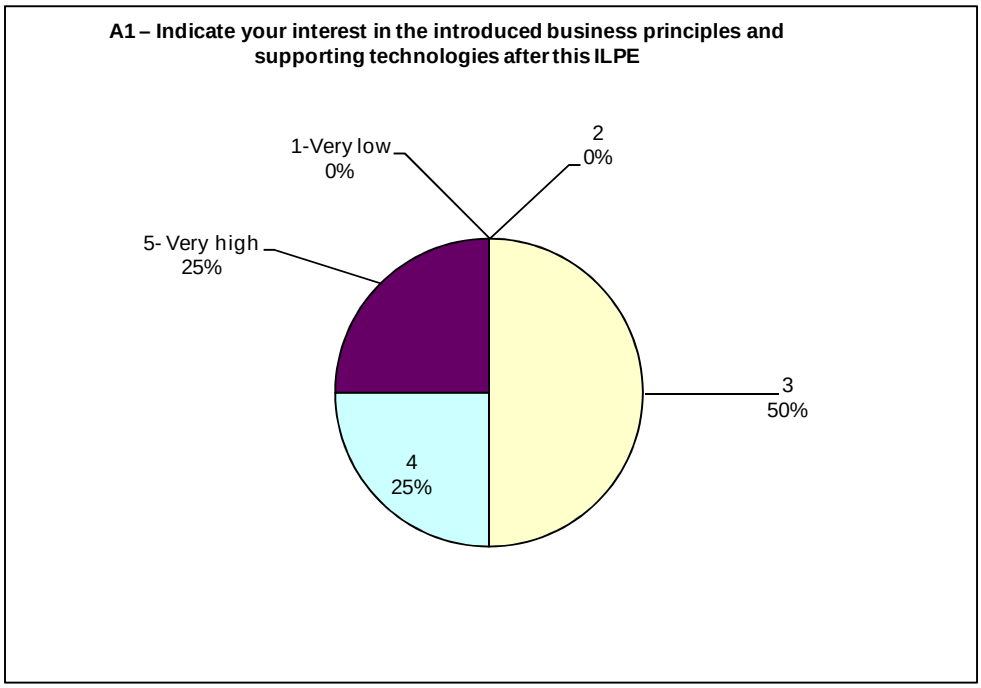
10.3.4 Analysis of the ILPE#3 questionnaires

Attitude

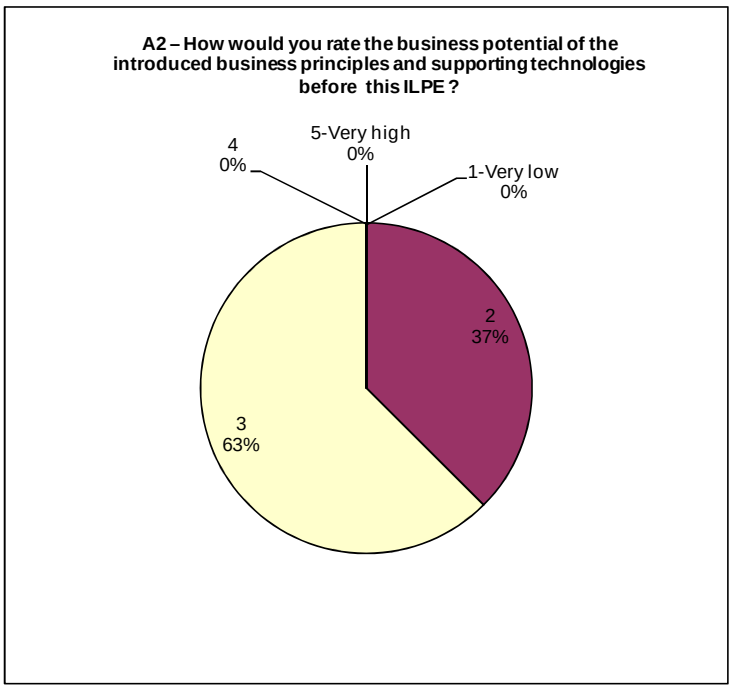
A1 – Indicate your interest in the introduced business principles and supporting technologies before this ILPE



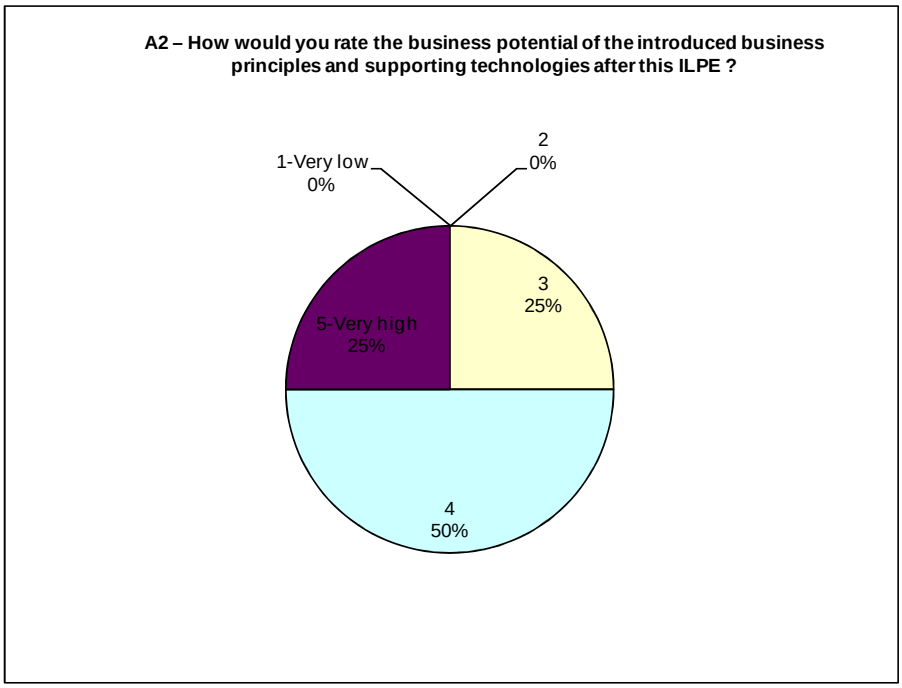
A1 – Indicate your interest in the introduced business principles and supporting technologies after this ILPE



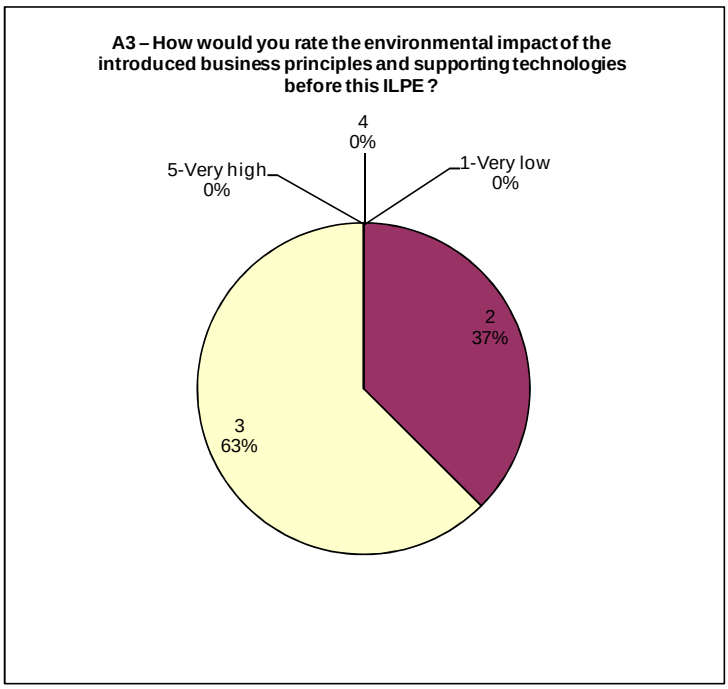
A2 – How would you rate the business potential of the introduced business principles and supporting technologies before this ILPE?



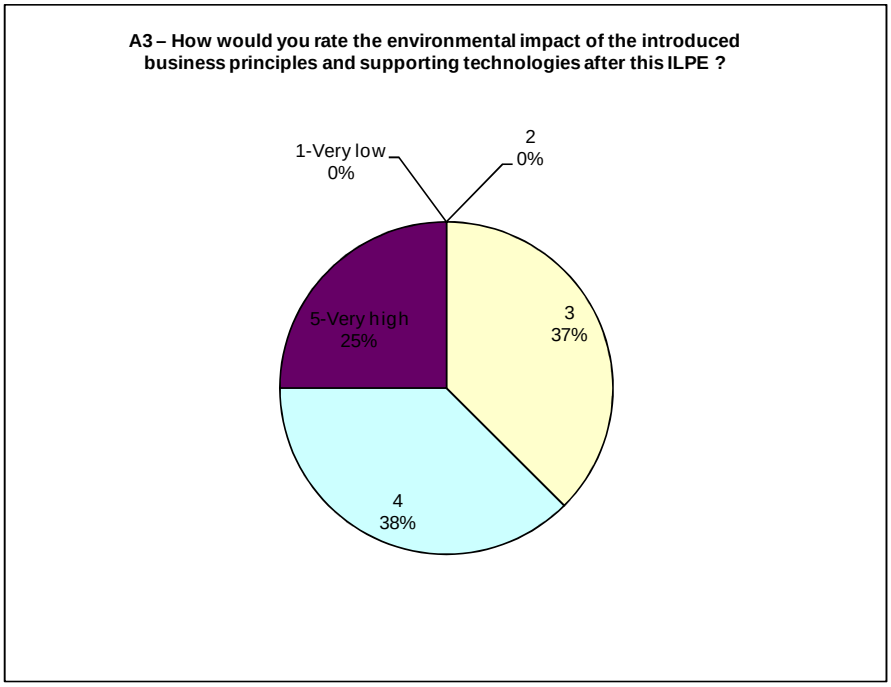
A2 – How would you rate the business potential of the introduced business principles and supporting technologies after this ILPE?



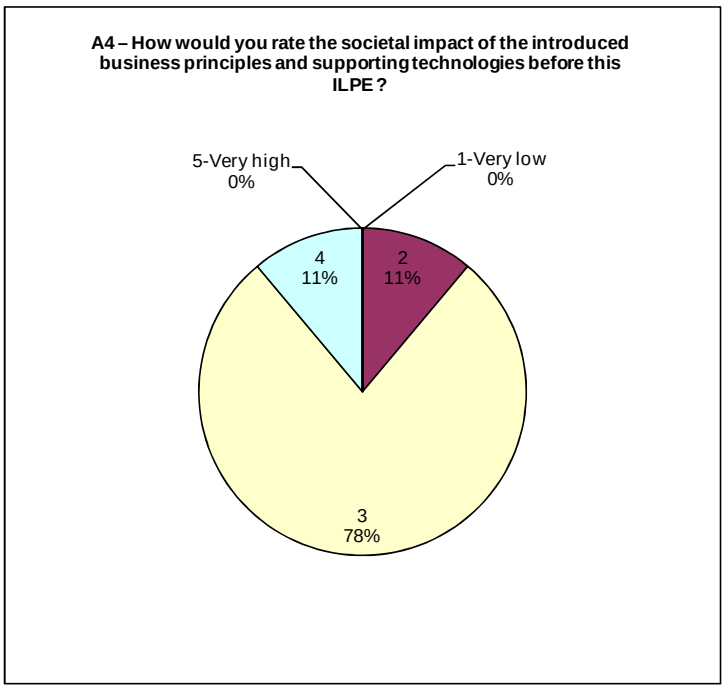
A3 – How would you rate the environmental impact of the introduced business principles and supporting technologies before this ILPE?



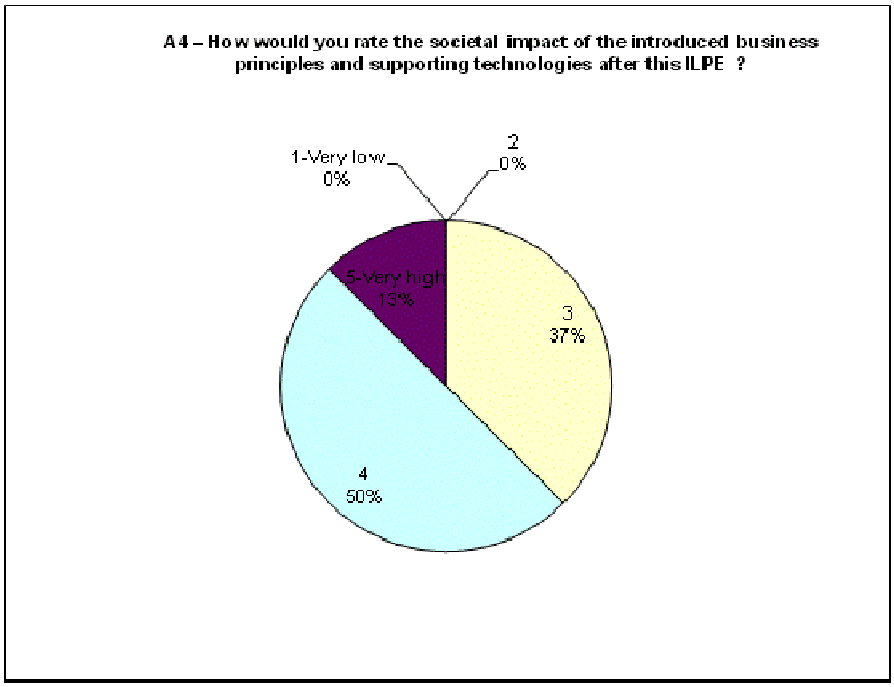
A3 – How would you rate the environmental impact of the introduced business principles and supporting technologies after this ILPE?



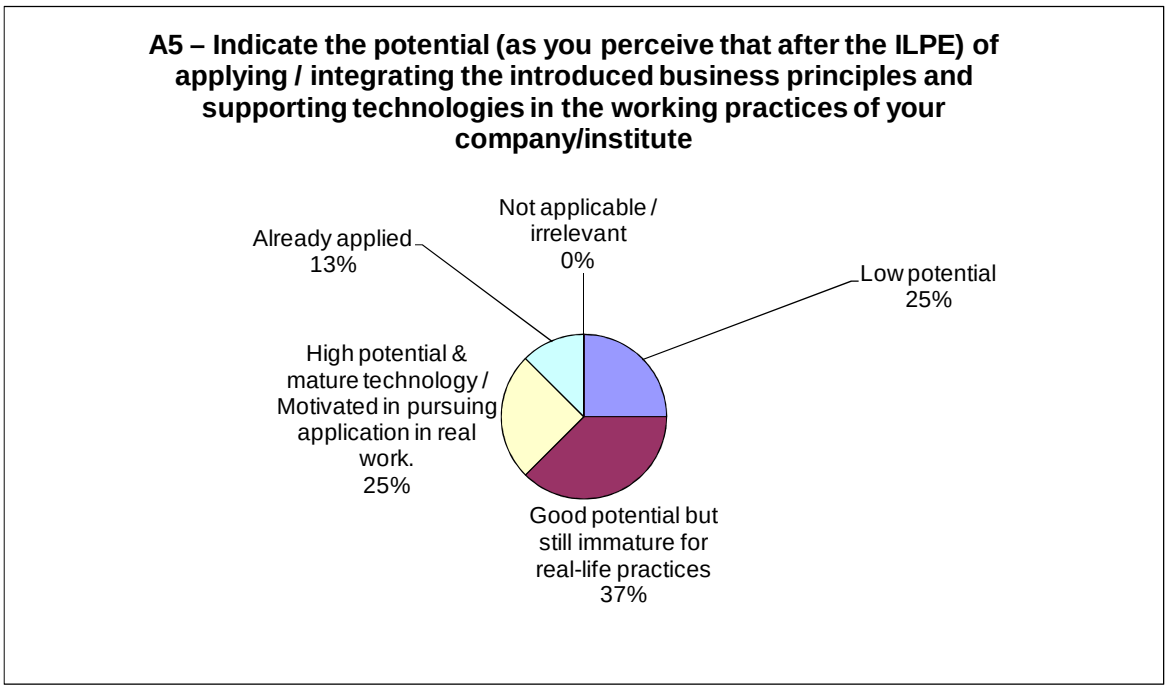
A4 – How would you rate the societal impact of the introduced business principles and supporting technologies before this ILPE?



A4 – How would you rate the societal impact of the introduced business principles and supporting technologies after this ILPE?

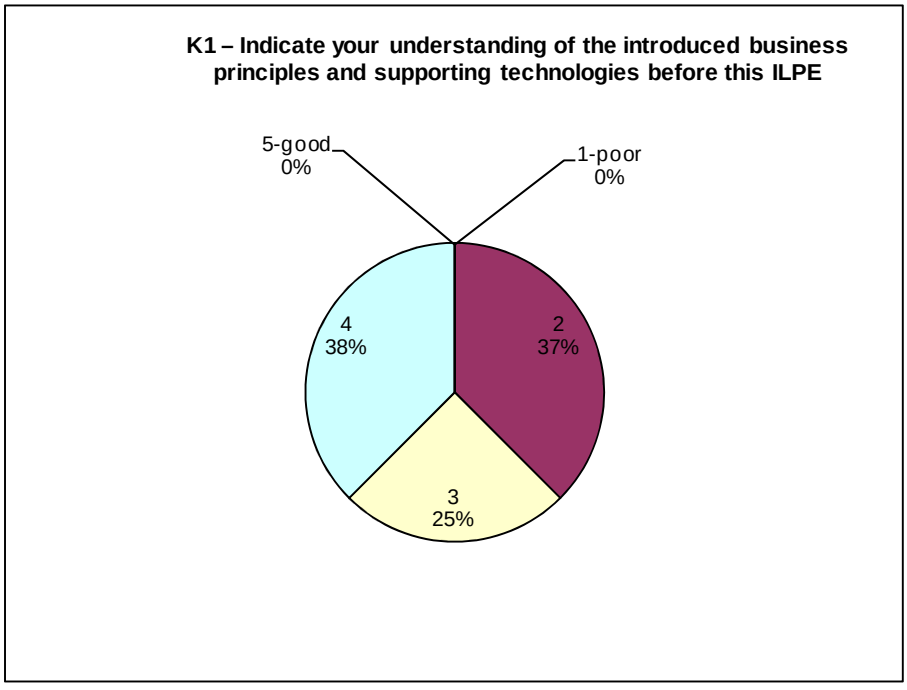


A5 – Indicate the potential (as you perceive that after the ILPE) of applying / integrating the introduced business principles and supporting technologies in the working practices of your company/institute

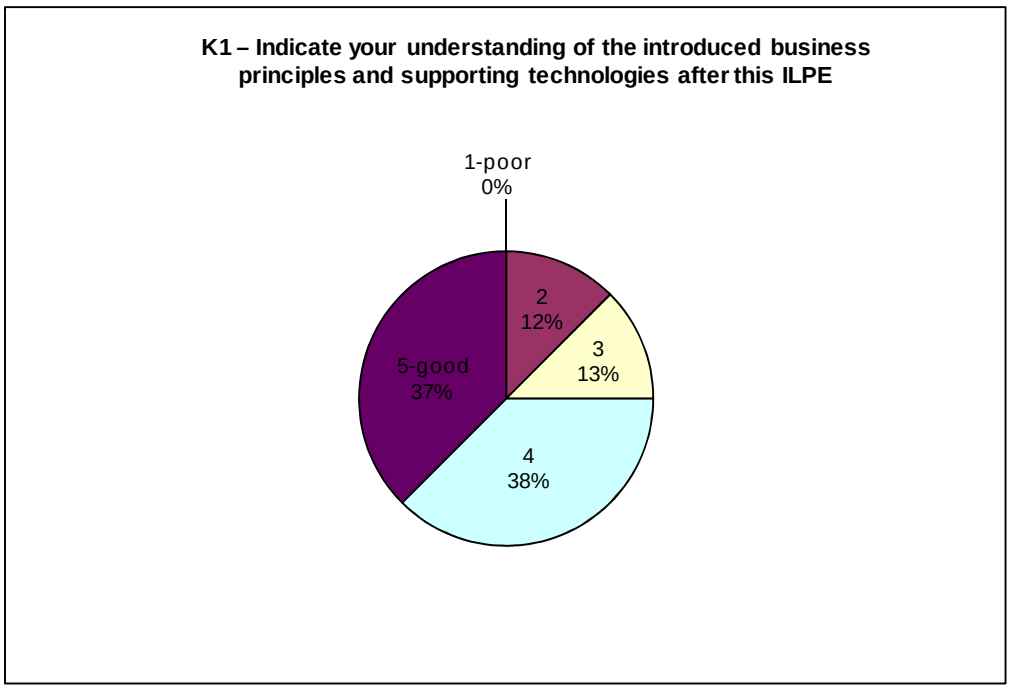


Knowledge

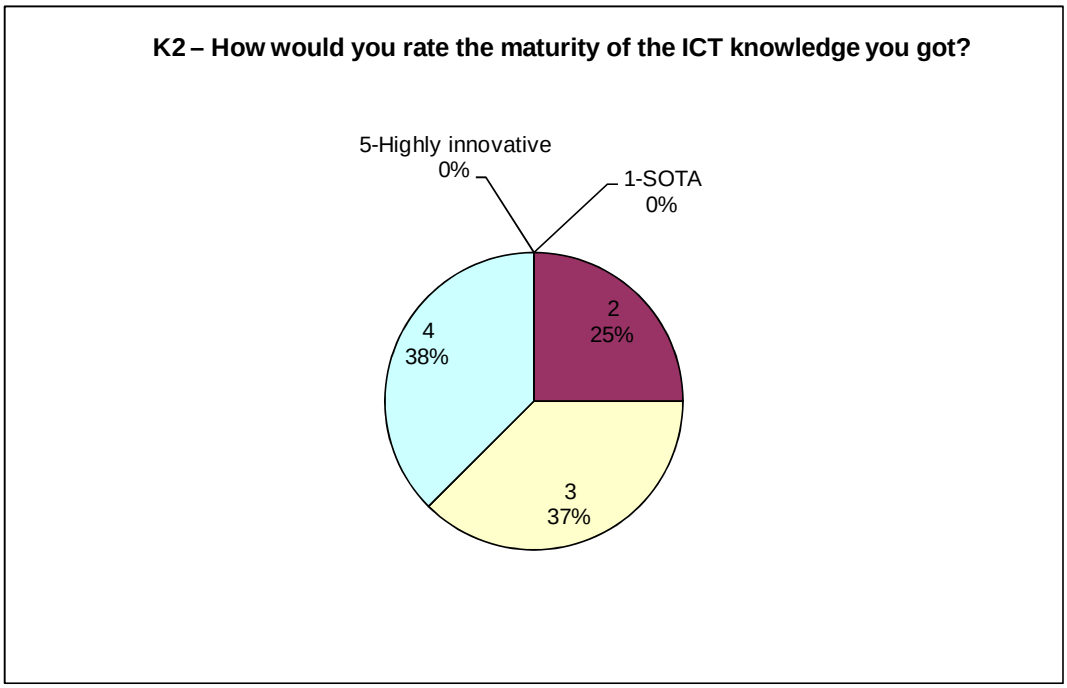
K1 – Indicate your understanding of the introduced business principles and supporting technologies before this ILPE.



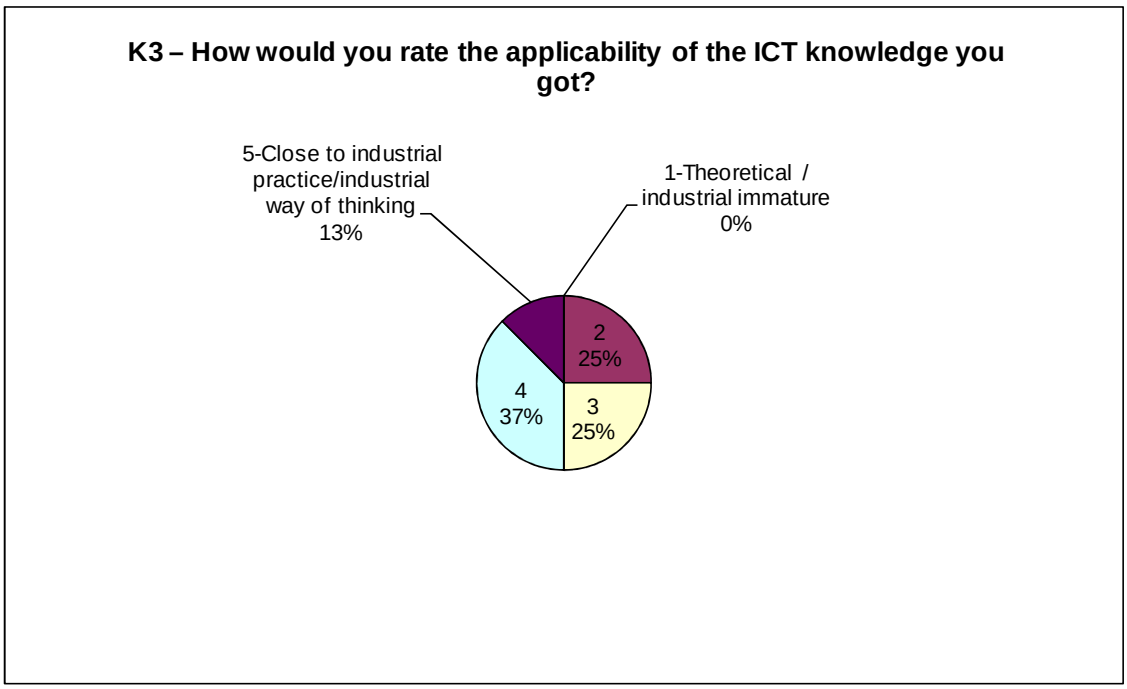
K1 – Indicate your understanding of the introduced business principles and supporting technologies after this ILPE.



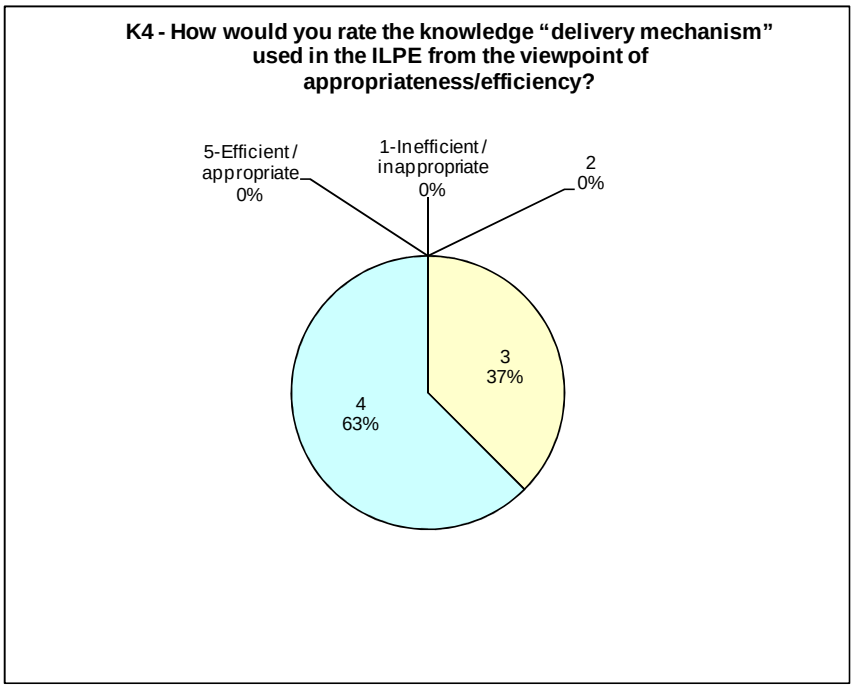
K2 – How would you rate the maturity of the ICT and business knowledge you got?



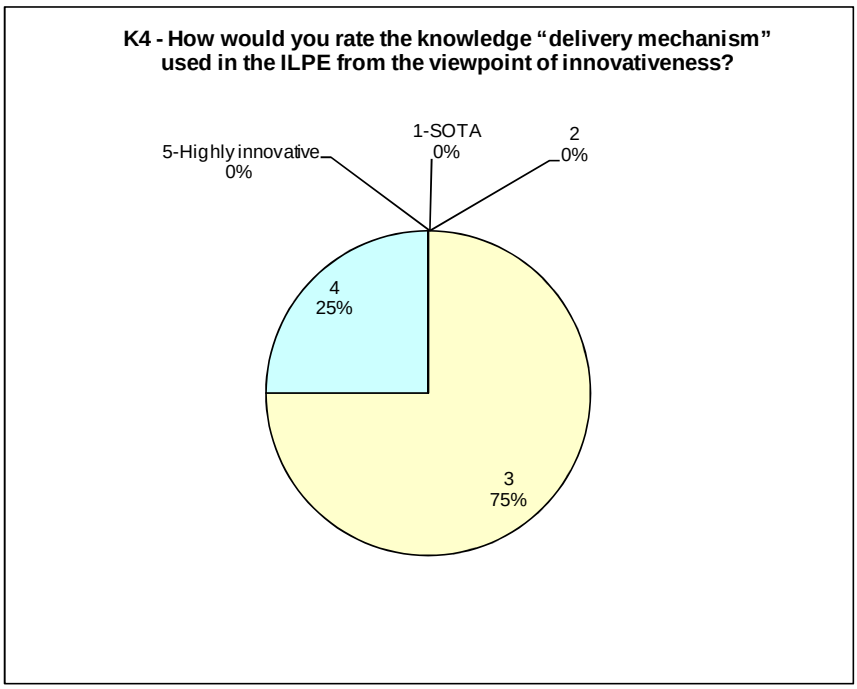
K3 – How would you rate the applicability of the ICT and business knowledge you got?



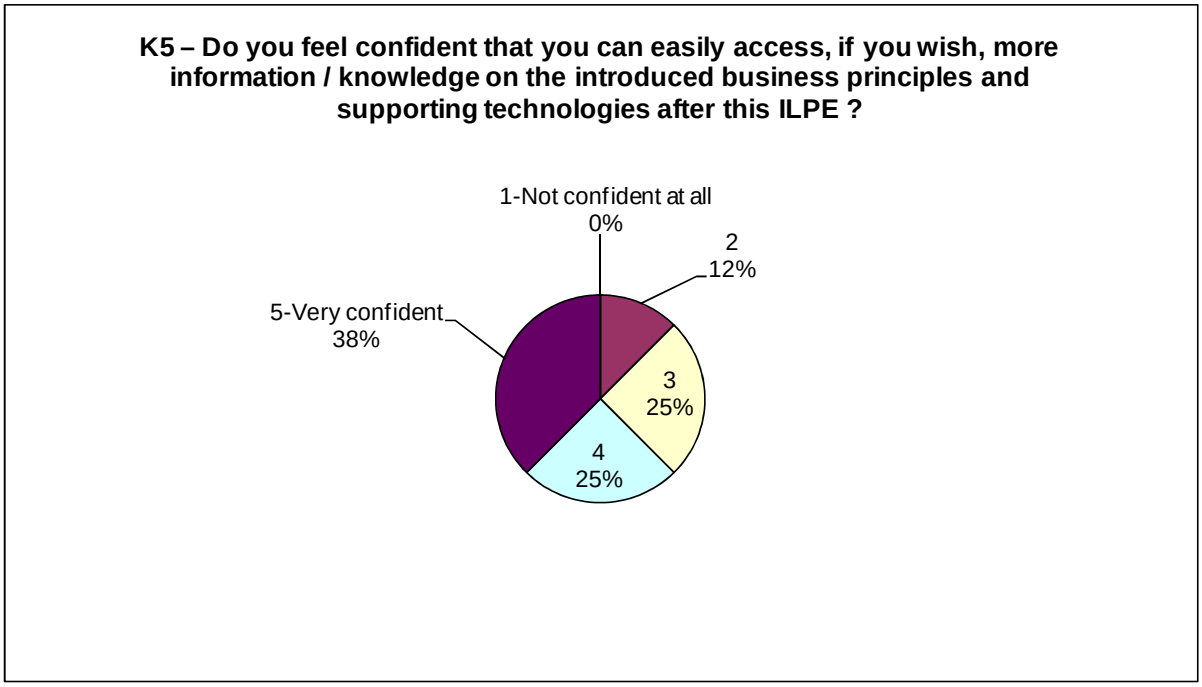
K4 - How would you rate the knowledge “delivery mechanism” used in the ILPE from the viewpoint of appropriateness/efficiency?



K4 - How would you rate the knowledge “delivery mechanism” used in the ILPE from the viewpoint of innovativeness?

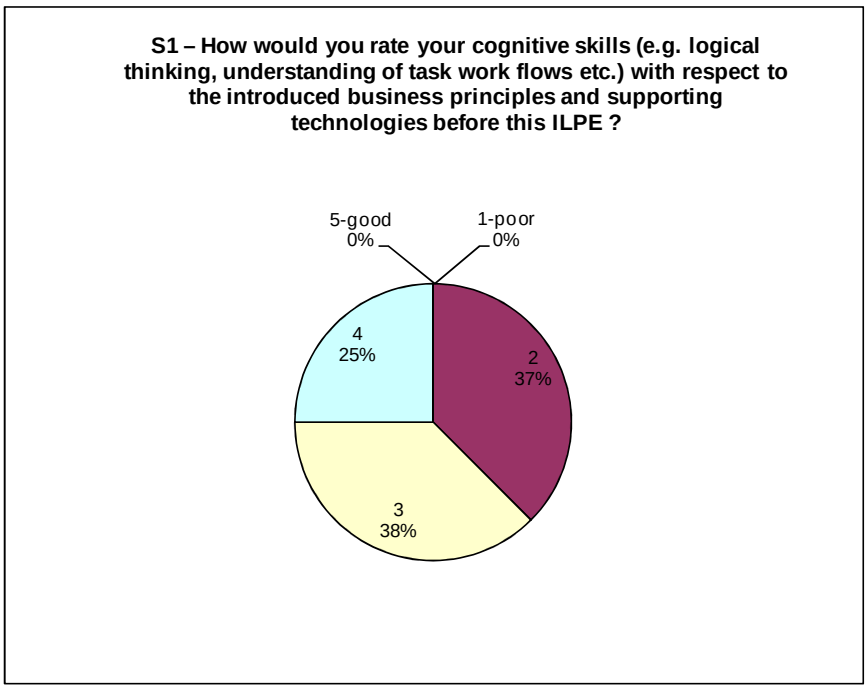


K5 – Do you feel confident that you can easily access, if you wish, more information / knowledge on the introduced business principles and supporting technologies after this ILPE?

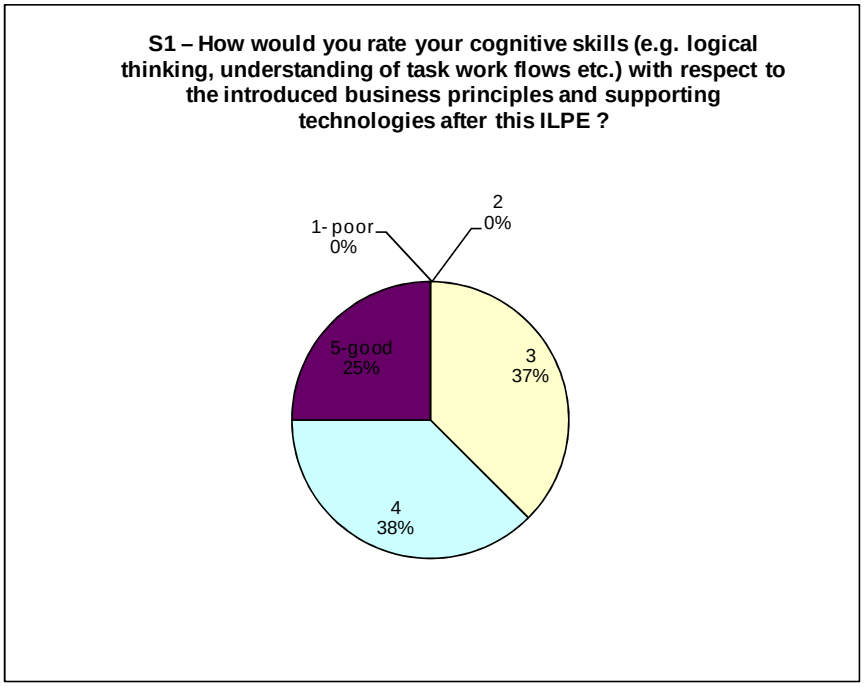


Skills

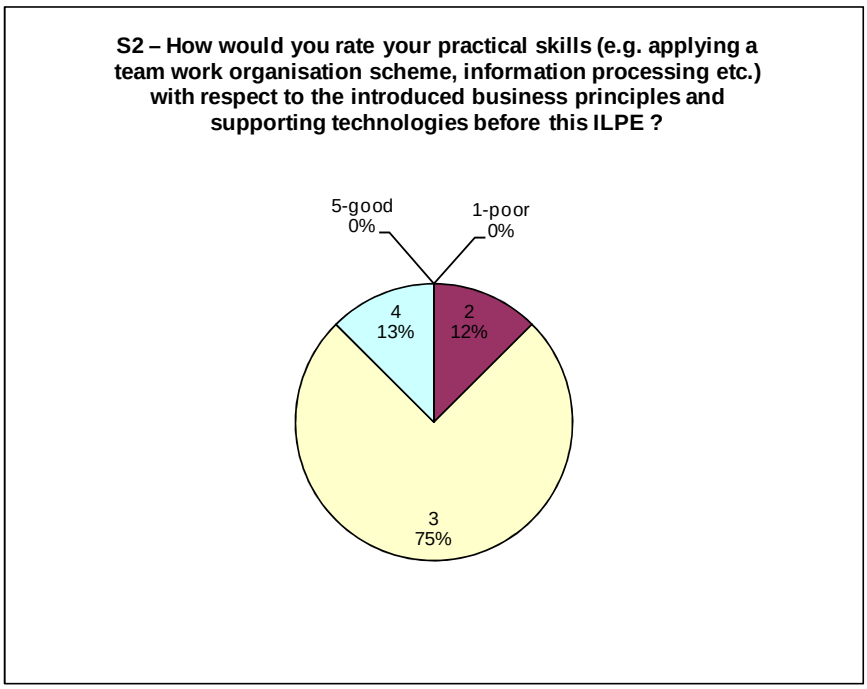
S1 – How would you rate your cognitive skills (e.g. logical thinking, understanding of task work flows etc.) with respect to the business principles and supporting technologies before this ILPE?



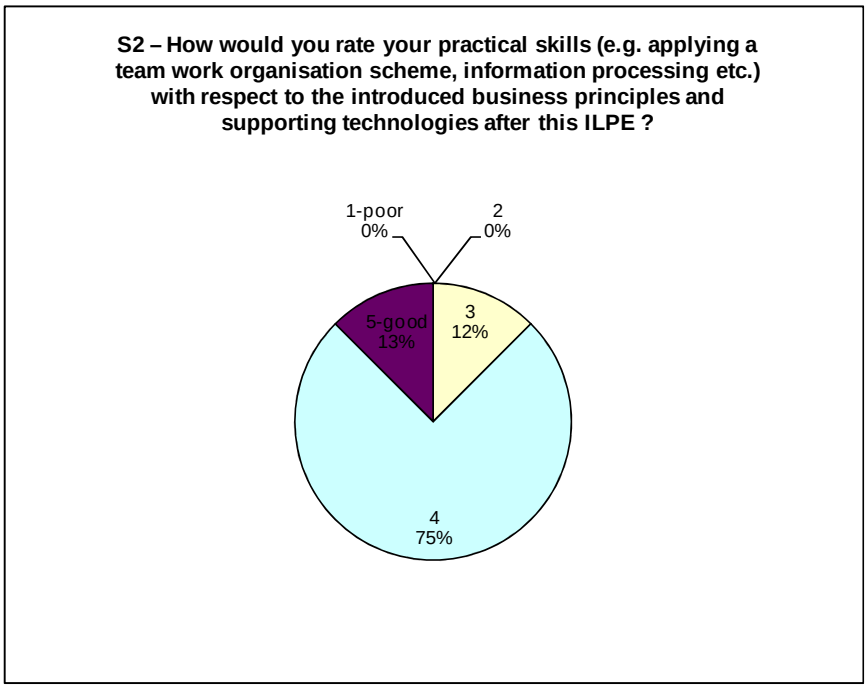
S1 – How would you rate your cognitive skills (e.g. logical thinking, understanding of task work flows etc.) with respect to the business principles and supporting technologies after this ILPE?



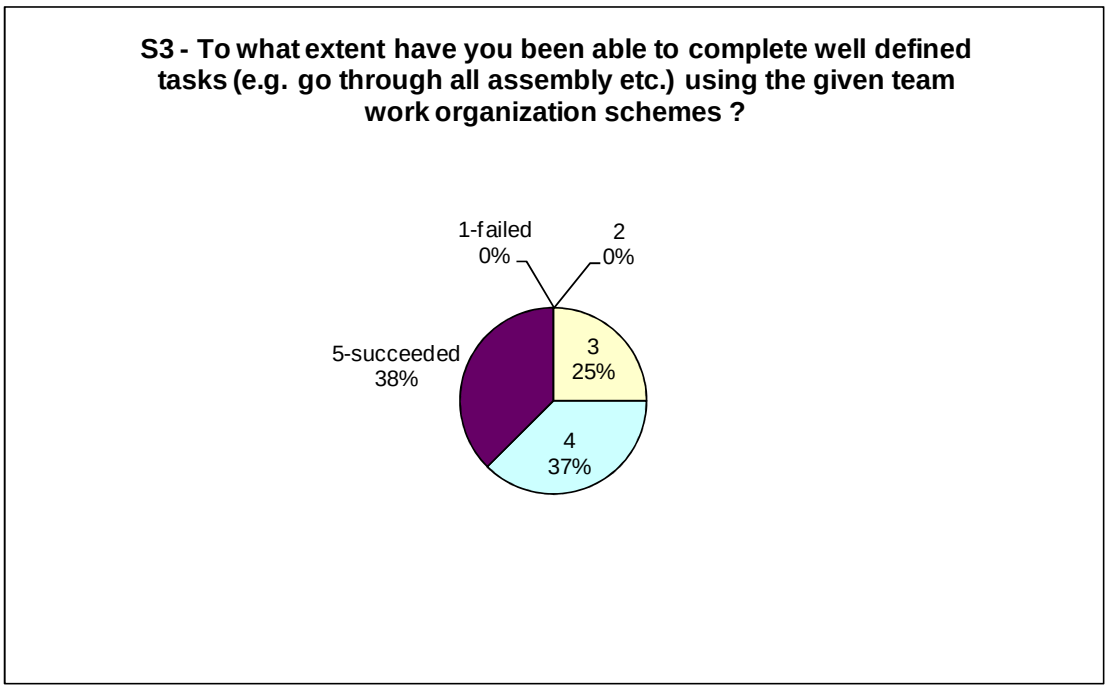
S2 – How would you rate your practical skills (e.g. applying a team work organization scheme, information processing etc.) with respect to the introduced business principles and supporting technologies before this ILPE?



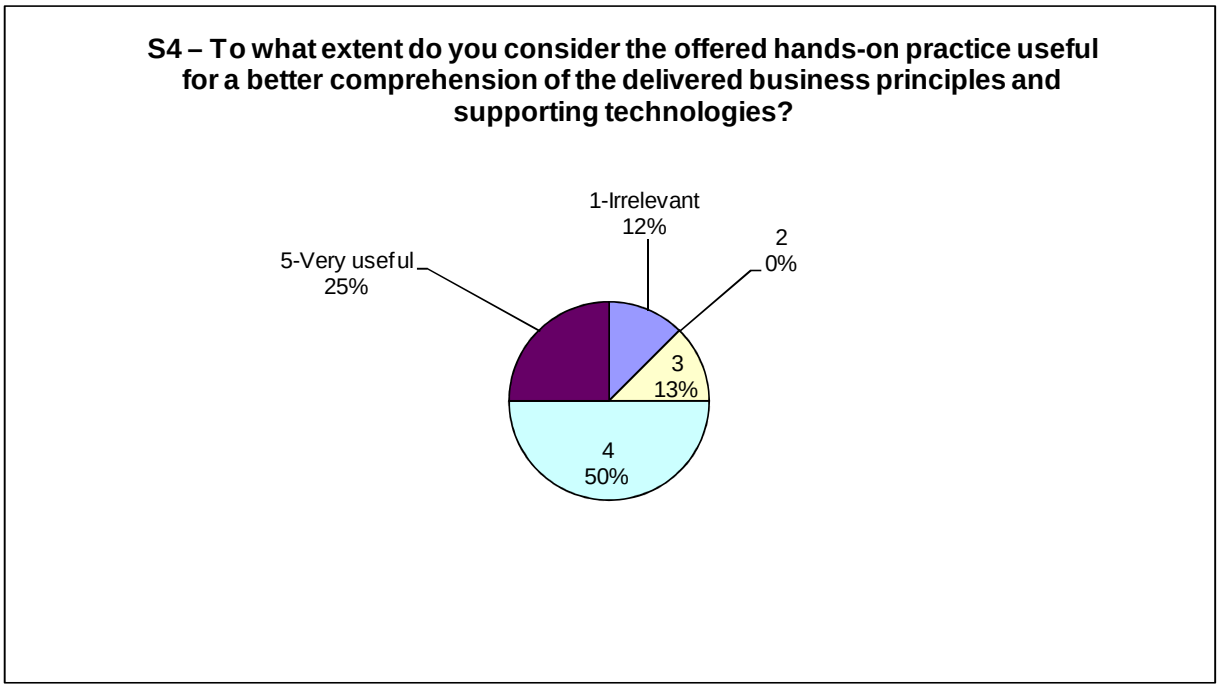
S2 – How would you rate your practical skills (e.g. applying a team work organization scheme, information processing etc.) with respect to the introduced business principles and supporting technologies after this ILPE?



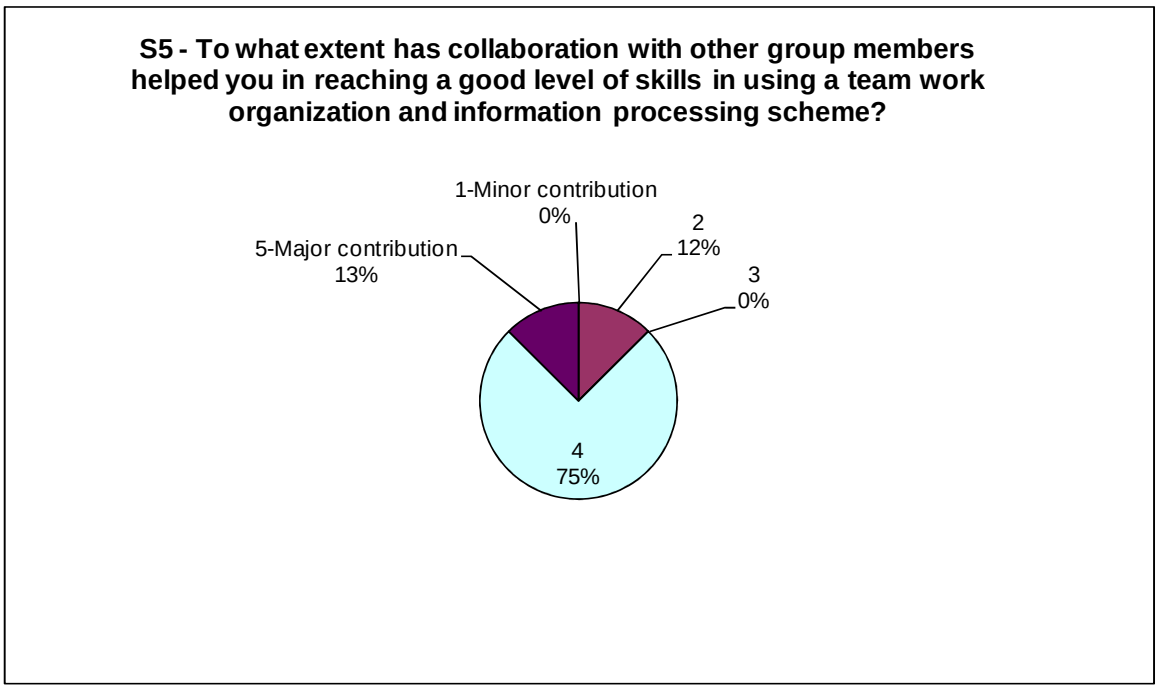
S3 - To what extent have you been able to complete well defined tasks (e.g. go through all assembly operation steps etc.) using the given team work organization schemes?



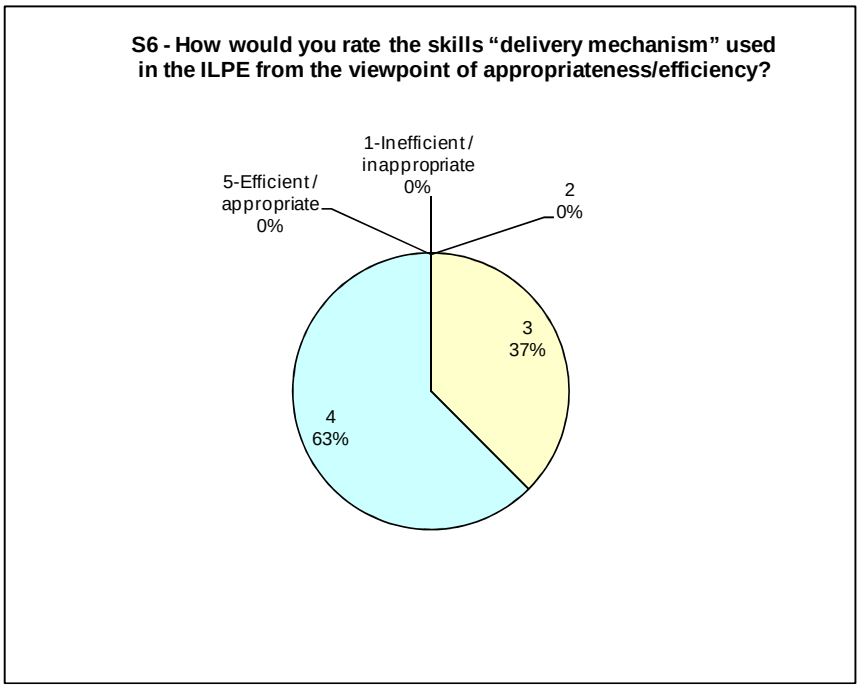
S4 – To what extent do you consider the offered hands-on practice useful for a better comprehension of the delivered business principles and supporting technologies?



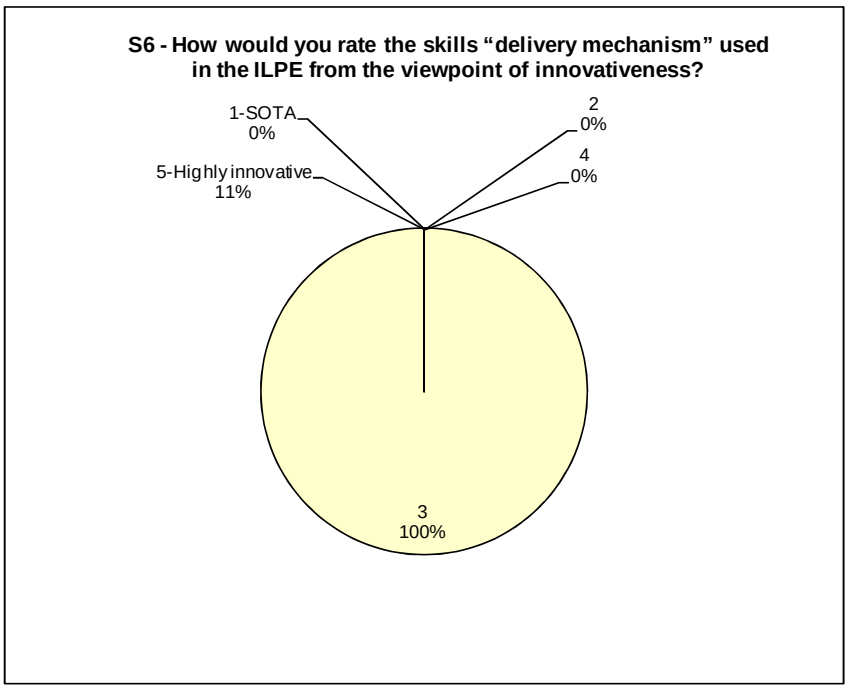
S5 - To what extent has collaboration with the other group members helped you in reaching a good level of skills in applying a team work organization and information processing scheme?



S6 - How would you rate the skills “delivery mechanism” used in the ILPE from the viewpoint of appropriateness/efficiency?

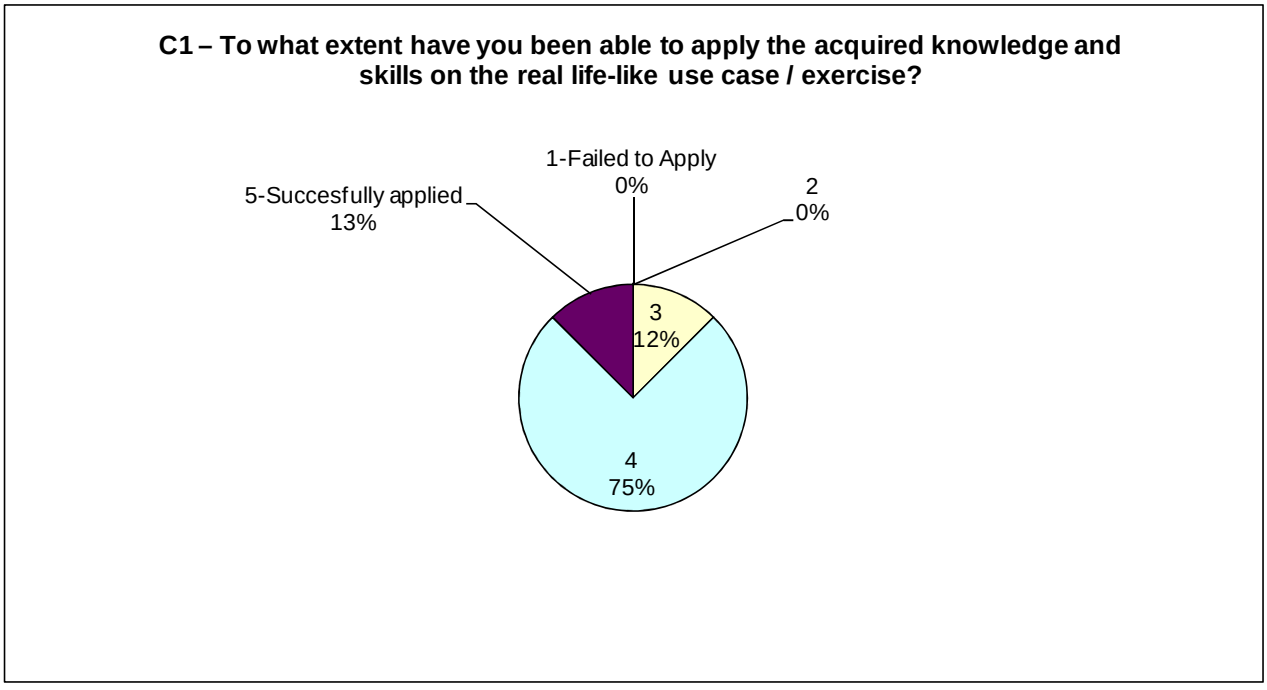


S6 - How would you rate the skills “delivery mechanism” used in the ILPE from the viewpoint of innovativeness?

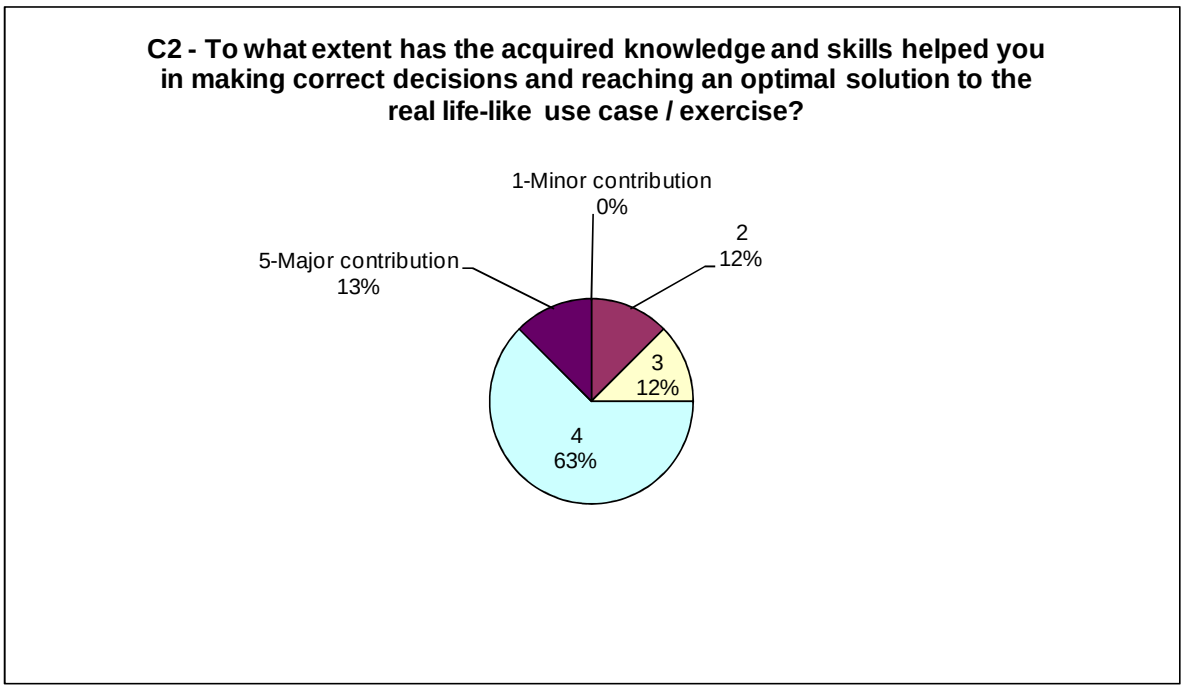


Competence

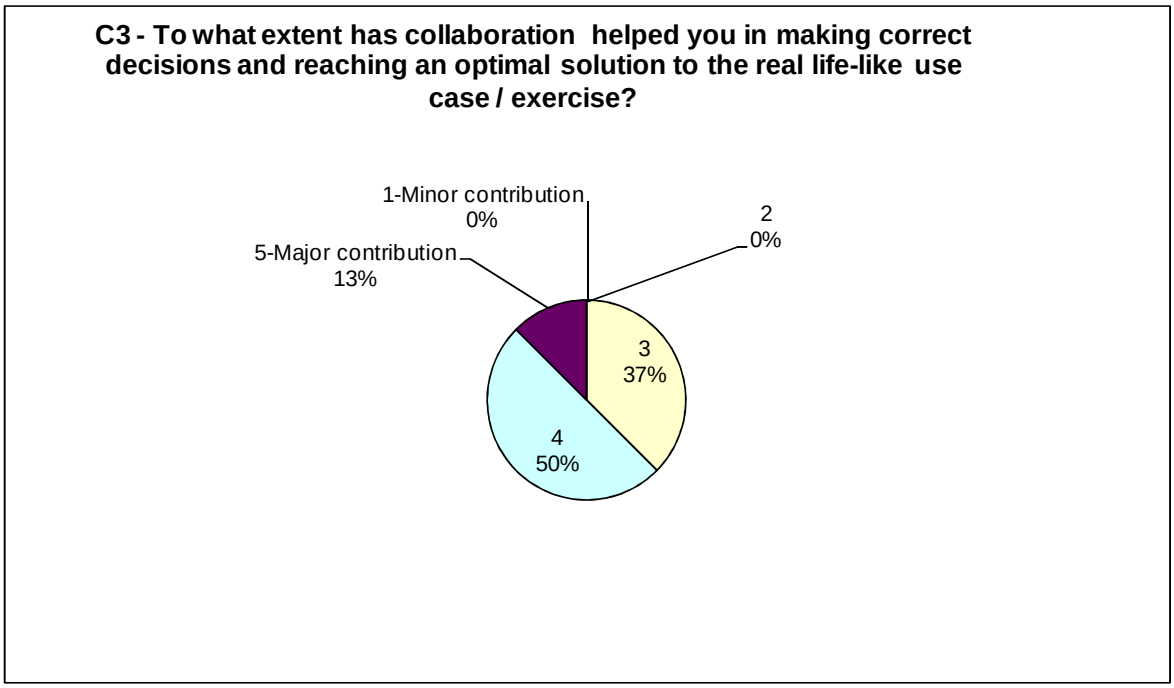
C1 – To what extent have you been able to apply the acquired knowledge and skills on the real life-like use case / exercise?



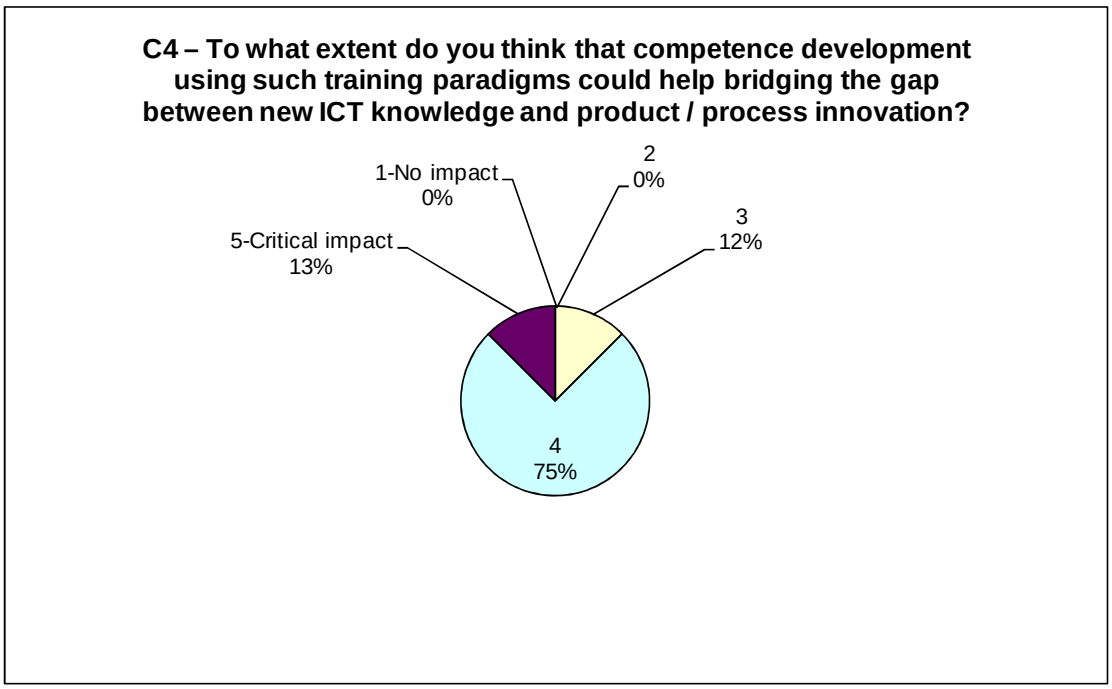
C2 - To what extent has the acquired knowledge and skills helped you in making correct decisions and reaching an optimal solution to the real life-like use case / exercise?



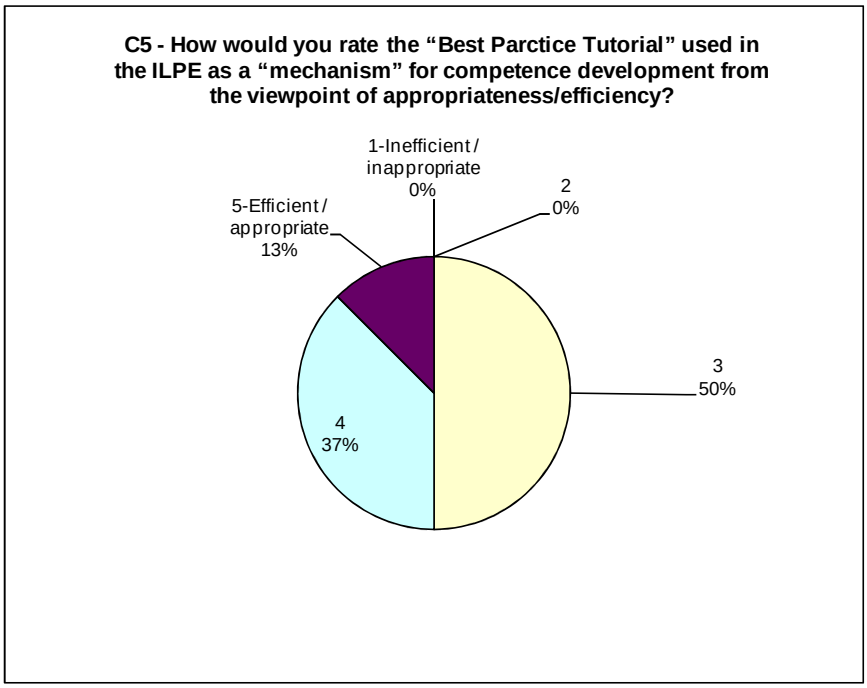
C3 - To what extent has collaboration helped in making correct decisions and reaching an optimal solution to the real life-like use case / exercise?



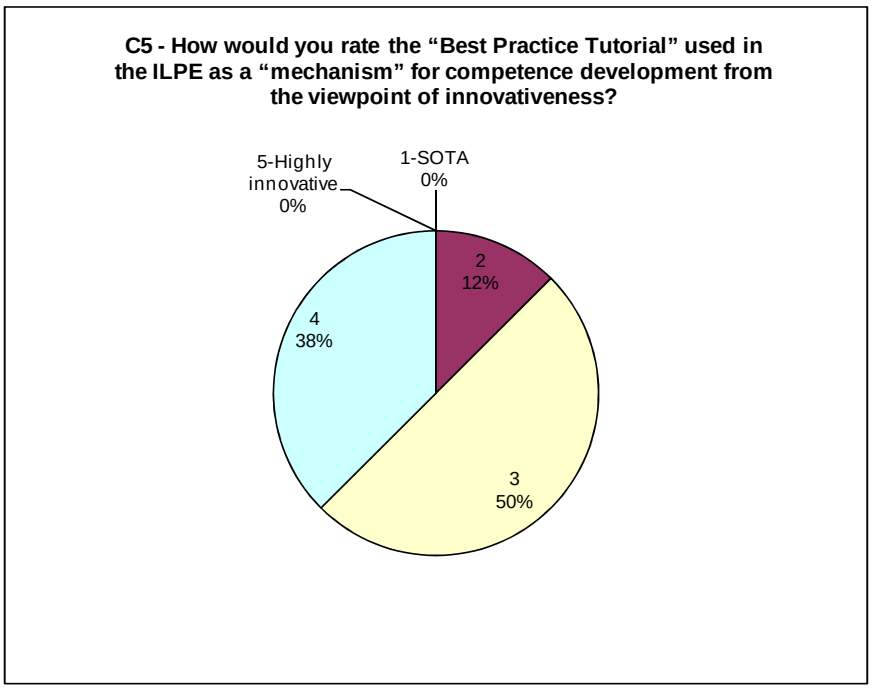
C4 – To what extent do you think that competence development using such training paradigms could help bridging the gap between new ICT / business knowledge and product / process innovation?



C5 - How would you rate the “Best Practice Tutorial” used in the ILPE as a “mechanism” for competence development from the viewpoint of appropriateness/efficiency?

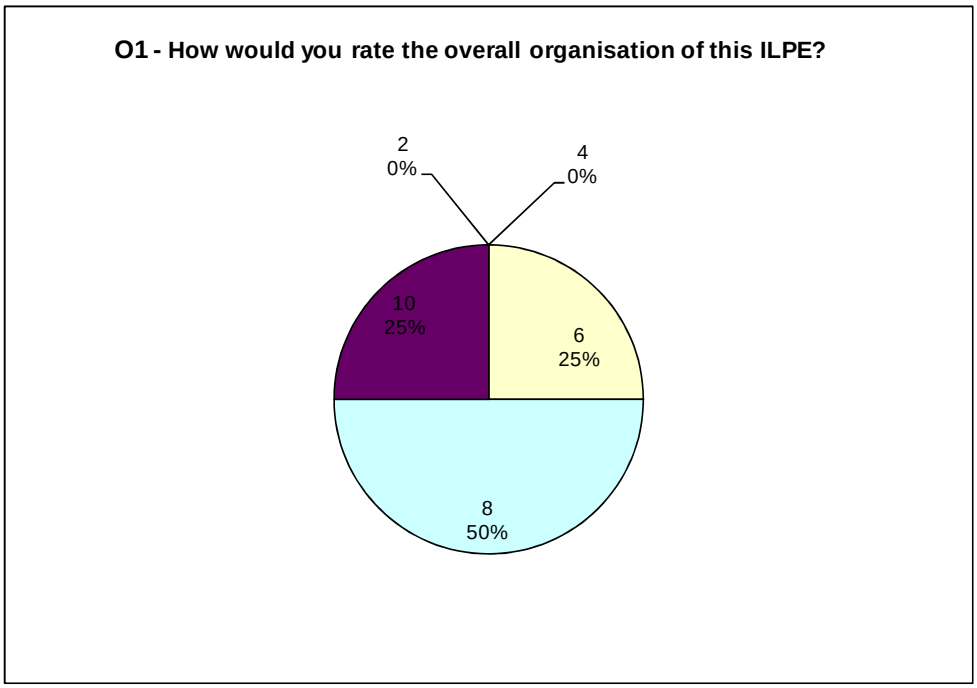


C5 - How would you rate the “Best Practice Tutorial” used in the ILPE as a “mechanism” for competence development from the viewpoint of innovativeness?

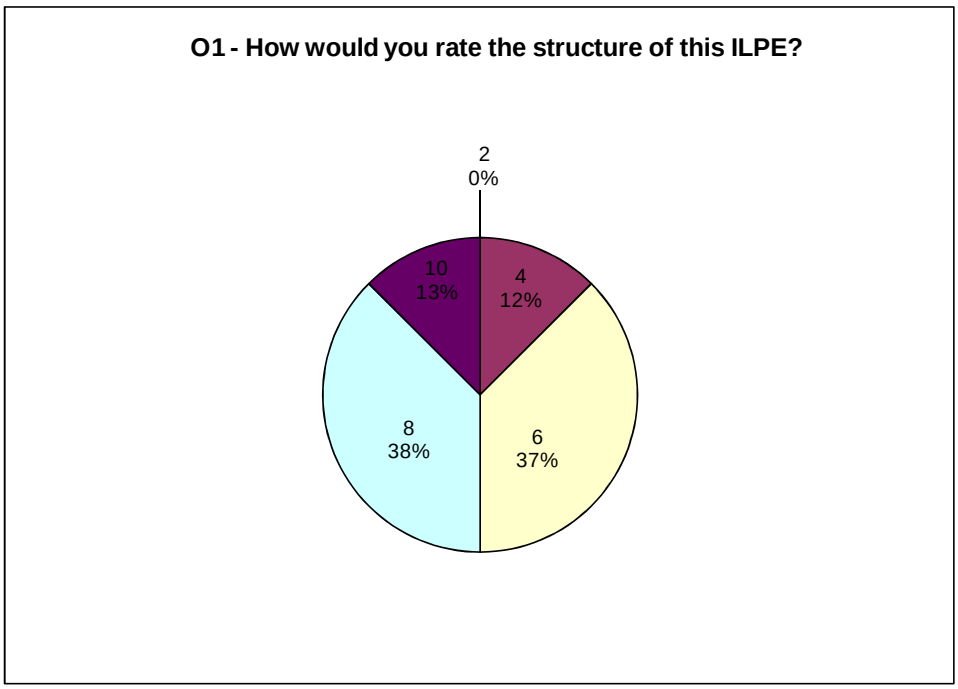


Overall ILPE

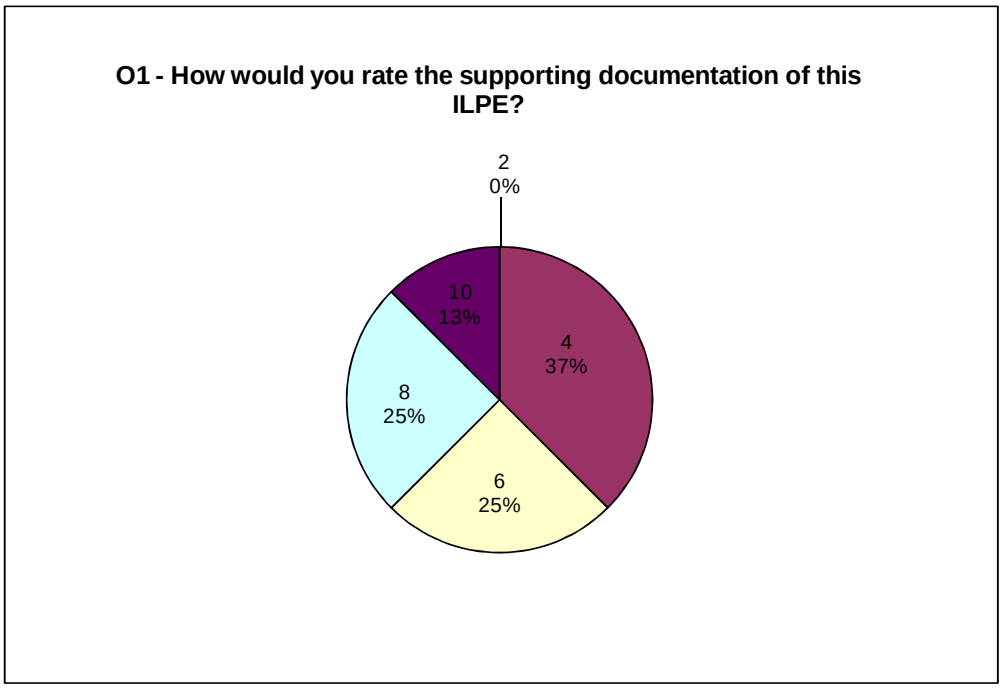
O1 - How would you rate the overall organisation of this ILPE?



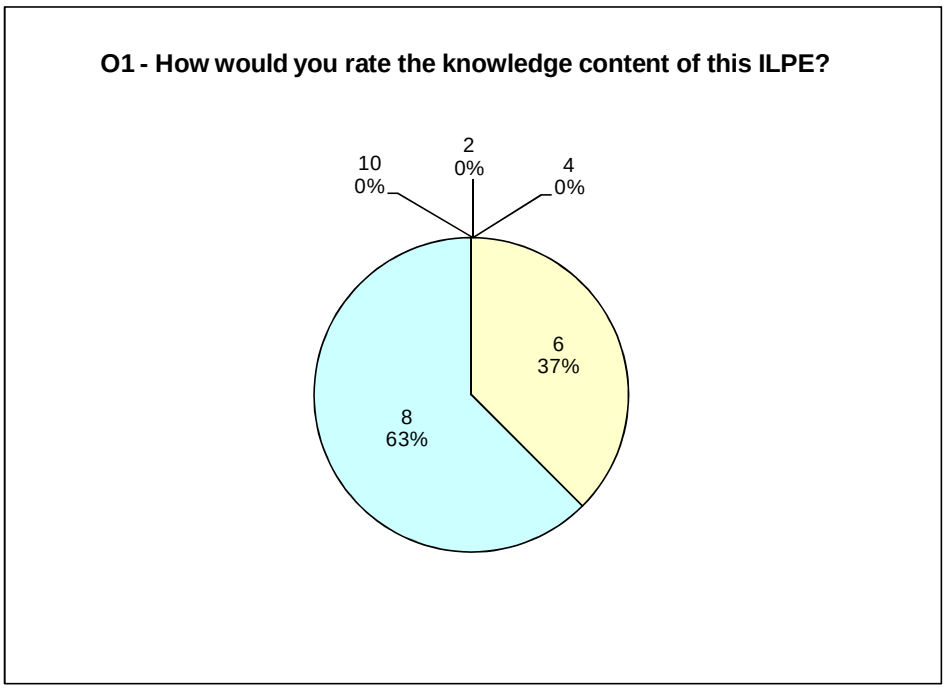
O1 - How would you rate the structure of this ILPE?



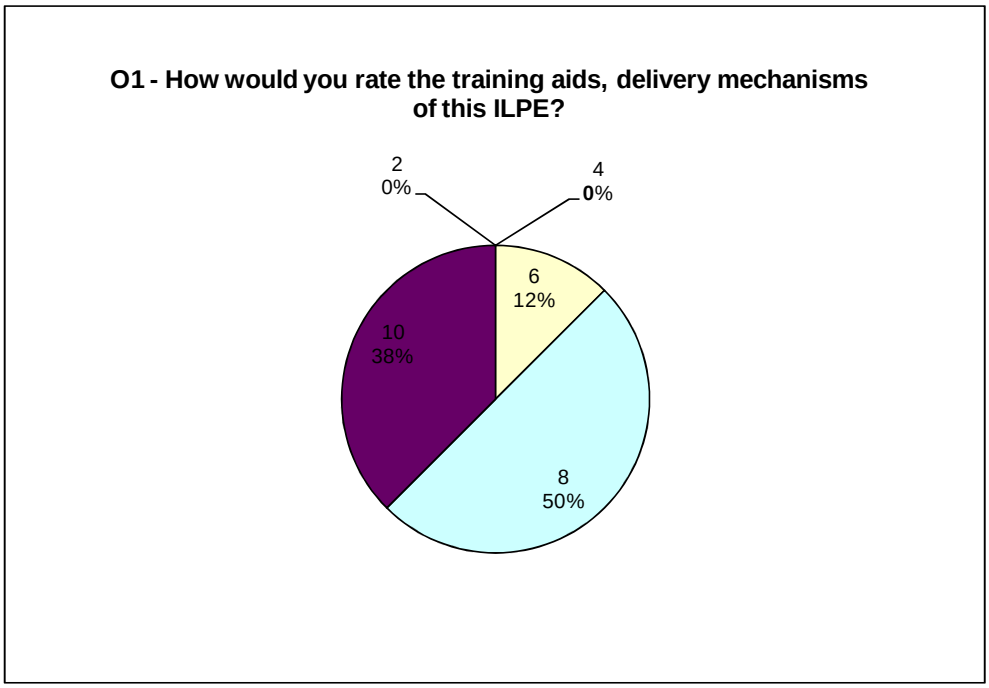
O1 - How would you rate the supporting documentation of this ILPE?



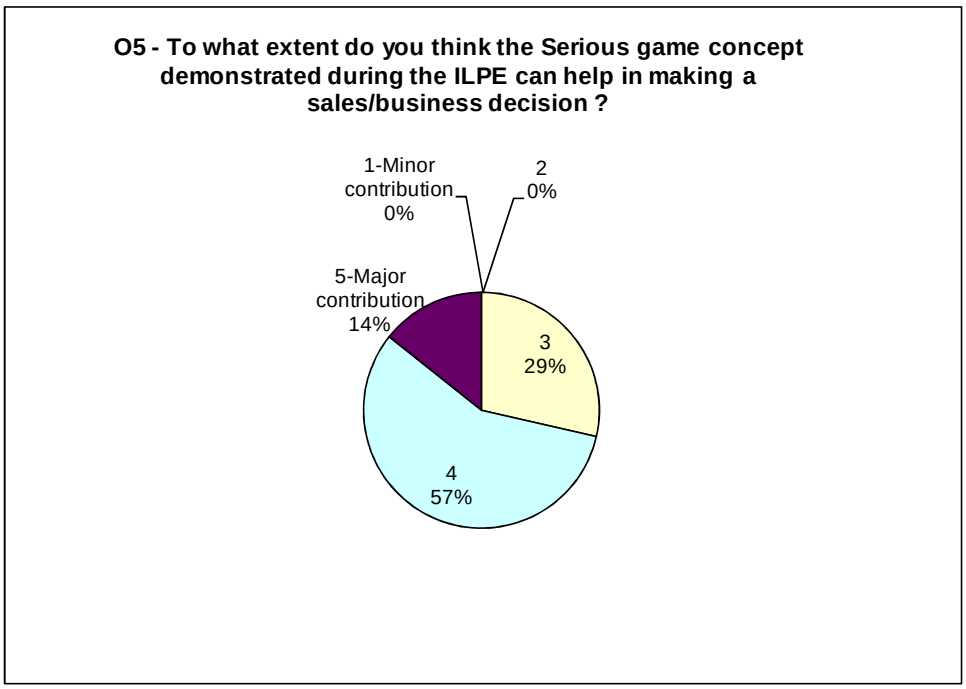
O1 - How would you rate the knowledge content of this ILPE?



O1 - How would you rate the training aids, delivery mechanisms of this ILPE?

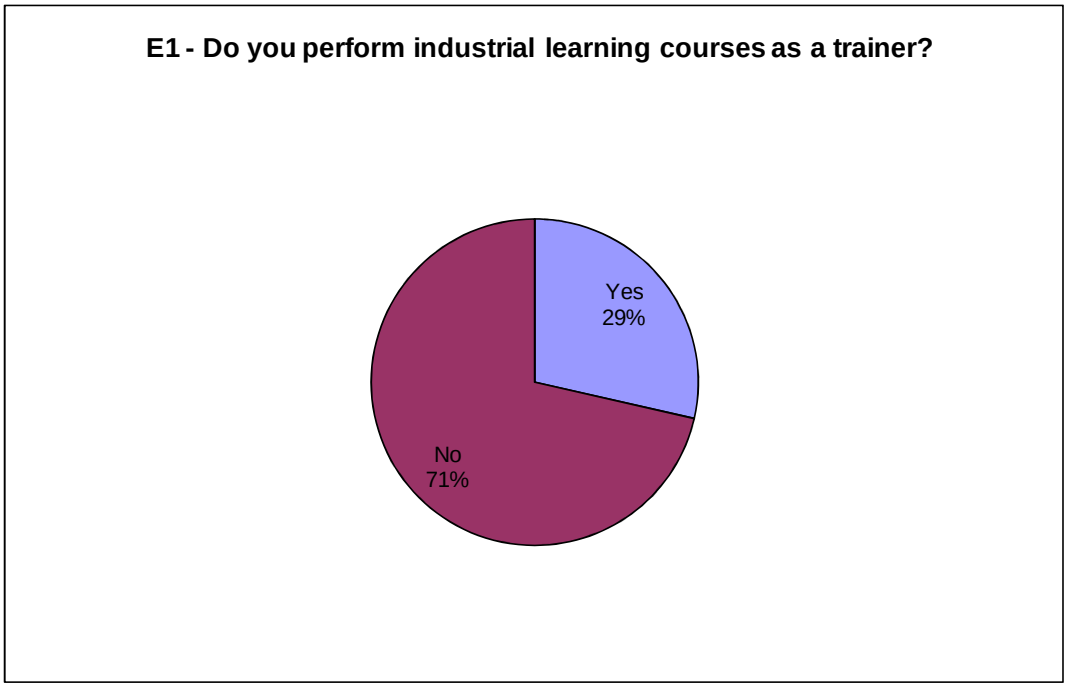


O5 - To what extent do you think the Serious Games concept demonstrated during the ILPE can help in making a sales/business decision?

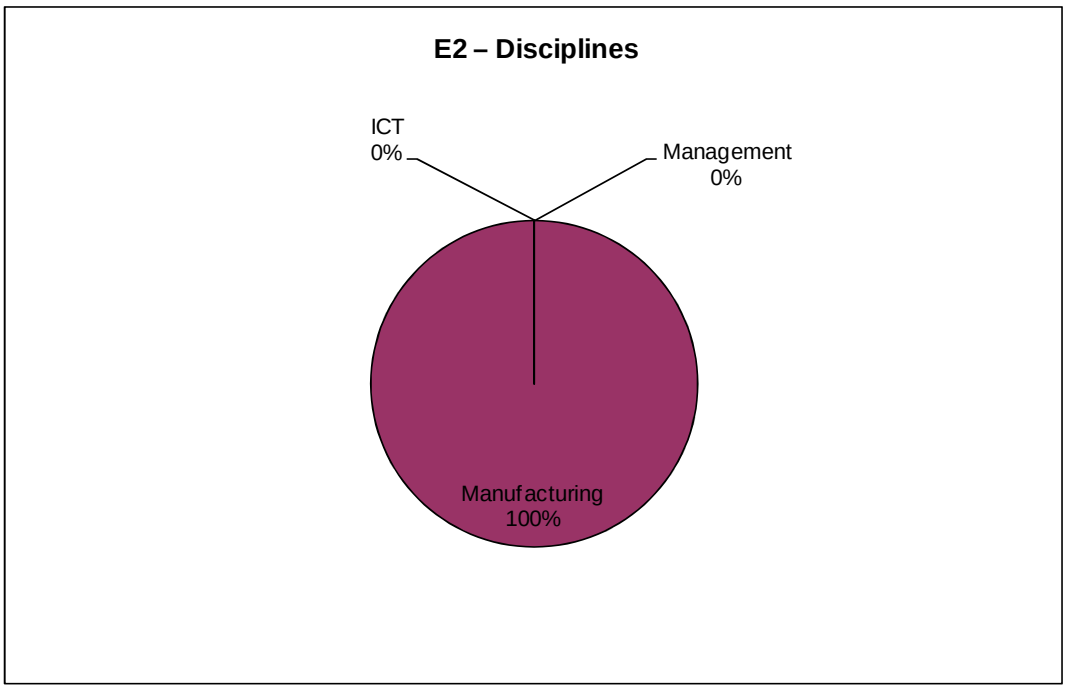


Experiences in performing Industrial Learning

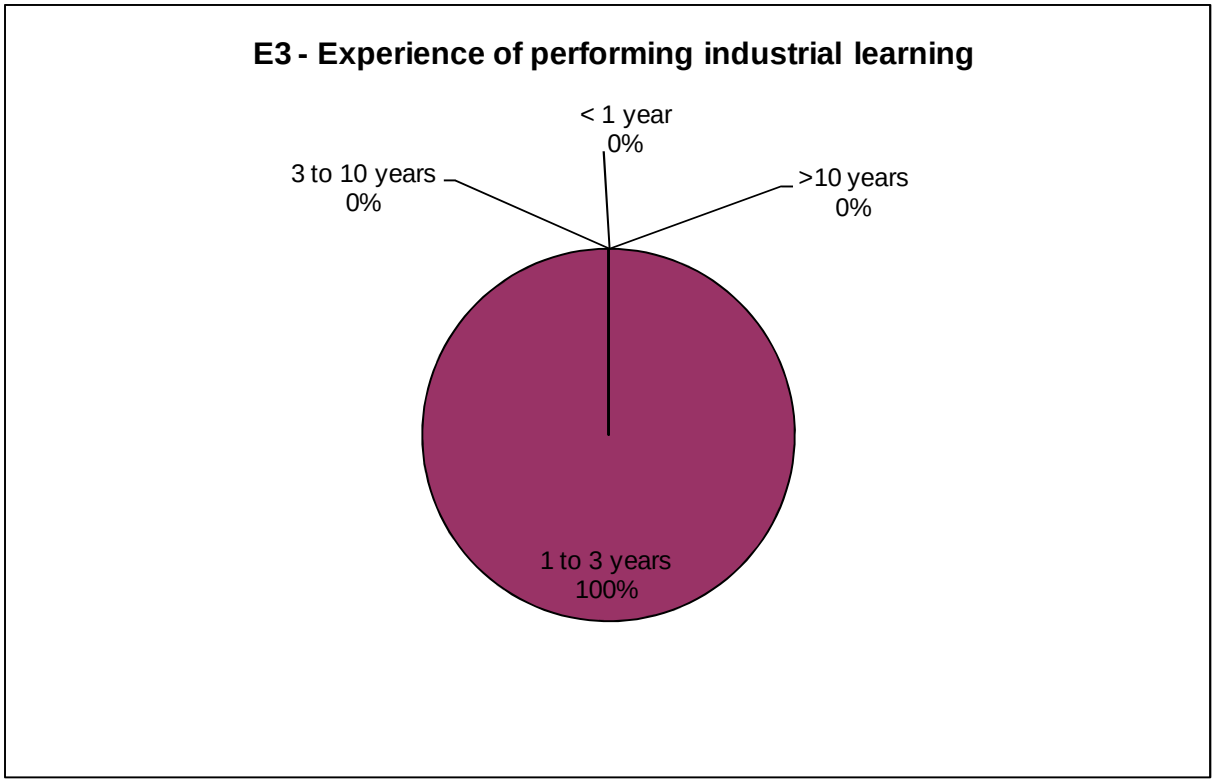
E1 - Do you perform industrial learning courses as a trainer?



E2 – Disciplines



E3 - Experience of performing industrial learning



10.3.5 Evaluation of learning process

This paragraph includes the qualitative assessment of the "contribution" of the 3rd ILPE in improving the attitude, knowledge, skills and competence of the trainees with respect to the introduced learning module. The assessment is based on the trainees' responses to the ILPE Questionnaire.

10.3.5.1 Attitude

- A major increase of the trainees' interest in the introduced business principles and supporting technologies has been reported, as a result of this ILPE.
- The trainees indicated a much higher confidence in the business potential of the introduced business principles and supporting technologies, as a result of this ILPE.
- There has been a rather balanced response concerning the maturity or not of the introduced business principles and supporting technologies for integration in industrial working practices, with the bigger group of trainees indicating that they may have good potential but they are still immature for real-life practices.
- The trainees indicated that the ILPE significantly helped in better understanding the environmental impact of the introduced business principles and supporting technologies.
- The trainees indicated that the ILPE significantly helped in better understanding the societal impact of the introduced business principles and supporting technologies.

10.3.5.2 Knowledge

- The trainees reported a major improvement of their overall understanding of the introduced business principles and supporting technologies, as a result of this ILPE.
- The majority of the trainees considered the ICT and business knowledge delivered during the ILPE quite "innovative".
- The majority of the trainees considered the ICT and business knowledge delivered during the ILPE quite "close to industrial practice".
- The knowledge "delivery mechanism" used in the ILPE has been considered highly appropriate / efficient.
- The big majority of the trainees considered the knowledge "delivery mechanism" being of moderate "innovation".
- The trainees felt quite confident that they can easily access more information / knowledge on the introduced business principles and supporting technologies after this ILPE.

10.3.5.3 Skills

- The trainees indicated a significant improvement of their cognitive skills (e.g. logical thinking, understanding of task work flows etc.) with respect to the introduced business principles and supporting technologies, after this ILPE.
- The trainees indicated a significant improvement of their practical skills (e.g. in applying different methods and tools for closed loop PLM and related information processing, etc.) with respect to the introduced business principles and supporting technologies after this ILPE.
- The trainees have mostly succeeded in completing well defined practical tasks involved in the application of methods and tools for closed loop PLM and related information processing.
- The trainees considered the offered hands-on practice very useful for a better comprehension of the delivered business principles and supporting technologies.
- The trainees indicated that collaboration with the other group members significantly helped in successfully applying the methods and tools for closed loop PLM.

- The skills "delivery mechanism" used in the ILPE has been considered as appropriate and efficient, but moderately new.

10.3.5.4 Competence

- The trainees indicated that they have been able to successfully apply the acquired knowledge and skills on the real life-like exercise
- The trainees indicated that the acquired knowledge and skills significantly contributed in making correct decisions and reaching an optimal solution to the real life-like exercise
- Collaboration and team work generally helped in making correct decisions and reaching an optimal solution to the real life-like exercise
- The trainees indicated that competence development using such training paradigms can have significant impact in bridging the gap between new ICT / business knowledge and product / process innovation
- The "Best Practice" tutorial, has been considered by the trainees as an appropriate and efficient "mechanism" for competence development in the field of closed loop PLM. The majority of the trainees considered that moderately new.

10.3.6 General observations

10.3.6.1 General observations by the Rapporteurs

Two Rapporteurs followed the activities of the trainees group, in order to comment on qualitative issues, such as the actual work flow and performance of the group, the difficulties encountered by the trainees, their actual involvement, their co-operation level etc.

The major general observations of the Rapporteurs have been the following:

- All the participants had some basic background about traditional PLM concepts, but there was a varying level of familiarity with the advanced PLM technologies introduced.
- The learning topic (closed loop PLM) and the knowledge delivery mechanism (Best Practice Tutorial) were generally considered as very interesting by the participants
- The "theory" presentations (ICT concepts, tools relevant to PLM and related applications) have well attracted the interest of the trainees.
- No detailed description of the exercises, or written instructions, was made available before the ILPE. The trainees also looked like they did not perceive very clearly the objectives of the exercise.
- Due to these facts, there has been some comprehension problems related to the exercise process. The instructors had to intervene quite often on practical issues.
- There were no incentives provided to ensure a high motivation from the trainees. Varying level of involvement also due to the different type of roles. Generally, involvement has been adequate for achieving the exercise objectives.
- No major decision making required by the trainees in the context of carrying out the exercise.

10.3.6.2 General observations by the Expert Trainers

Two expert trainers participated with an "observer" role in the 3rd ILPE. Their major general observations throughout the exercise execution are summarized hereafter.

- The methodological framework of the workshop, or the applied industrial learning concept, which would connect different approaches and fit them to a specific training model, was not that clear.
- Knowledge transfer included a good overview of the concept of Product Life Cycle Management over the internet, and a really impressive live demo.
- Presentations and exercises were though quite focused on the presentation of the applications (theoretical base, technical details, functionalities) and not on their potential uses. This generally reduces the attractiveness of a training session for the participants
- The efforts to practically demonstrate the applications presented and involve participants in the usage of these tools were rather weak and fragmentary. These efforts didn't go deep into the functions of the tools and, more importantly, they didn't fit with the rest of the presentations.
- The conclusion of the workshop was missing. In training sessions, normally the participant has to take with him something "tangible" when leaving the room, which was not the case in this workshop.
- With respect to the basic learning model used in the ActionPlanT project (Attitudes-> Knowledge-> Skills-> Competencies), the workshop rather stopped at the informative part (create awareness and attract interest) and did not adequately proceeded to the development of skills and competencies.

10.3.7 Overall impression

Based on their responses to the ILPE Questionnaire, the overall impression indicated by the trainees about the 3rd ILPE, may be summarized in the following points:

- The trainees considered the overall ILPE organization being very good.
- The structure, the knowledge content, the training aids and delivery mechanisms have been very well received from the trainees.
- The ILPE supporting documentation was rated as being of moderate quality.
- The trainees consider that the "Best Practice" concept demonstrated during the ILPE can significantly contribute in making a sales/business decision.

The trainees have considered the following points as the strengths of the 3rd ILPE:

- Very interesting case studies applied in industrial environments.
- Development of non conventional skills.
- Training and practice on real-life use cases.

The trainees have considered the following points as the weaknesses of the 3rd ILPE:

- Not very good supporting documentation.
- Very simple use of software modules.
- Hands-on practice was rather limited.

10.3.8 Recommendations

10.3.8.1 Trainees' suggestions

- A detailed description of the exercise with a clear definition of the objectives, the steps and the roles of the participants would greatly improve the outcome of the training.

- Some interviews from industrial people involved in the case studies could be introduced in the knowledge transfer session.

10.3.8.2 Expert trainers' suggestions

- PPT presentations and hands-on exercises looked as if they were almost independent one from the other. May be if the workshop included more but smaller "exercises" embedded into the course of the presentations, we could reach a better learning outcome.
- If the focus of the PPT presentations and exercises was on the potential use of the tools and especially the way in which these tools can fit into current industrial operations or business processes, this would make it more interesting and useful for the participants. Especially in the case that the audience is coming from a non-technical background, a "user" and not "developer" approach is necessary.
- In such training sessions, the participants should develop by themselves something that generally fits their specific "needs". An ideal solution would be if the participants could use the "exercises" that they participated in during the workshop to develop parts of this personal "roadmap" that could take with them when leaving the class.

10.3.9 Conclusion

The ILPE#3 took place on the 7th of September 2011, at CERN (the European Organization for Nuclear Research) in Geneva.

The learning paradigm chosen to be used and evaluated in this ILPE was that of "Best Practice Tutorial" which was used for learning the principles of closed loop PLM emerged from PRMISE project

The ILPE comprised two presentations followed by exercises aiming to experiment the introduced concepts in the presentations.

The recommendations from ILPE#3 of the trainees and the expert trainers will be investigated in order to identify those that can be implemented for each of the forthcoming ILPEs.

10.4 Annex 4: ILPE#4

10.4.1 Description of the 4th ActionPlanT ILPE exercise

The purpose of the exercise of the 4th ActionPlanT ILPE was ***the simulation of car's assembly line*** by playing ***Muscle Car*** based on ***LEGO® car models*** where the participants should assemble as much cars as possible testing different types of organization: traditional, self optimized and lean.

The exercise involves 3 main rounds described as follows:

In the first round of the game, the participants manufacture cars according to a specific organization described by game rules.

In the second round, the participants propose their own organization in order to fix the problems identified in the first round.

Then in the 3rd round, the participants experience some Lean principles in action in order to make production more efficient (Figure 8).

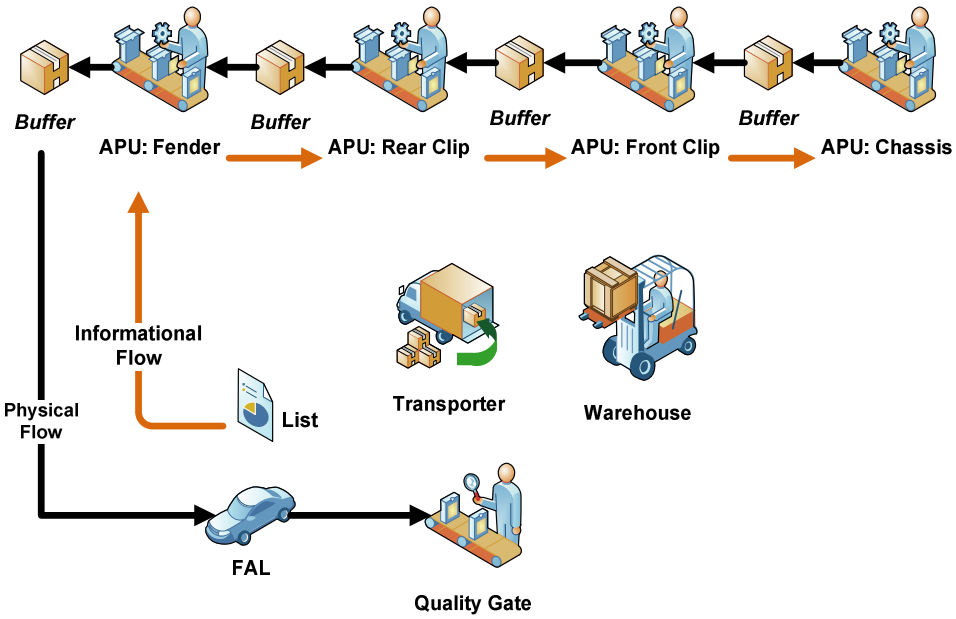


Figure 8
. Organization using lean principles

At the end of the three rounds of the game, participants will have an overview (Debrief) of the impact of their choices on results and "lean Manufacturing", followed by a more formal presentation on Lean principles and the kind of ICT systems from the ActionPlanT roadmap that are needed to implement them in modern production organizations.

The structure and timing of the 3 rounds of the serious game are shown in Table 24.

Table 24: Structure and timing of Muscle Car Serious Game

Round I	Initial rules of the game (role distribution and setup)	30'
	3 simulated weeks of work: | 10 minutes equal to one week (5 days) | + a break of 4 minutes for week-ends	52'
Round II	Team's own organization preparation	15'
	3 simulated weeks of work: | 10 minutes equal to one week (5 days) | + a break of 4 minutes for week-ends	52'
Round III	New rules of the game (document to read)	15'
	3 simulated weeks of work: | 10 minutes equal to one week (5 days) | + a break of 4minutes for week-ends	52'
	Debrief	30'

10.4.2 Goals of the 4th ActionPlanT ILPE

The goals of the 4th ActionPlanT ILPE regarding the improvement of attitude, knowledge skills and competencies are presented in Table 25.

Table 25: 4th ActionPlanT ILPE goals regarding attitude, knowledge skills and competencies

	Definition	**ILPE goals**	**4th ILPE Goals**

Attitude	"Attitude" is a hypothetical construct that represents an individual's degree of like or dislike for an item. Attitudes are generally positive or negative views of a person, place, thing, or event.	Create awareness, attract interest, increase motivation to learn & apply	Create awareness and attract interest with respect to Lean Manufacturing and the supporting ICTs
Knowledge	"Knowledge" means the outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices that is related to a field of work or study.	Create a basic understanding on business principles & supporting ICTs (basics of relevant theory & SW) oriented to industrial practice.	Create a basic understanding about the major principles, pillars and limitations of Lean Manufacturing, as well as about the manufacturing ICTs (e.g. MES, ERP, RFID etc.) implementing the underlying principles and enabling lean production
Skills	"Skills" means the ability to apply knowledge and use know-how to complete well defined tasks. Skills may be cognitive or practical	Acquaint with functions of software tools, information processing, workflows and organization schemes, and complete a well defined series of tasks applying the given knowledge	Apply different schemes for team work organization and information processing in assembly operations, including traditional schemes, self-organization and lean principles
Competencies	"Competence" means the proven ability to use knowledge, skills and personal, social and/or methodological abilities. Competences may be considered as the interface between the learning and the innovation processes.	Build-up basic ability to combine different pieces of knowledge, developed skills and own understanding, to make decisions, optimize operations and address real life-like use cases	Develop the capability of addressing realistic use cases involved in car assembly operations, requiring decision making and optimization of teamwork organization and information processing

The overall objective of the 4th ActionPlanT ILPE was the assessment of the "Serious Games" paradigm as a knowledge delivery mechanism for IL about Lean Manufacturing.

Another characteristic of the 4th ActionPlanT ILPE was the consideration of two groups involving participants with different roles from the same company.

The evaluation of the 4th ActionPlanT ILPE takes into account all these viewpoints and assesses to what extent the different objectives have been achieved.

10.4.3 Participants in the 4th ActionPlanT ILPE

The participants in this ILPE were partitioned into two groups. The results of the exercise (number of assembled cars) are compared for each group according to the different types of organization and between the two groups for each type of organization.

The participants in the first group are given in Table 26.

Table 26: List of participants in the first group

Trainee	Function
A Chakir *(team leader)*	Production engineer
B Bourgeoisat	Maintenance coordinator
C Goudart-Rodier	Process ingineer
D Bertrand	Business Development
D Picard	Manager 2nd production line
F Davaine	IT
G Ba	Lean / 6 sigma
L Lalaite	Manager IT
S Perrault	Manager 1st production line

The participants in the second group are given in Table 27.

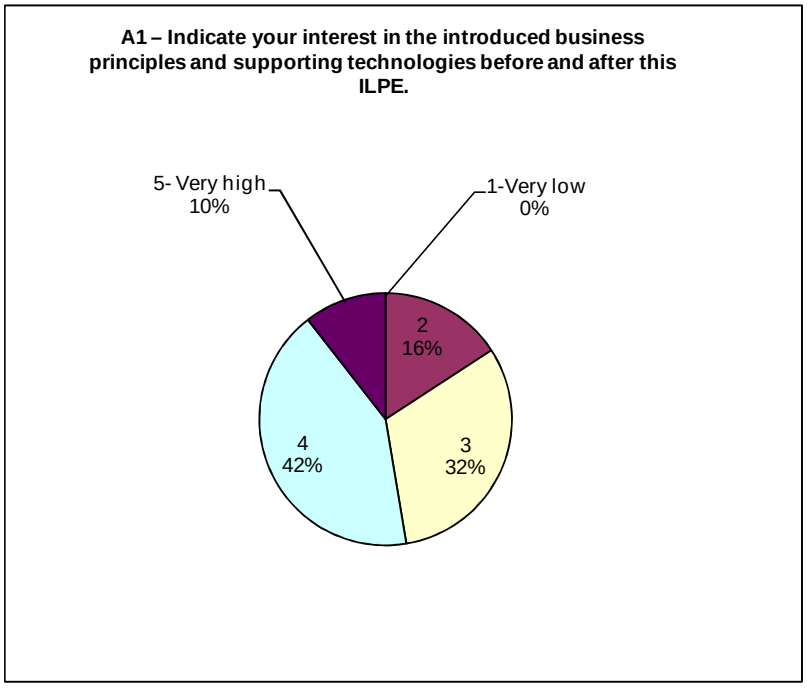
Table 27: List of participants in the second group

Trainee	Function
P Vannier *(team leader)*	IT
T Meynier	Production engineer
D Copinet	Process ingineer
G Froelhin	Manager 2nd production line
F Lange	Training center
H Ansquer	Project manager
J Boiton	Process ingineer
M Egreteau	Production engineer
L Proust	Maintenance manager
C Souris	Production engineer

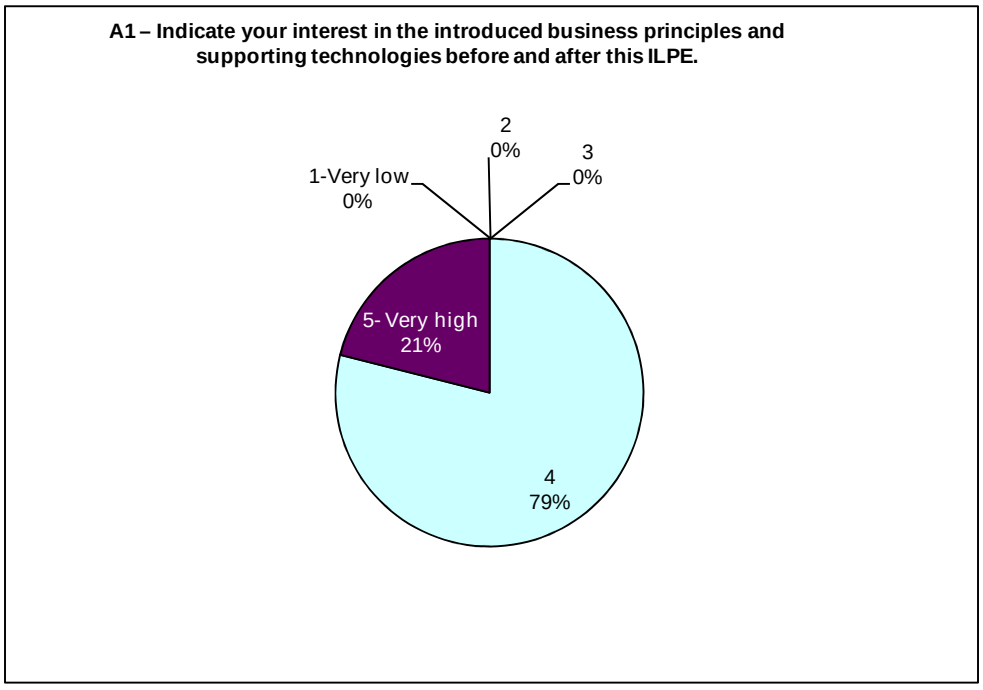
10.4.4 Analysis of the ILPE#4 questionnaires

Attitude

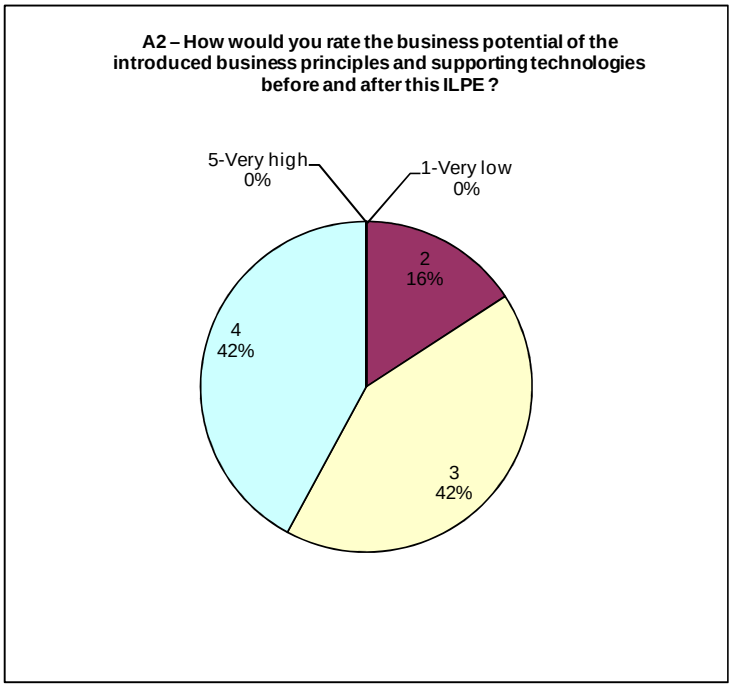
A1 – Indicate your interest in the introduced business principles and supporting technologies before this ILPE



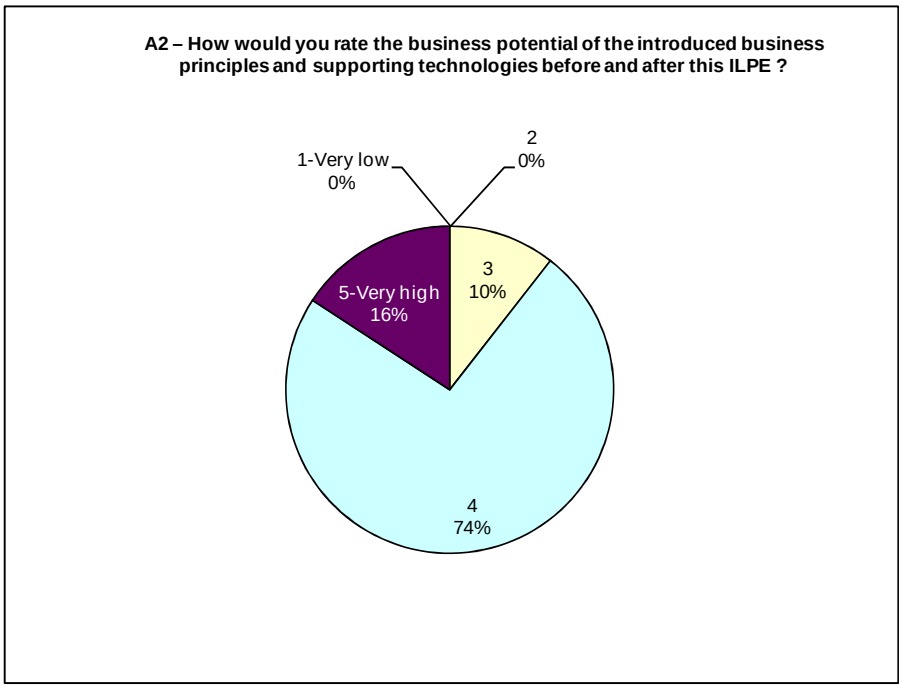
A1 – Indicate your interest in the introduced business principles and supporting technologies after this ILPE



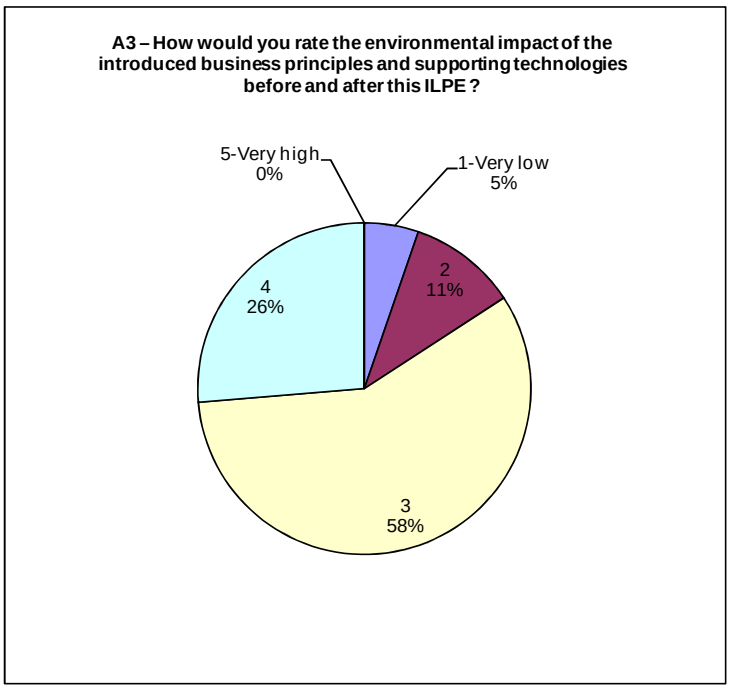
A2 – How would you rate the business potential of the introduced business principles and supporting technologies before this ILPE?



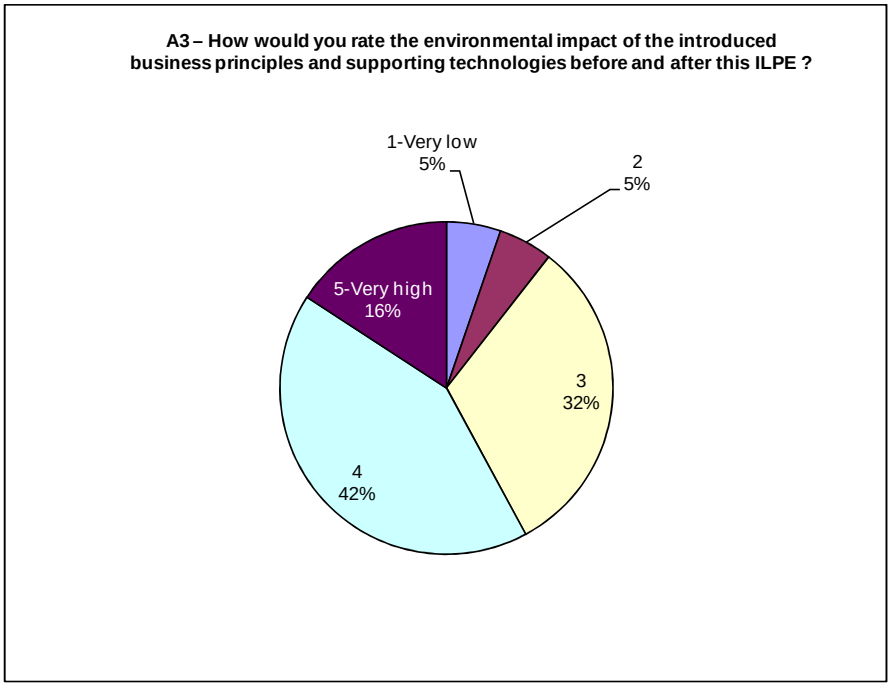
A2 – How would you rate the business potential of the introduced business principles and supporting technologies after this ILPE?



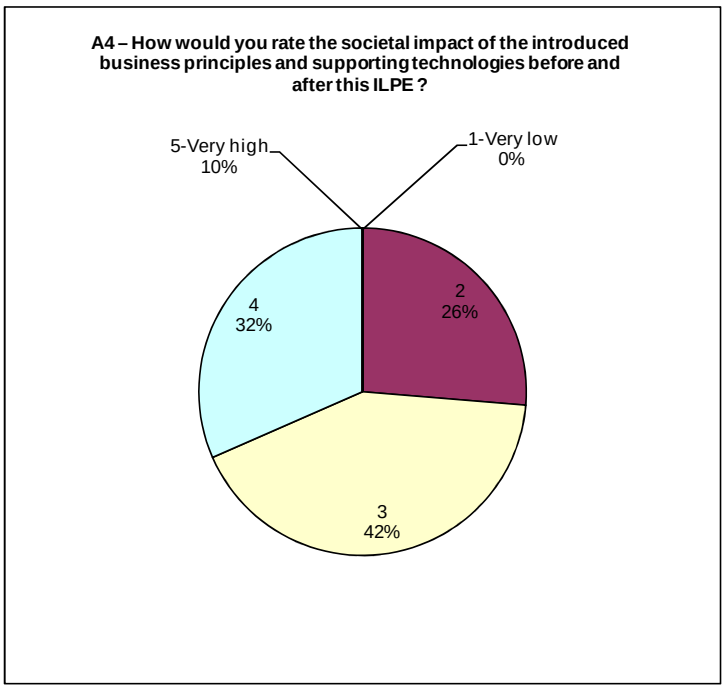
A3 – How would you rate the environmental impact of the introduced business principles and supporting technologies before this ILPE?



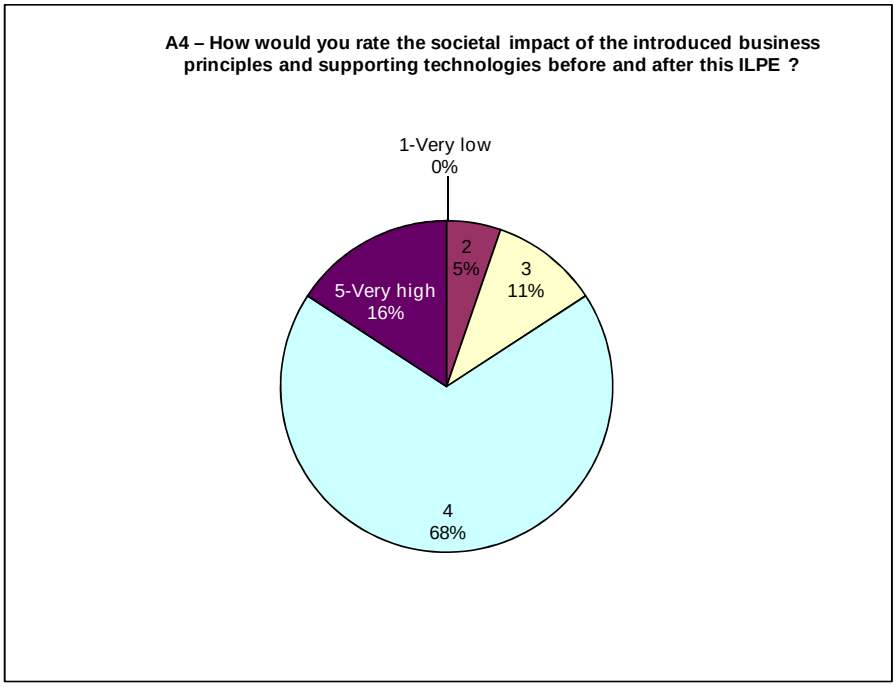
A3 – How would you rate the environmental impact of the introduced business principles and supporting technologies after this ILPE?



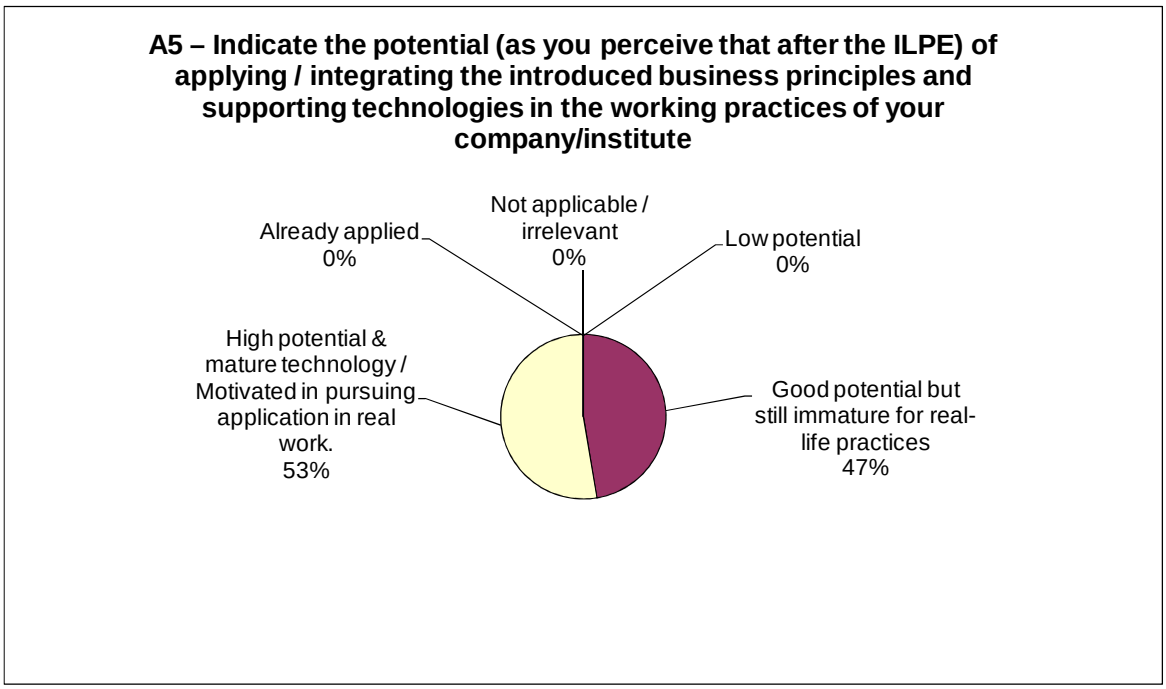
A4 – How would you rate the societal impact of the introduced business principles and supporting technologies before this ILPE?



A4 – How would you rate the societal impact of the introduced business principles and supporting technologies after this ILPE?

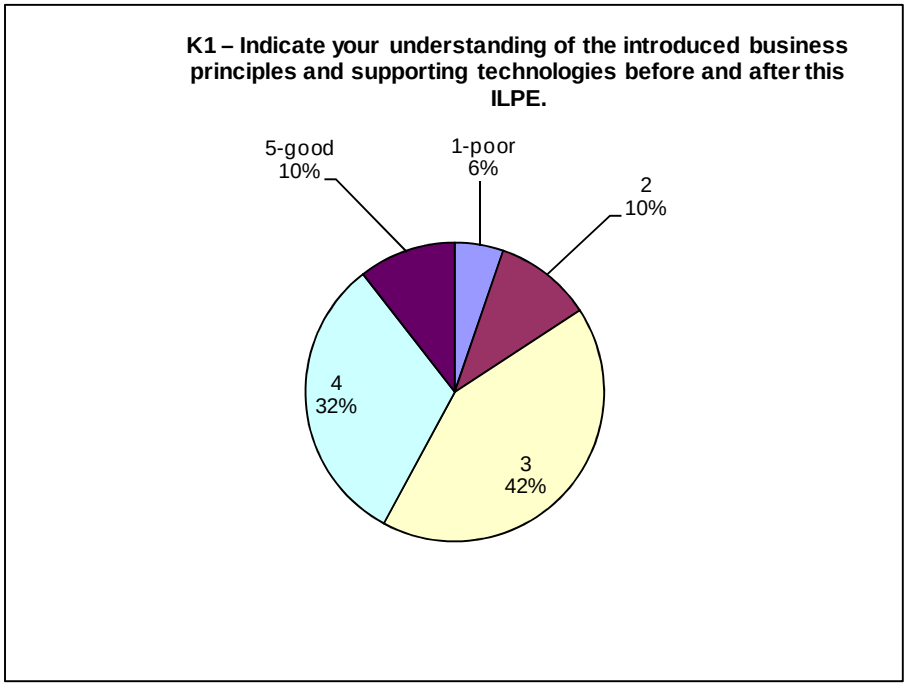


A5 – Indicate the potential (as you perceive that after the ILPE) of applying / integrating the introduced business principles and supporting technologies in the working practices of your company/institute

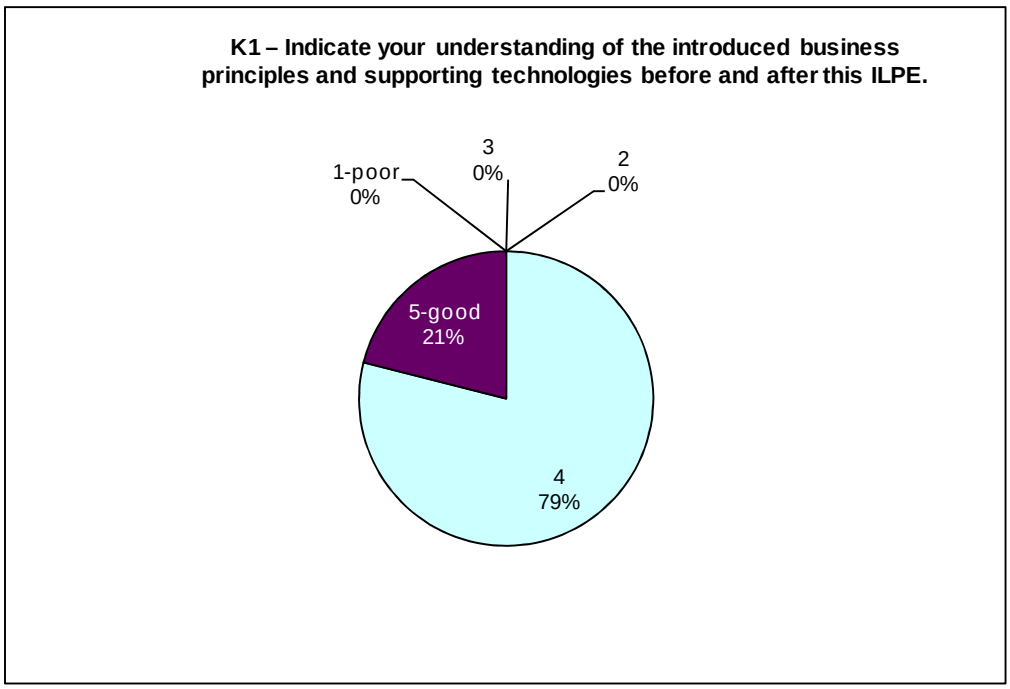


Knowledge

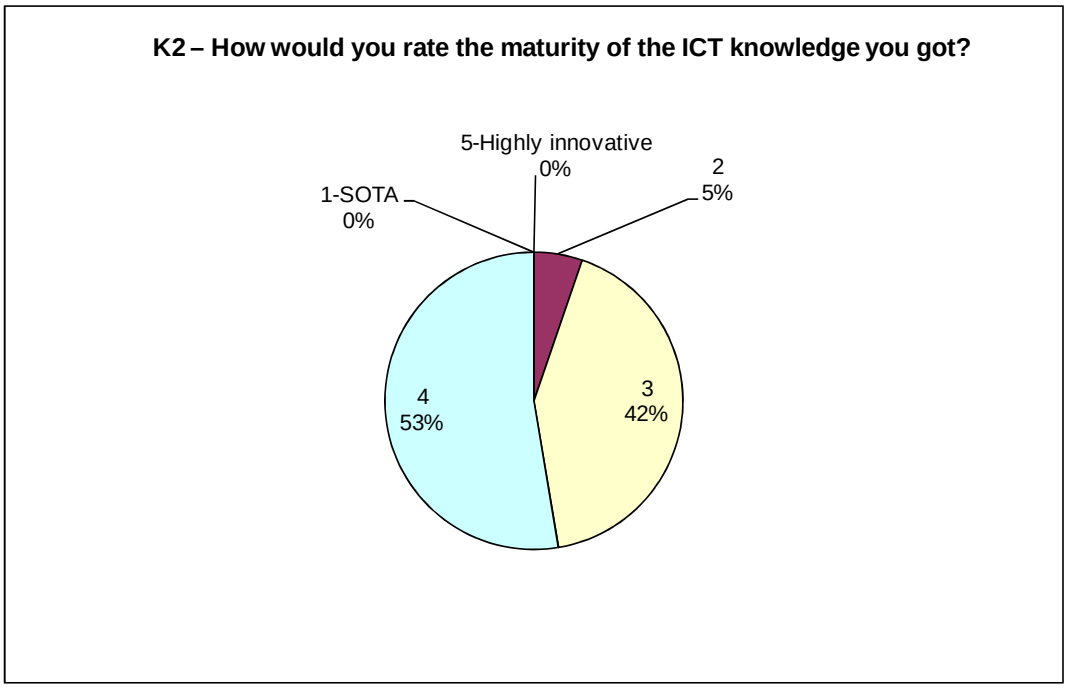
K1 – Indicate your understanding of the introduced business principles and supporting technologies before this ILPE.



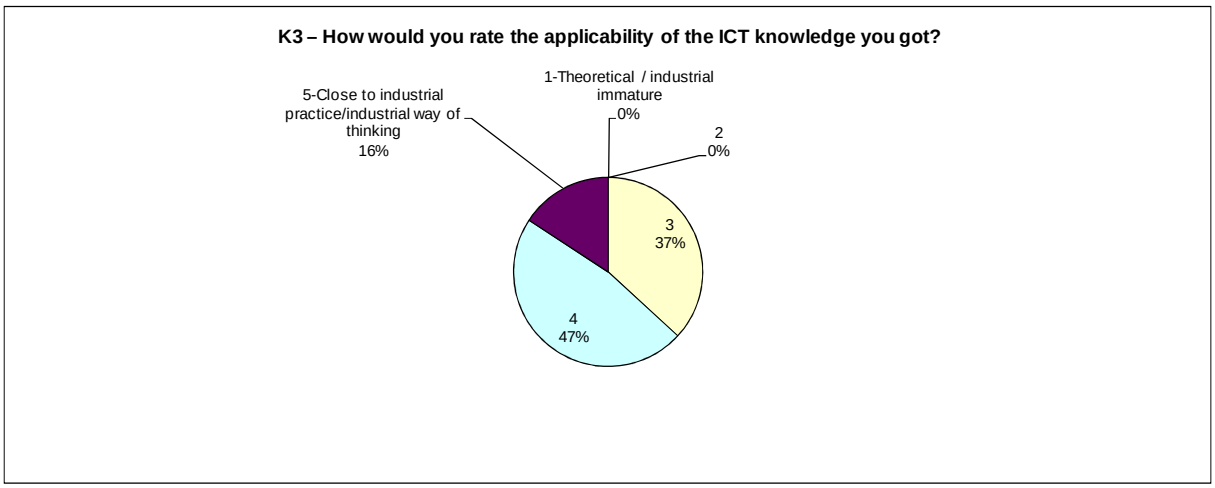
K1 – Indicate your understanding of the introduced business principles and supporting technologies after this ILPE.



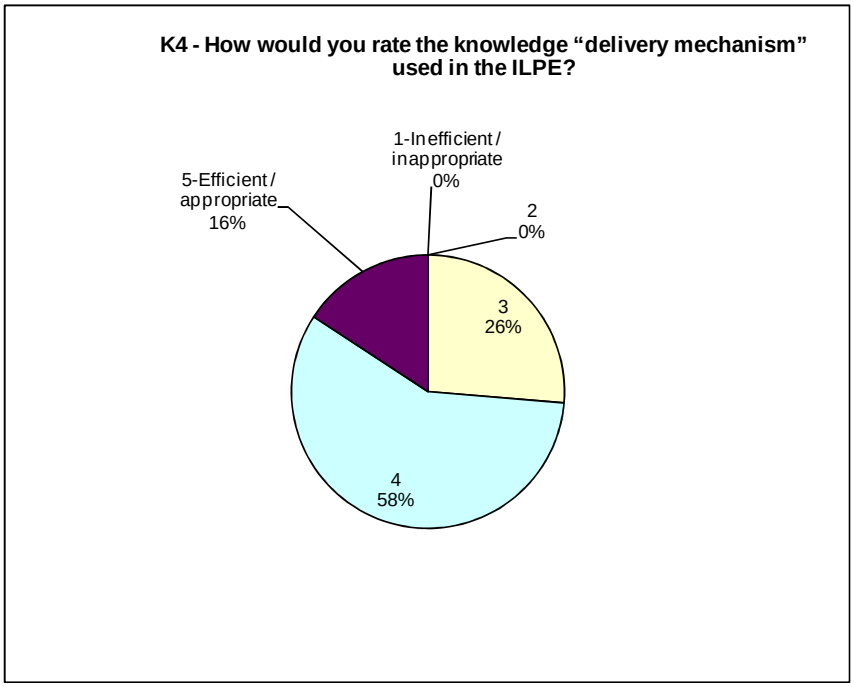
K2 – How would you rate the maturity of the ICT and business knowledge you got?



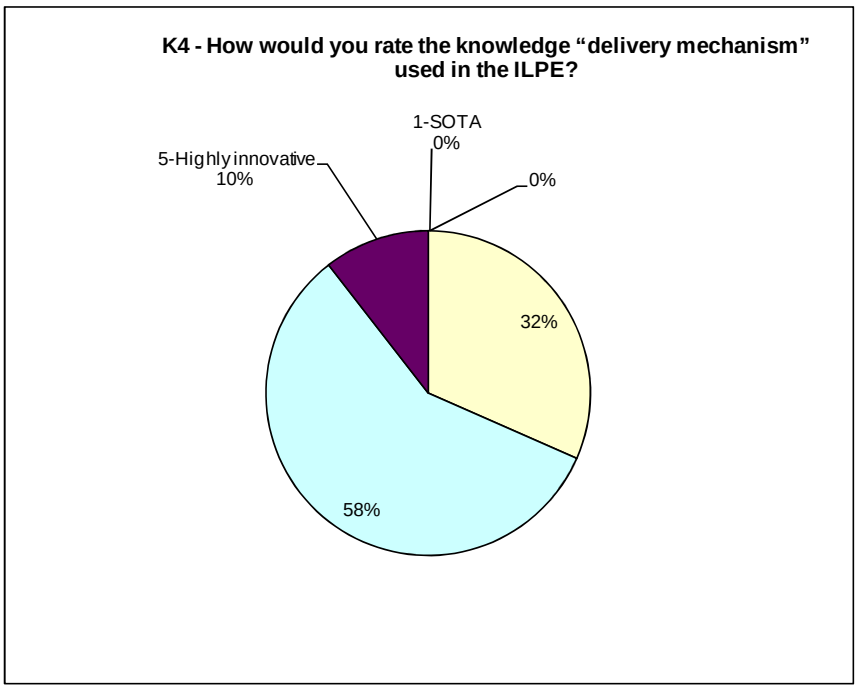
K3 – How would you rate the applicability of the ICT and business knowledge you got?



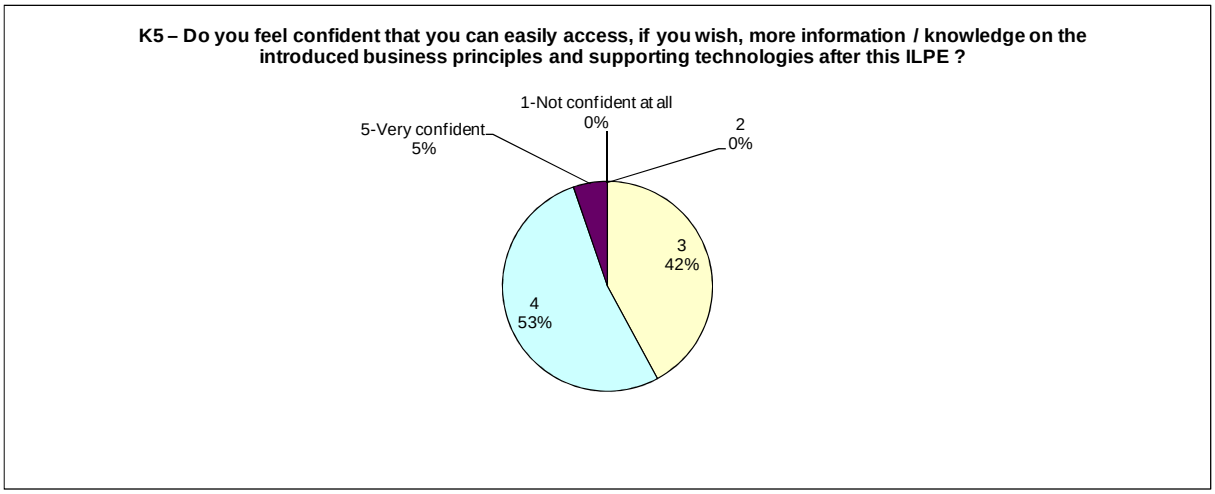
K4 - How would you rate the knowledge “delivery mechanism” used in the ILPE from the viewpoint of appropriateness/efficiency?



K4 - How would you rate the knowledge “delivery mechanism” used in the ILPE from the viewpoint of innovativeness?

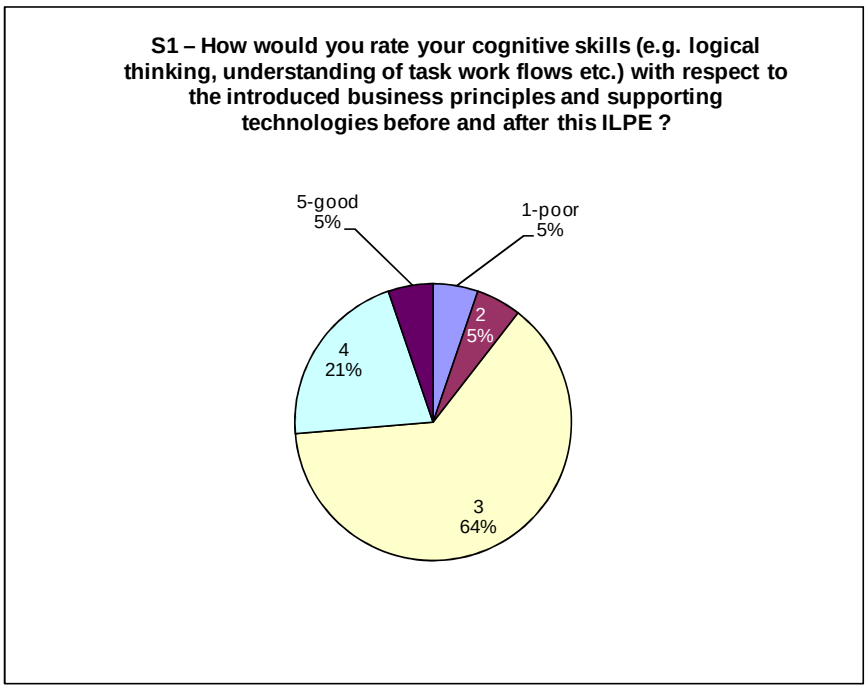


K5 – Do you feel confident that you can easily access, if you wish, more information / knowledge on the introduced business principles and supporting technologies after this ILPE?

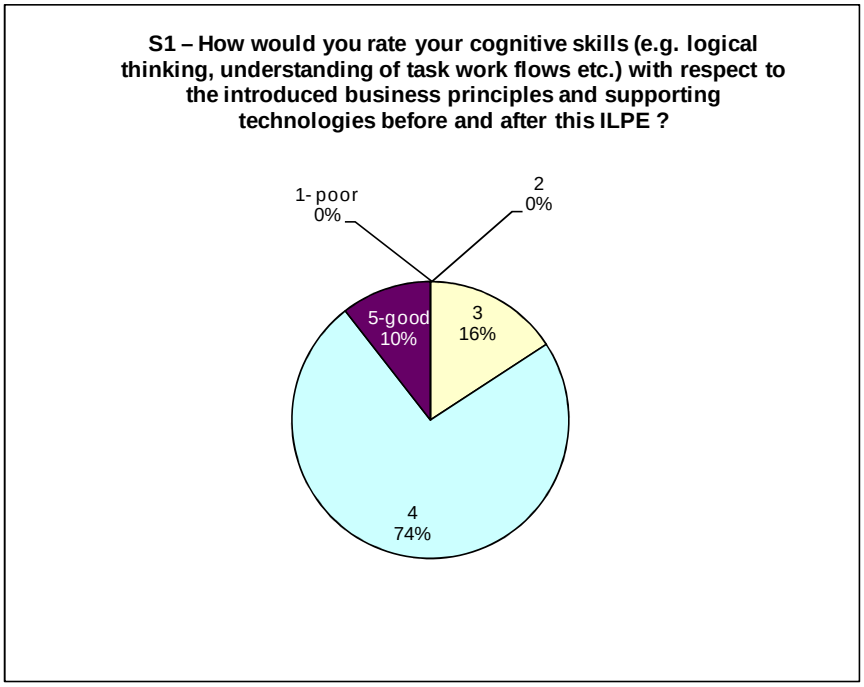


Skills

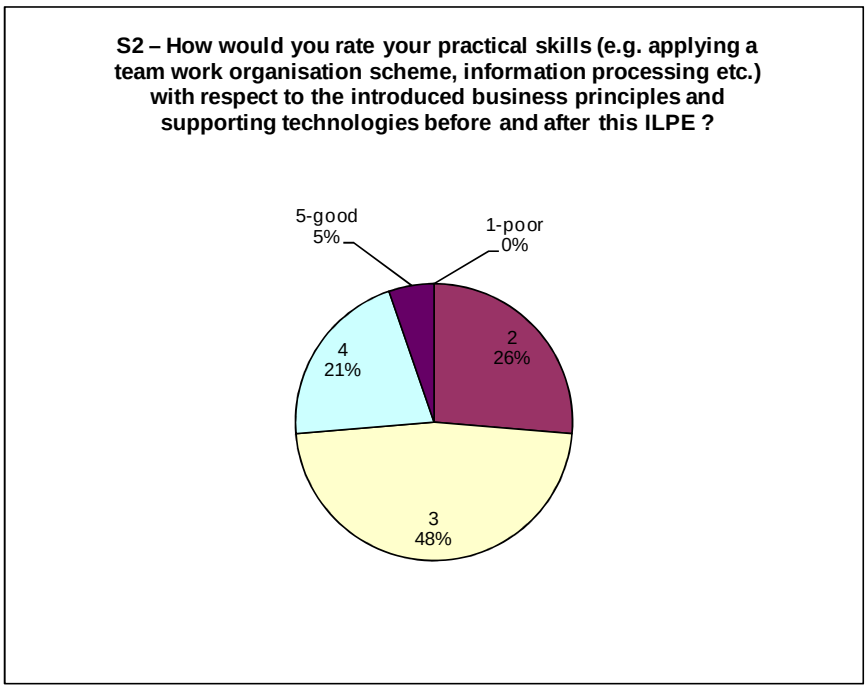
S1 – How would you rate your cognitive skills (e.g. logical thinking, understanding of task work flows etc.) with respect to the business principles and supporting technologies before this ILPE?



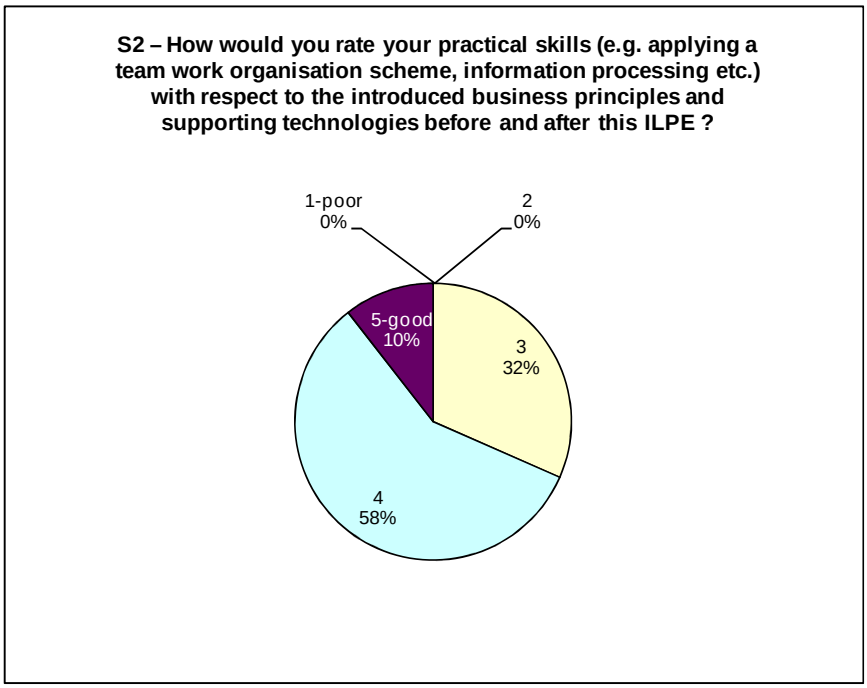
S1 – How would you rate your cognitive skills (e.g. logical thinking, understanding of task work flows etc.) with respect to the business principles and supporting technologies after this ILPE?



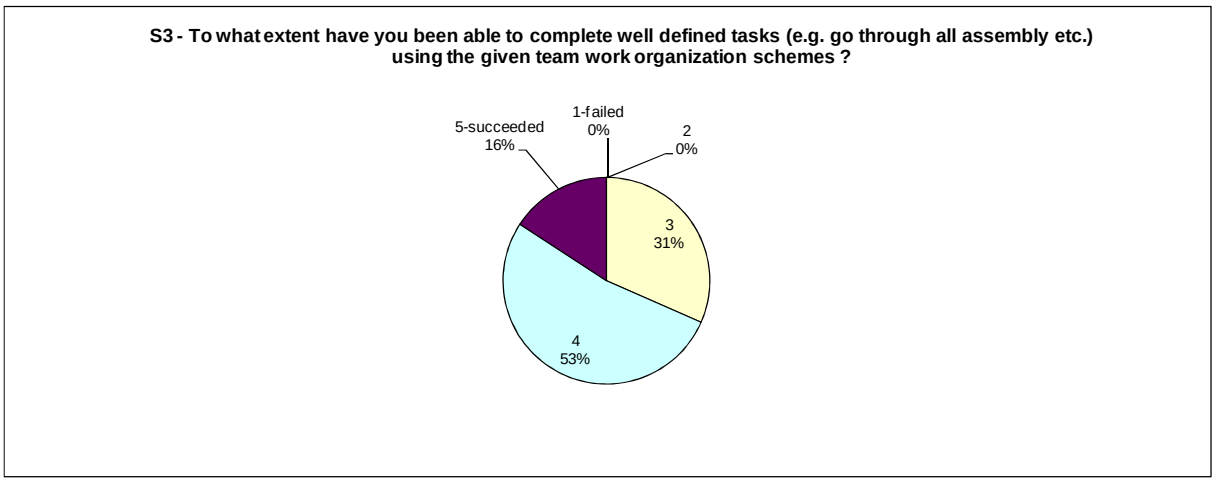
S2 – How would you rate your practical skills (e.g. applying a team work organization scheme, information processing etc.) with respect to the introduced business principles and supporting technologies before this ILPE?



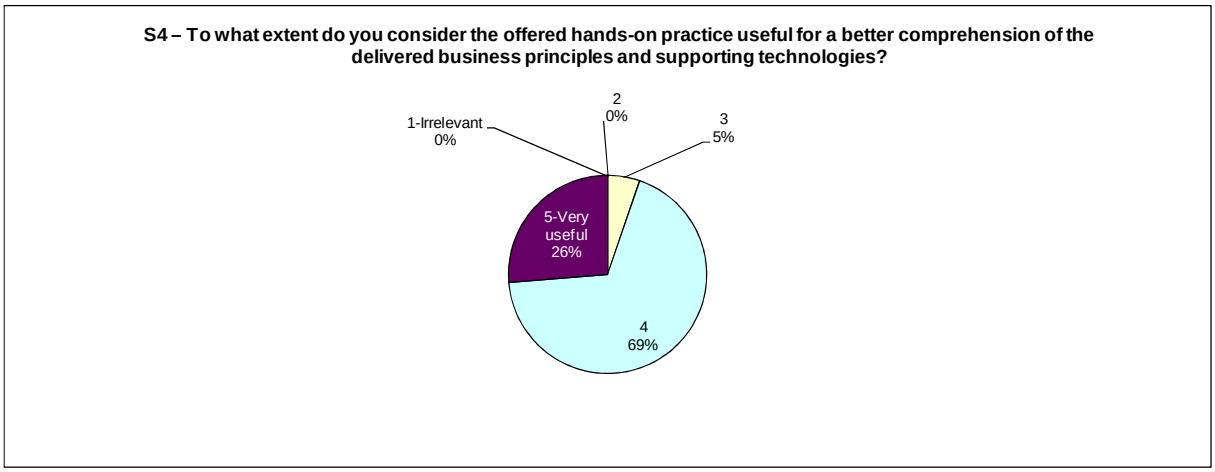
S2 – How would you rate your practical skills (e.g. applying a team work organization scheme, information processing etc.) with respect to the introduced business principles and supporting technologies after this ILPE?



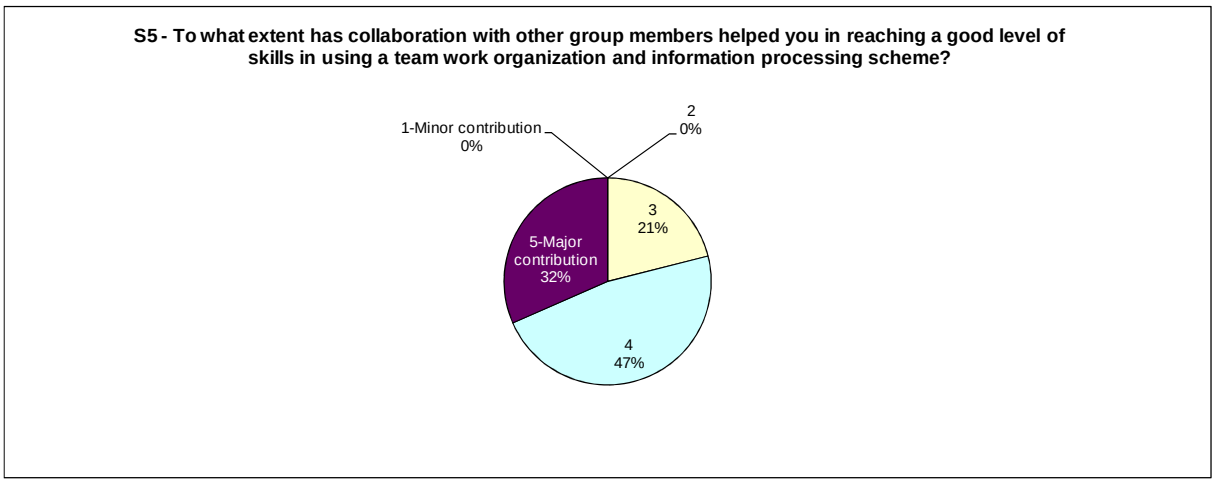
S3 - To what extent have you been able to complete well defined tasks (e.g. go through all assembly operation steps etc.) using the given team work organization schemes?



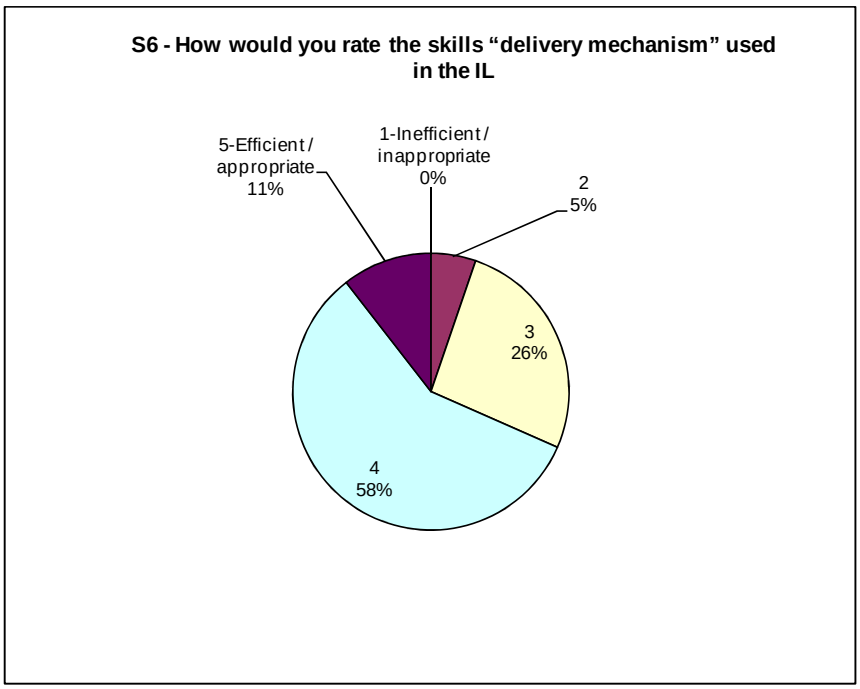
S4 – To what extent do you consider the offered hands-on practice useful for a better comprehension of the delivered business principles and supporting technologies?



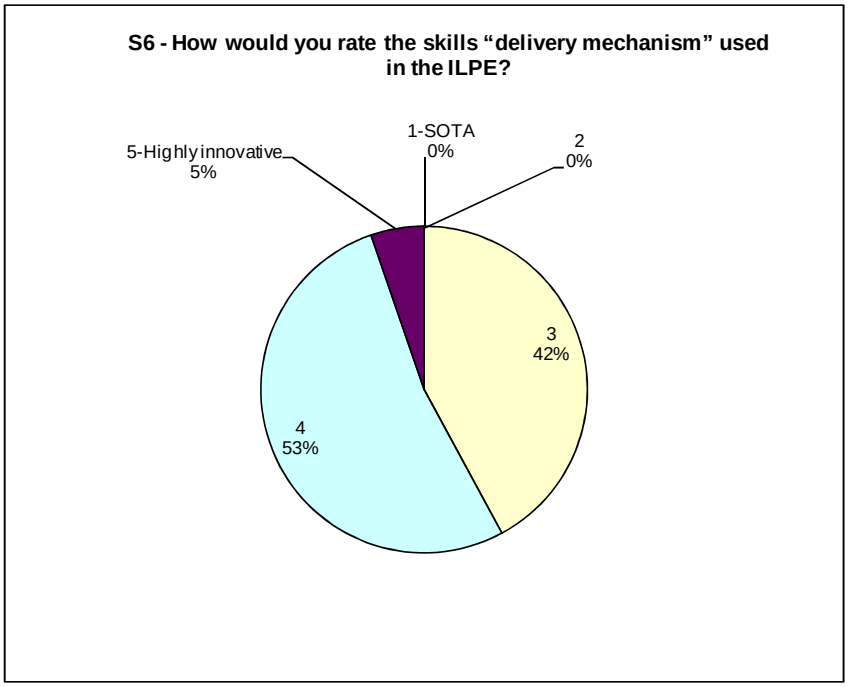
S5 - To what extent has collaboration with the other group members helped you in reaching a good level of skills in applying a team work organization and information processing scheme?



S6 - How would you rate the skills “delivery mechanism” used in the ILPE from the viewpoint of appropriateness/efficiency?



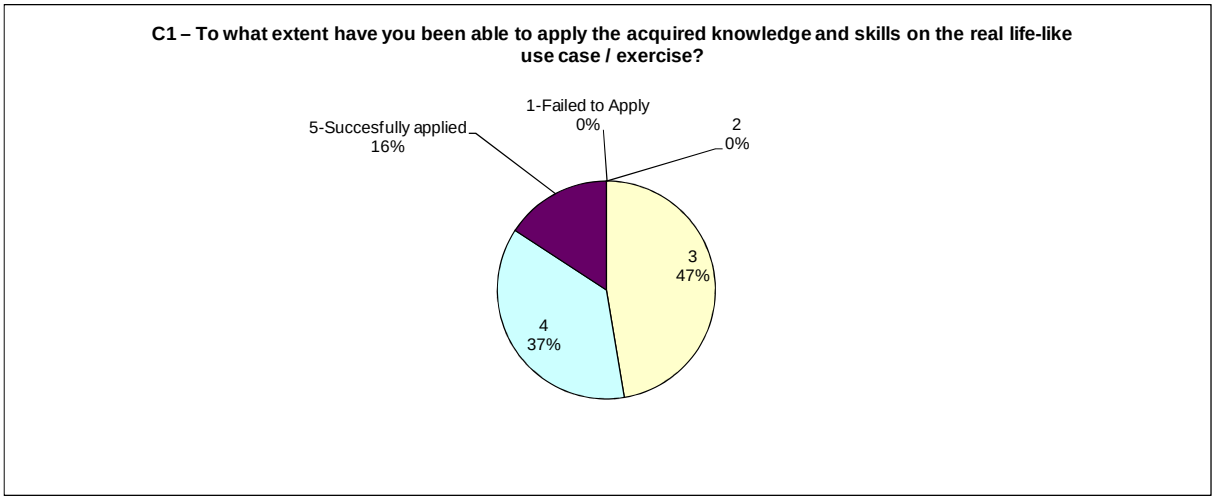
S6 - How would you rate the skills “delivery mechanism” used in the ILPE from the viewpoint of innovativeness?



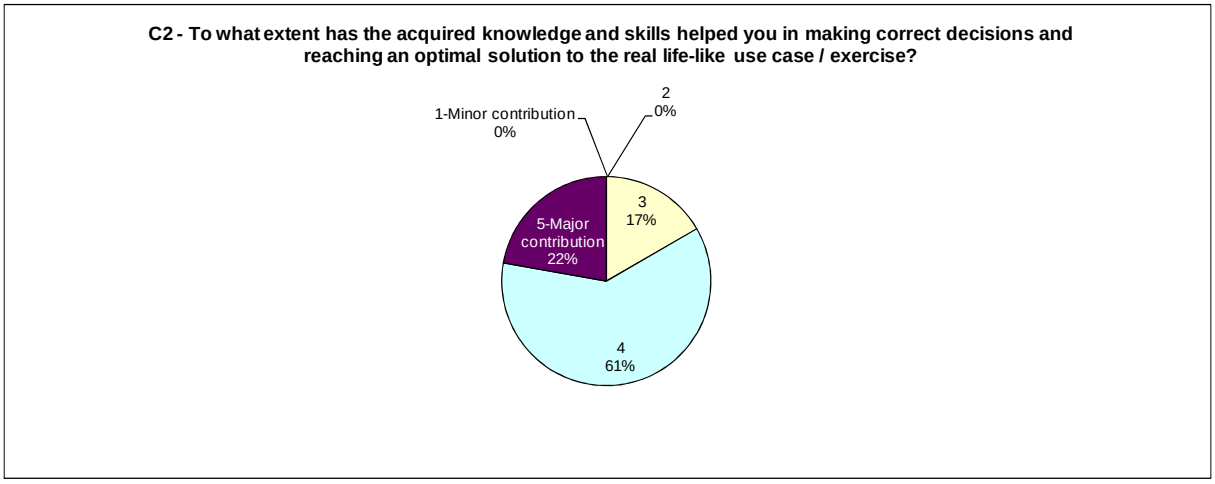
Competence

C1 – To what extent have you been able to apply the acquired knowledge and skills on the real life-like

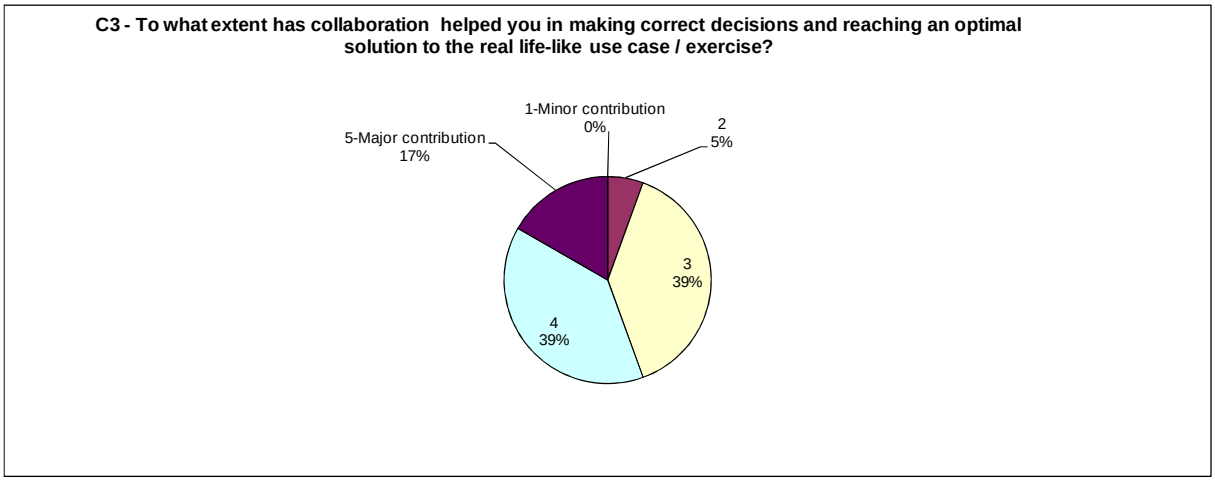
use case / exercise?



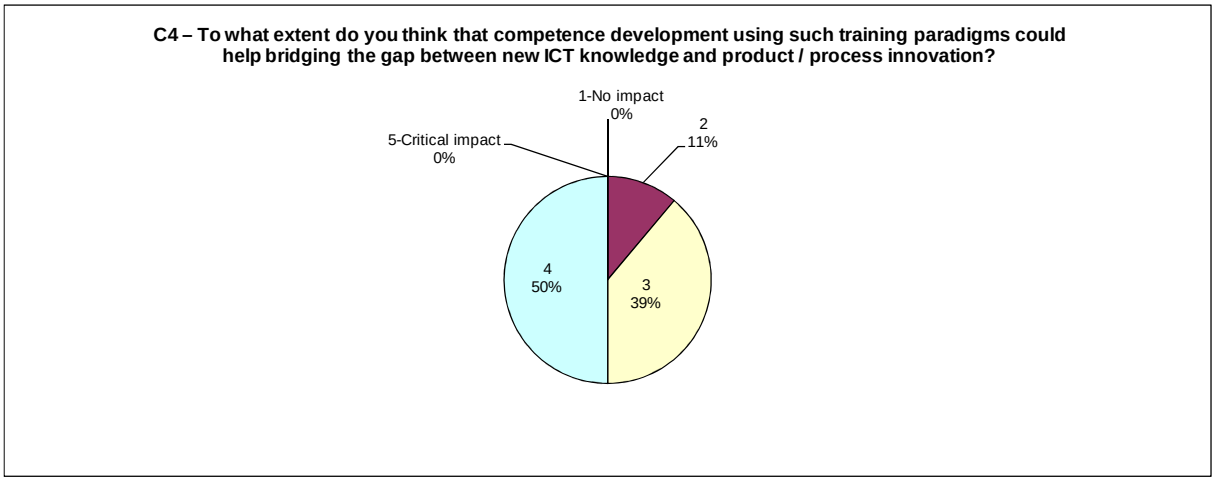
C2 - To what extent has the acquired knowledge and skills helped you in making correct decisions and reaching an optimal solution to the real life-like use case / exercise?



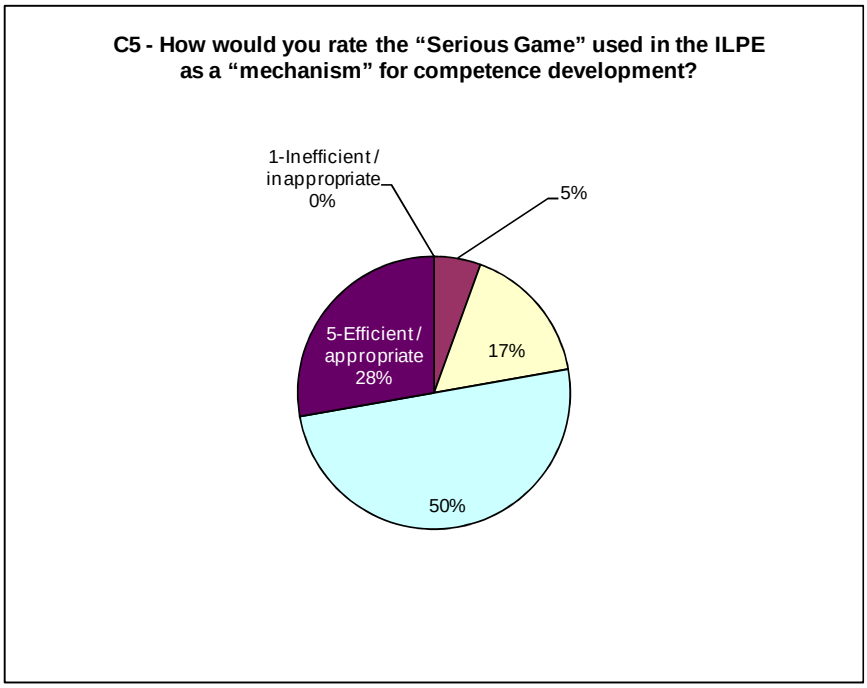
C3 - To what extent has collaboration helped in making correct decisions and reaching an optimal solution to the real life-like use case / exercise?



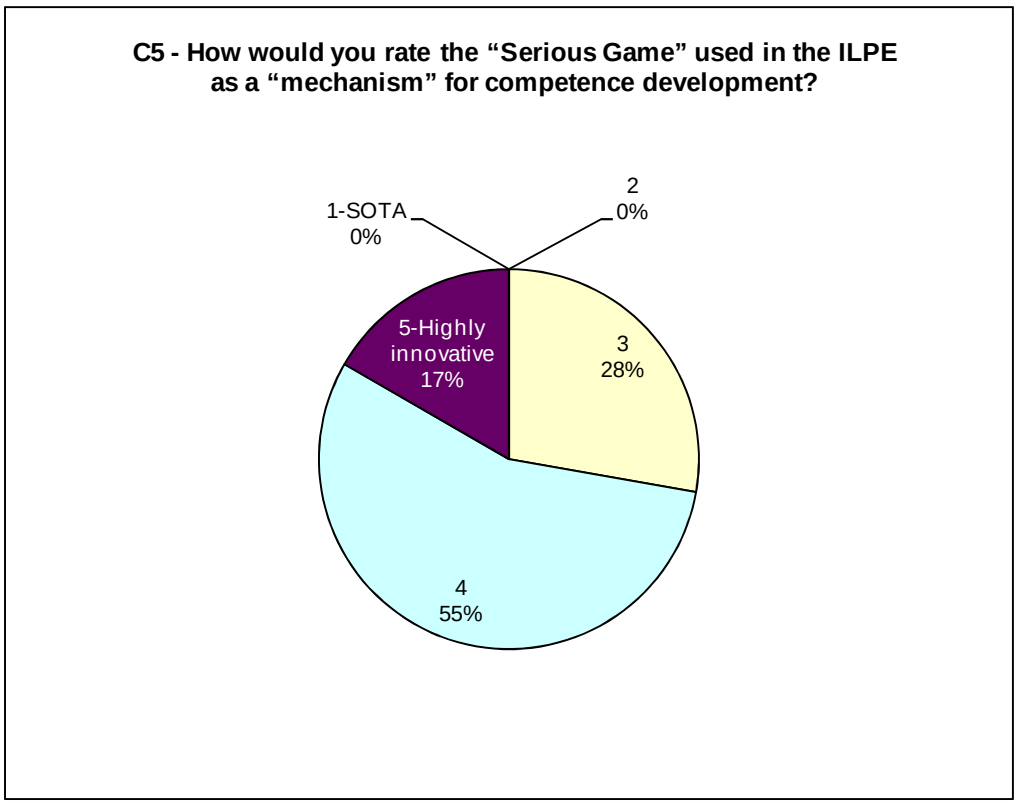
C4 – To what extent do you think that competence development using such training paradigms could help bridging the gap between new ICT / business knowledge and product / process innovation?



C5 - How would you rate the “Serious Game” used in the ILPE as a “mechanism” for competence development from the viewpoint of appropriateness/efficiency?

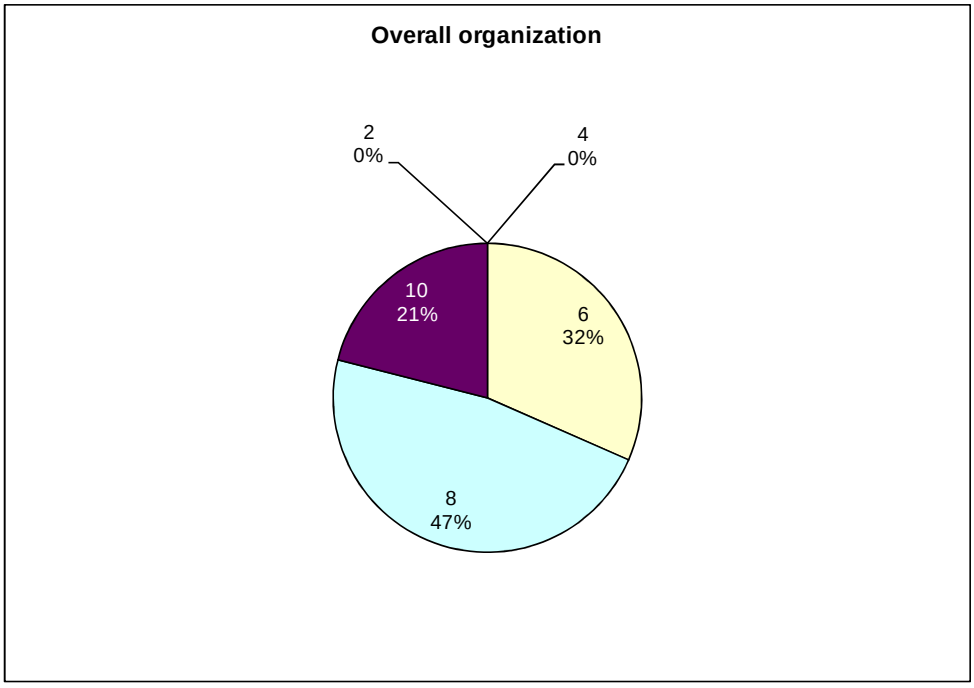


C5 - How would you rate the “Serious Game” used in the ILPE as a “mechanism” for competence development from the viewpoint of innovativeness?

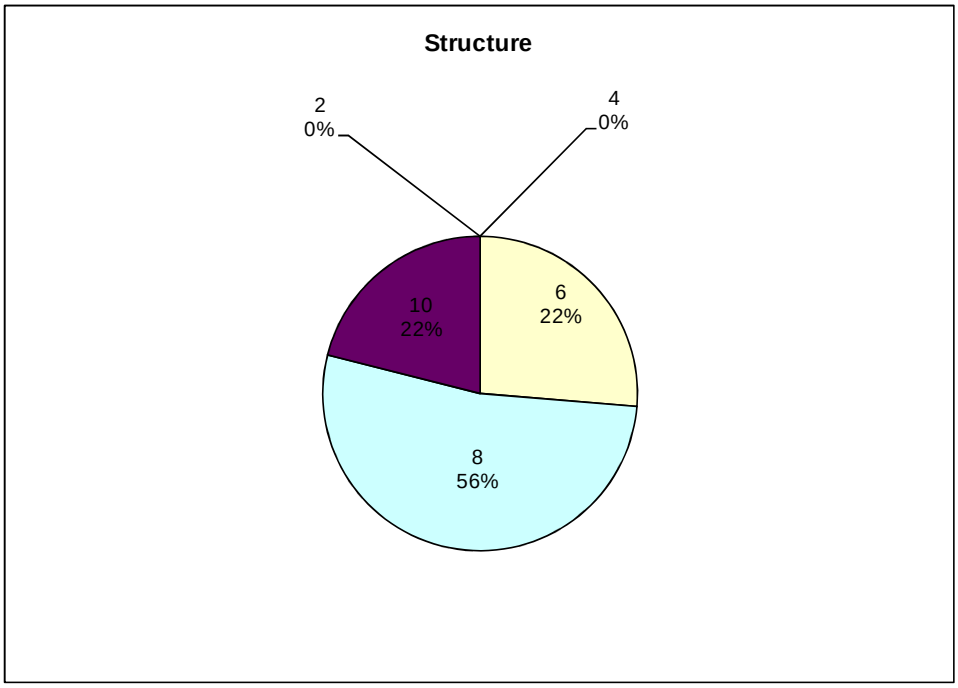


Overall ILPE

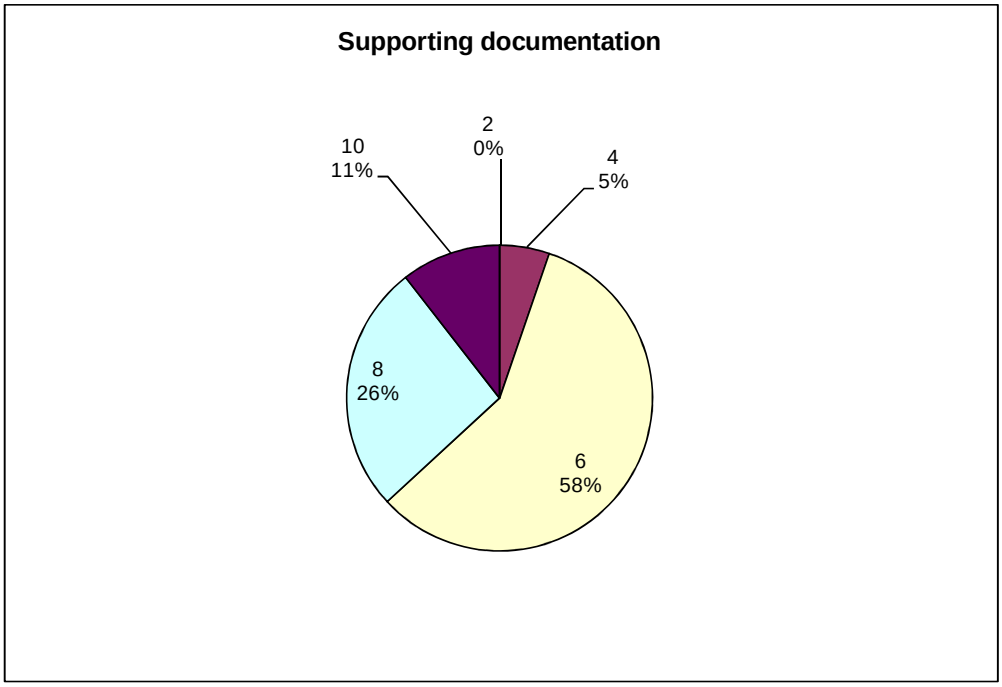
O1 - How would you rate the overall organisation of this ILPE?



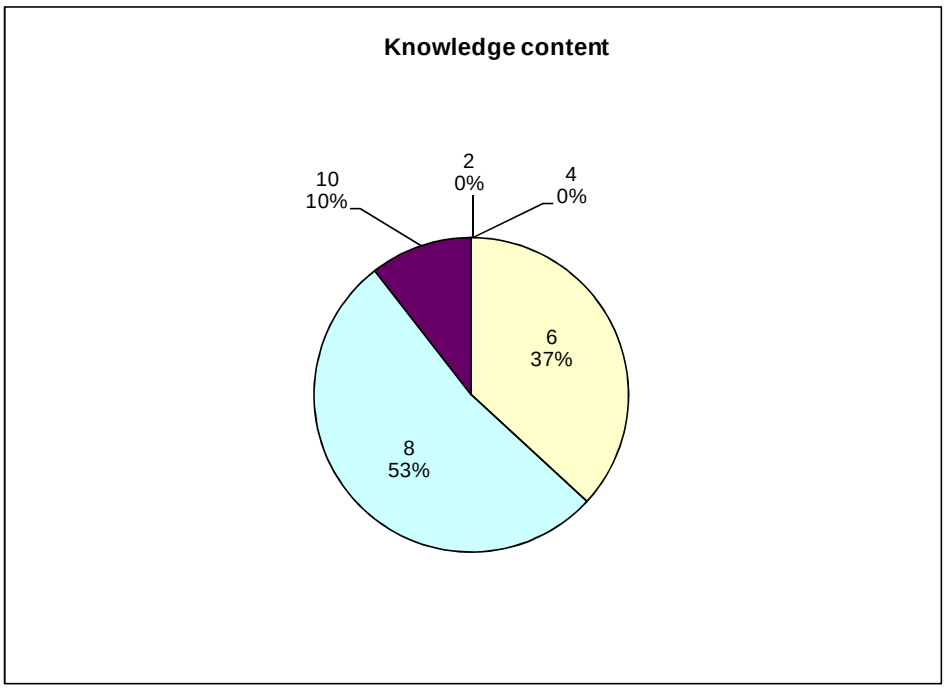
O1 - How would you rate the structure of this ILPE?



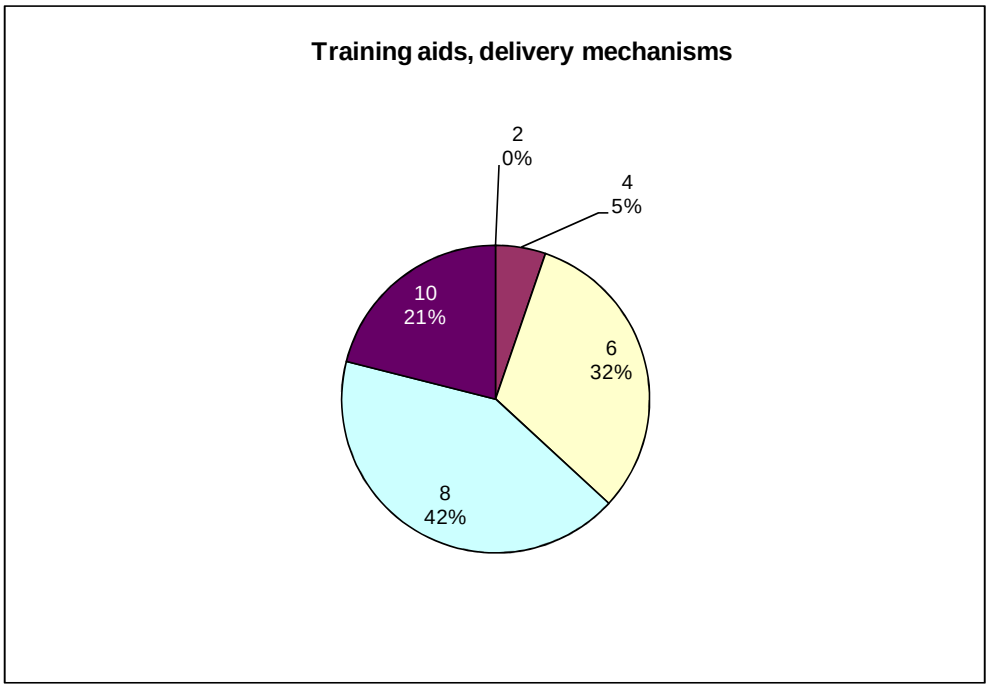
O1 - How would you rate the supporting documentation of this ILPE?



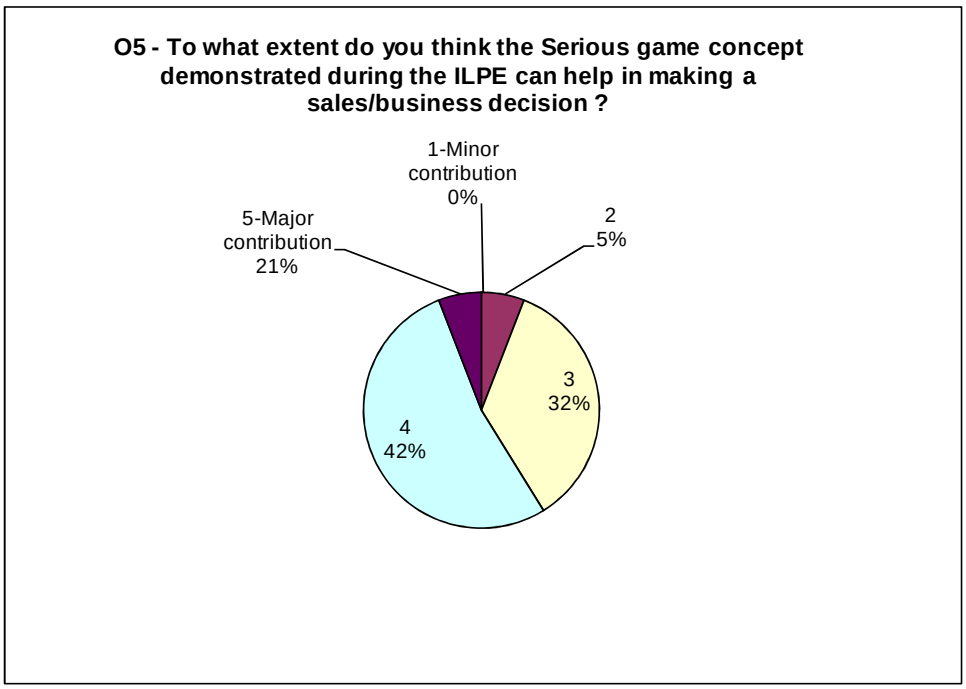
O1 - How would you rate the knowledge content of this ILPE?



O1 - How would you rate the training aids, delivery mechanisms of this ILPE?

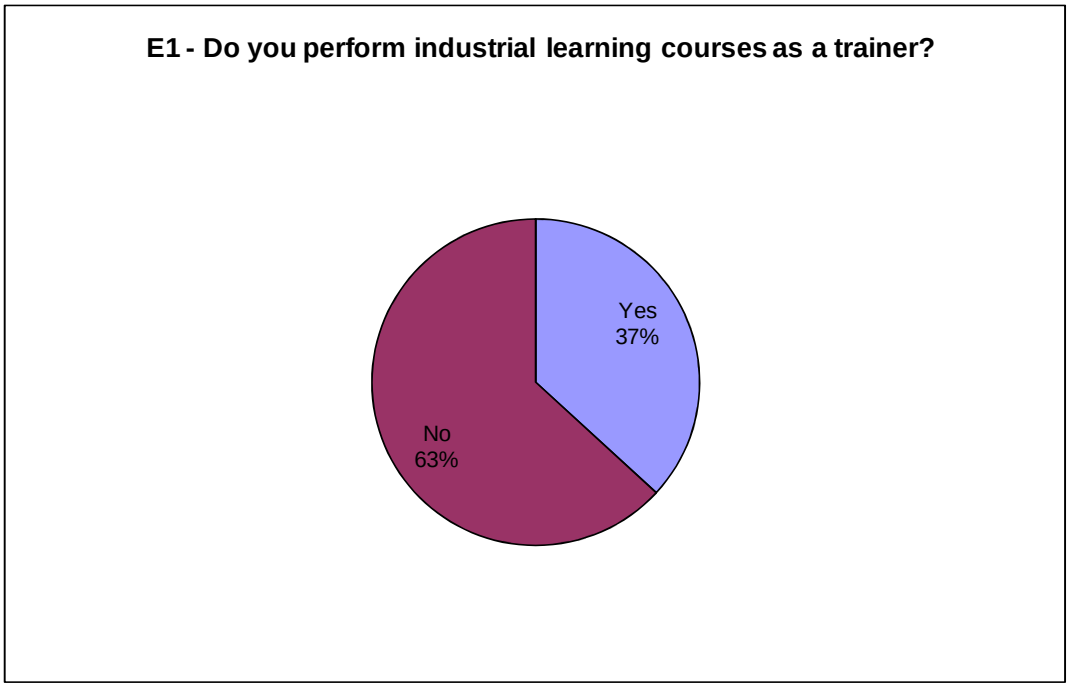


O5 - To what extent do you think the Serious Games concept demonstrated during the ILPE can help in making a sales/business decision?

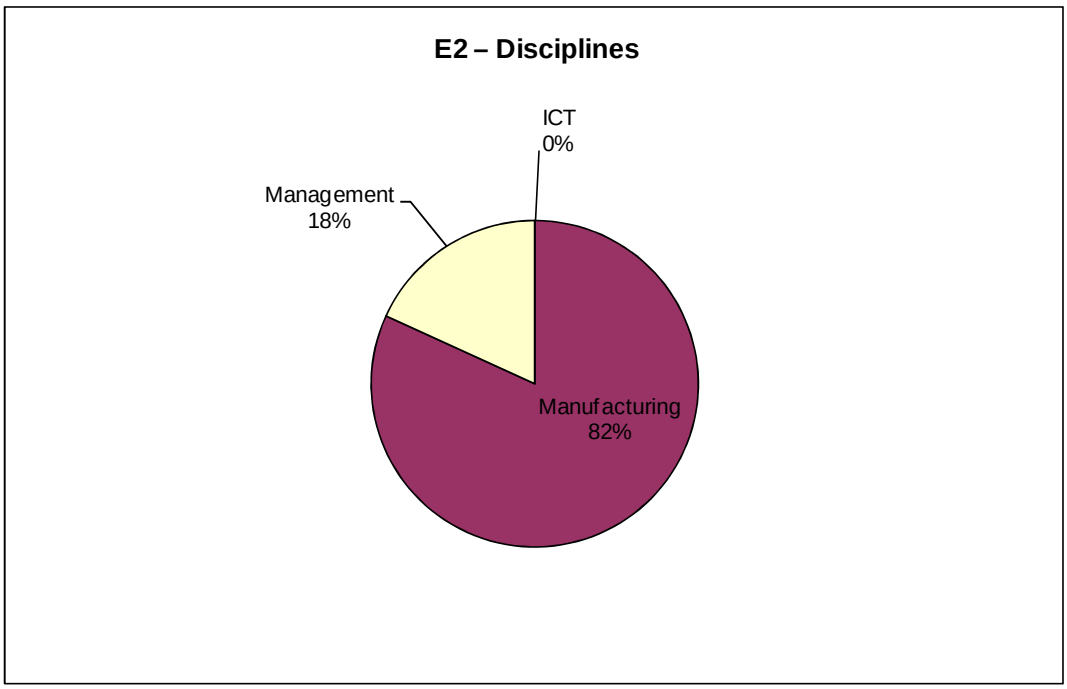


Experiences in performing Industrial Learning

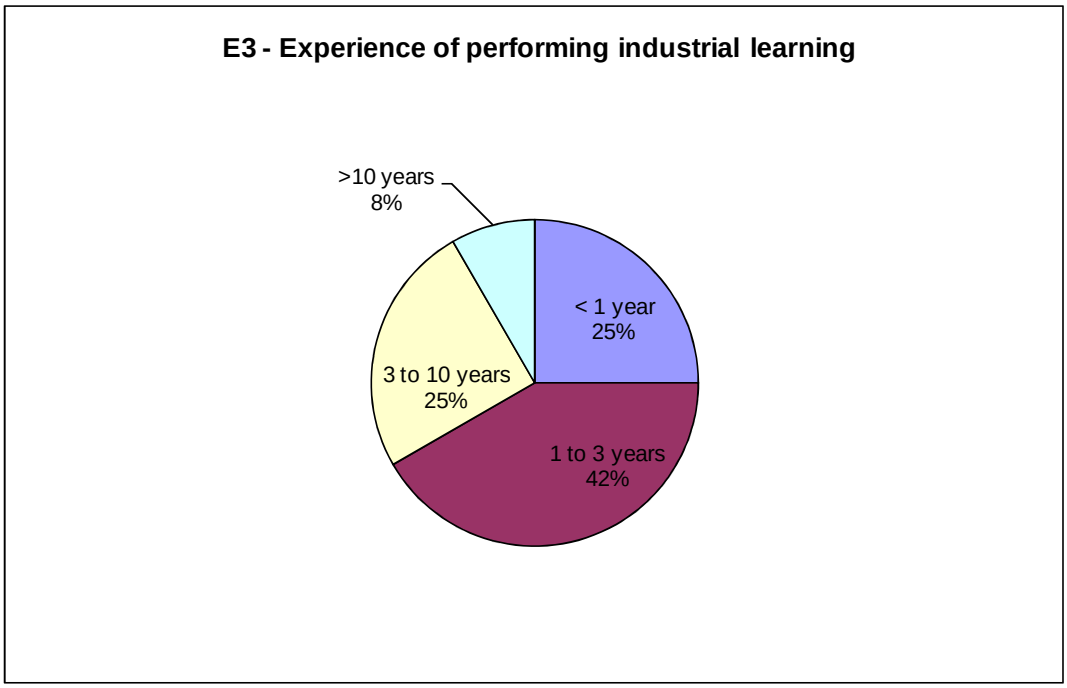
E1 - Do you perform industrial learning courses as a trainer?



E2 – Disciplines



E3 - Experience of performing industrial learning



10.4.5 Evaluation of learning process

This section includes the qualitative assessment of the "contribution" of the 4th ILPE in improving the attitude, knowledge, skills and competence of the trainees with respect to the introduced learning module. The assessment is based on the trainees' responses to the ILPE Questionnaire.

10.4.5.1 Attitude

- A significant increase of the trainees' interest in the introduced business principles and supporting technologies has been reported, as a result of the 4th ILPE. In fact, the number of the participants who are now highly and very highly interested has doubled (approximately 50% before the ILPE, while now 100% after the ILPE).
- Similar conclusions apply to the business potential of the introduced business principles and supporting technologies as it is now perceived by the trainees. The trainees indicated a much higher confidence to the business potential. Indicatively, before the ILPE 42% of the trainees could identify high business potential, while after the ILPE 74% could identify high potential and moreover 16% could identify very high potential.
- Furthermore, the trainees after the ILPE seem much more aware of the high environmental impact of the introduced principles and supporting technologies.
- The same can be derived from the answers of the trainees regarding the societal impact. The trainees indicate that the ILPE significantly helped them in better understanding the societal impact of the introduced business principles and supporting technologies.
- Finally, all trainees indicated that the introduced business principles and technologies demonstrate significant potential. However, there is a differentiation regarding its maturity, since some trainees identify a still immature technology while others identify a mature concept.

10.4.5.2 Knowledge

- A significant increase can be identified regarding the understanding of the introduced business principles after the ILPE. All trainees were able to answer that they have a rather good understanding after the ILPE.
- The majority of the trainees identified a medium-to-high level of innovation regarding the ICT and business knowledge they gained.
- All trainees identified a medium-to-high level applicability regarding the ICT and business knowledge they got, close to industrial practice and way of thinking.
- The majority of the participants identified the knowledge delivery mechanism of the 4th ILPE as innovative.
- After the ILPE, the participants indicated that they feel moderately-to-highly confident to access more information on the introduced business principles.

10.4.5.3 Skills

- The trainees clarified that their cognitive skills with respect to the business principles and supporting technologies significantly improved after their participation to the 4th ILPE.
- Similarly, the practical skills of the trainees significantly improved after the ILPE. The majority of the trainees could now rate their practical skills as rather good.
- The majority of the trainees was able to complete well defined tasks using the given team work organization schemes. However, 31% could indicate moderate success.
- Almost all trainees found useful the offered hands-on practice for a better comprehension of the delivered business principles and supporting technologies.
- The majority of the trainees indicated that the collaboration with the other group members helped them in reaching a good level of skills in applying a team work organization and information processing scheme. In fact, 32% of the participants indicated major contribution.
- The majority of the trainees rated the skills delivery mechanism used in the 4th ILPE from the viewpoint of appropriateness/efficiency as moderately-to-highly efficient.
- Similarly, the majority of the trainees rated the skills delivery mechanism used in the 4th ILPE from the viewpoint of innovativeness as moderately-to-highly innovative.

10.4.5.4 Competence

- The big majority of the trainees identified that they moderately or successfully applied the acquired knowledge and skills on the real life-like use case / exercise.
- A high, 83% of the participants were able to respond that the acquired knowledge and skills strongly helped them in making correct decisions and reaching an optimal solution to the real life-like use case / exercise.
- Collaboration and team work generally positively contributed in making correct decisions and reaching an optimal solution to the real life-like use case / exercise.
- The trainees identified that competence development using such training paradigms could have moderate or high impact on bridging the gap between new ICT knowledge and product / process innovation. Interestingly, no participant responded with 'Critical impact' or 'No impact'.
- The "Serious Game" used in the ILPE as the mechanism for competence development was highly rated by the trainees regarding its appropriateness/efficiency and innovativeness.

10.4.6 Overall impression

- The trainees rated the overall organization, structure and the knowledge content of the 4th ILPE as very good.
- Similarly, the trainees also rated the trainings aids and the delivery mechanisms as very good. Additionally, the majority of the trainees rated the supporting documentation of the ILPE as moderately good.
- The trainees also indicated that the Serious Games concept demonstrated during the ILPE can have a very high impact on helping them making a sales/business decision.

Additional issues that have been identified based on the previous analysis are provided hereafter:

- A first interesting point identified by the previous analysis has to do with the potential of the introduced business principles and technologies and their maturity. It is interesting to note that even though all trainees identify good or high potential, there is a balanced response regarding the maturity level. About half of the trainees identify a high maturity level while the others identify a low maturity level.
- Additionally, we can identify the relation between the applicability and the maturity of the ICT and business knowledge that was gained. Almost similar responses were given regarding applicability and maturity.
- The knowledge and skills delivery mechanism was found efficient and innovative by the trainees.

The trainees have considered the following points as the strengths of the 4th ILPE:

- It was simple and efficient.
- Progressive learning, synergy and knowledge sharing were helpful.
- The trainees were actively involved in the exercise.

The trainees have considered the following points as the weaknesses of the 4th ILPE:

- It was probably too short to be fully understood.
- Debrief time was missing.

10.4.7 Recommendations

The following recommendations were provided:

- The duration of the ILPE could be extended. Maybe one day for theory/modeling and one day of experiments could be followed.
- The summary part of the session should enable the participants to share their thoughts and build up a process to implement findings in real-life cases.
- Teamwork should be reinforced.

10.4.8 Conclusion

The ILPE#4 took place on the 17th of January 2012, at the Altis semiconductor' premises in Paris.
The learning paradigm chosen to be used and evaluated in this ILPE was that of "Serious Game" which was used for learning the principles of lean manufacturing.
This ILPE has greatly benefited from the recommendations formulated by the trainees and the observers of the first 3 ILPEs hold in Dresden, Paris and Geneva. These recommendations were implemented in ILPE#4 as far as possible. The excellent motivation and involvement of the participants of the two groups in the exercise have also contributed to the achievement of ILPE#4.
The game was improved through the introduction of an intermediate round where the participants proposed their own organization in order to fix the problems encountered in the first round. The intermediate round allows the trainees to better follow the evolution from a traditional organization to a lean organization. This was appreciated by both the trainees and the expert trainers.
The ILPE also included a presentation about lean principles. This presentation made a link between the industrial learning and roadmap activities of ActionPlanT through listing the different research topics from the roadmap that provide potential solutions for dealing with the different challenges about applying ICTs in lean manufacturing emphasized in the presentation.

10.5 Annex 5: ActionPlanT ILPE Questionnaire

The objective of this questionnaire is to help assess the effectiveness of the learning model / methodology and the knowledge delivery mechanisms, which are suggested and applied by the ActionPlanT project. Your feedback will help us to further improve the suggested learning model / methodology and identify best practices in the use of knowledge delivery mechanisms for industrial learning.

In this Industrial Learning Pilot Event (ILPE), the questionnaire focuses on the assessment of the "Teaching Factory" paradigm as a knowledge delivery mechanism for industrial learning. In terms of content, the questionnaire is structured around the four major building blocks of the learning process, which are addressed by the ActionPlanT industrial learning model / methodology, i.e. attitude, knowledge, skills, competencies. These learning building blocks, together with the respective goals of this ILPE, are defined in the table hereafter.

	Definition	ILPE goals
Attitude	"Attitude" is a hypothetical construct that represents an individual's degree of like or dislike for an item. Attitudes are generally positive or negative views of a person, place, thing, or event.	Create awareness, attract interest, increase motivation to learn & apply
Knowledge	"Knowledge" means the outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices that is related to a field of work or study.	Create a basic technology understanding (basics of relevant theory & SW) oriented to industrial practice, and acquaint with relevant ICT tools to search for further information
Skills	"Skills" means the ability to apply knowledge and use know-how to complete well defined	Acquaint with the use of dedicated software tools, complete a well

	tasks. Skills may be cognitive or practical	defined task involving processing of data with the given tools
Competencies	"Competence" means the proven ability to use knowledge, skills and personal, social and/or methodological abilities. Competences may be considered as the interface between the learning and the innovation processes.	Build-up basic ability to combine different pieces of knowledge, developed skills and own understanding, to make decisions and address real life-like use cases

Two additional question groups aim to capture your overall impression of this ILPE and possible relevant experiences you may have in industrial learning.

1. Participant Background

B1. Indicate your education discipline
- ☐ ICT
- ☐ Manufacturing / Engineering
- ☐ Management
- ☐ Economics
- ☐ Other

If "Other", please specify: …….

B2. Indicate the profile of your company / organization
- ☐ Information Technology Vendor
- ☐ Manufacturing Company
- ☐ University
- ☐ Research Institute
- ☐ Other

If "Other", please specify: …….

B3. Business position in the organization
- ☐ CEO / Director / General Manager
- ☐ R&D Manager
- ☐ Project Manager
- ☐ Professor
- ☐ Researcher
- ☐ Other

If "Other", please specify: …….

B4. Years of industrial experience on ICT for manufacturing
- ☐ 1-5
- ☐ 6-10
- ☐ >10
- ☐ Not applicable

2. Attitude

This is a set of questions to assess the impact of the ILPE on your personal attitude, namely the interest, the perceived impact / potential etc., against the introduced technology(ies).

A1 – Indicate your interest in the introduced technology(ies) before and after this ILPE.
Before the ILPE: very low ☐ ☐ ☐ ☐ ☐ very high
After the ILPE: very low ☐ ☐ ☐ ☐ ☐ very high

A2 – How would you rate the business potential of the introduced technology(ies) before and after this ILPE ?
Before the ILPE: very low ☐ ☐ ☐ ☐ ☐ very high
After the ILPE: very low ☐ ☐ ☐ ☐ ☐ very high

A3 – How would you rate the environmental impact of the introduced technology(ies) before and after

this ILPE ?

Before the ILPE: very low ☐ ☐ ☐ ☐ ☐ very high
After the ILPE: very low ☐ ☐ ☐ ☐ ☐ very high

A4 – How would you rate the societal impact of the introduced technology(ies) before and after this ILPE ?

Before the ILPE: very low ☐ ☐ ☐ ☐ ☐ very high
After the ILPE: very low ☐ ☐ ☐ ☐ ☐ very high

A5 – Indicate the potential (as you perceive that after the ILPE) of applying / integrating the introduced technology(ies) in the working practices of your company/institute

☐ Low potential
☐ Good potential but still immature for real-life practices
☐ High potential & mature technology / Motivated in pursuing application in real work.
☐ Already applied
☐ Not applicable / irrelevant

3. Knowledge

This is a set of questions to assess the transfer of "theoretical" knowledge during the ILPE, which is provided as a technology background.

K1 – Indicate your understanding of the introduced technology(ies) before and after this ILPE.

Before the ILPE: poor ☐ ☐ ☐ ☐ ☐ good
After the ILPE: poor ☐ ☐ ☐ ☐ ☐ good

K2 – How would you rate the maturity of the ICT knowledge you got?

State-of-the-art ☐ ☐ ☐ ☐ ☐ Highly innovative

K3 – How would you rate the applicability of the ICT knowledge you got?

Theoretical / industrially immature ☐ ☐ ☐ ☐ ☐ Close to industrial practice / industrial way of thinking

K4 - How would you rate the knowledge "delivery mechanism" used in the ILPE?

Inefficient / inappropriate ☐ ☐ ☐ ☐ ☐ Efficient / appropriate
State-of-the-art ☐ ☐ ☐ ☐ ☐ Highly innovative

K5 – Do you feel confident that you can easily access, if you wish, more information / knowledge on the introduced technology(ies) after this ILPE?

Not confident at all ☐ ☐ ☐ ☐ ☐ Very confident

4. Skills

This is a set of questions to assess the impact of the ILPE on the development of technical skills, oriented around the use of dedicated software tools.

S1 – How would you rate your cognitive skills (e.g. data manipulation, logical thinking, understanding of task work flows etc.) with respect to the introduced technology(ies) before and after this ILPE ?

Before the ILPE: poor ☐ ☐ ☐ ☐ ☐ good
After the ILPE: poor ☐ ☐ ☐ ☐ ☐ good

S2 – How would you rate your practical skills (e.g. good command of data input/output procedures, SW basic functions etc.) with respect to the introduced technology(ies) before and after this ILPE ?

Before the ILPE: poor ☐ ☐ ☐ ☐ ☐ good
After the ILPE: poor ☐ ☐ ☐ ☐ ☐ good

S3 - To what extent have you been able to complete well defined tasks (e.g. typical data processing et.) using the given software & hardware tools?

Failed ☐ ☐ ☐ ☐ ☐ Succeeded

S4 – To what extent do you consider the offered hands-on practice useful for a better comprehension of the delivered knowledge?

Irrelevant ☐ ☐ ☐ ☐ ☐ Very useful

S5 - To what extent has collaboration and team work helped you in reaching a good level of skills in using the software tools?

Minor contribution ☐ ☐ ☐ ☐ ☐ Major contribution

S6 - How would you rate the skills "delivery mechanism" used in the ILPE?

Inefficient / inappropriate ☐ ☐ ☐ ☐ ☐ Efficient / appropriate

State-of-the-art ☐ ☐ ☐ ☐ ☐ Highly innovative

5. Competence

This is a set of questions to assess the impact of the ILPE on the development of competences related to the introduced technology(ies), including addressing real-life like use cases, decision making, practicing teamwork etc.

C1 – To what extent have you been able to apply the acquired knowledge and skills on the real life-like use case / exercise?

Failed to apply ☐ ☐ ☐ ☐ ☐ Successfully applied

C2 - To what extent has the acquired knowledge and skills helped you in making correct decisions and reaching a solution to the real life-like use case / exercise?

Minor contribution ☐ ☐ ☐ ☐ ☐ Major contribution

C3 - To what extent has collaboration and team work helped in making correct decisions and reaching a solution to the real life-like use case / exercise?

Minor contribution ☐ ☐ ☐ ☐ ☐ Major contribution

C4 – To what extent do you think that competence development using such training paradigms could help bridging the gap between new ICT knowledge and product / process innovation?

No impact ☐ ☐ ☐ ☐ ☐ Critical impact

C5 - How would you rate the "Teaching Factory" used in the ILPE as a "mechanism" for competence development?

Inefficient / inappropriate ☐ ☐ ☐ ☐ ☐ Efficient / appropriate

State-of-the-art ☐ ☐ ☐ ☐ ☐ Highly innovative

6. Overall ILPE

O1 - How would you rate the following aspects of this ILPE?

Overall organization	0	☐ ☐ ☐ ☐ ☐	10
Structure	0	☐ ☐ ☐ ☐ ☐	10
Supporting documentation	0	☐ ☐ ☐ ☐ ☐	10
Knowledge content	0	☐ ☐ ☐ ☐ ☐	10
Training aids, delivery mechanisms	0	☐ ☐ ☐ ☐ ☐	10

O2 - What has been the strong point of this ILPE, e.g. with respect to the knowledge delivery mechanisms used etc., in comparison with other industrial learning courses you may have followed in the past ?

……
……

O3 - What has been the weak point of this ILPE, e.g. with respect to the knowledge delivery mechanisms used etc., in comparison with other industrial learning courses you may have followed in the past ?

……
……

O4 – During the ILPE activities, participants have been grouped in heterogeneous teams. Based on your overall ILPE experience, indicate which were the major pros and cons of this approach.
Pros ……
……
Cons ……
……

O5 - To what extent do you think the Teaching Factory concept demonstrated during the ILPE can help in making a sales/business decision?
Minor contribution ☐ ☐ ☐ ☐ ☐ Major contribution

O6 – Do you have any further comment (e.g. with respect to your answers in O1) that could help up us to further improve the industrial learning methodology & knowledge delivery mechanisms used in our ILPEs?
……
……
……

7. Experiences in performing Industrial Learning

E1 - Do you perform industrial learning courses as a trainer? ☐ Yes ☐ No

If no, please skip the next questions

E2 – Disciplines
ICT ☐
Manufacturing ☐
Management ☐

E3 - Experience of performing industrial learning
☐ < 1 year ☐ 1 to 3 years ☐ 3 – 10 years ☐ >10 years

E4 – Which are some typical major challenges you are facing in performing industrial learning courses?
……
……
……