

Training Programme on Advanced ICT Tools for enhancing Enterprise Process Planning competences in Plastic Industry SMEs

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Abstract

The identification of critical training needs related to enterprise planning activities in the sector of the plastic industry has led to the development of a training programme on advanced ICT tools for enhancing enterprise process planning competences in the plastic industry SMEs. The main objective of this training programme is to improve relevant and high-level basic and transversal competences in a lifelong learning perspective and promote the work-based learning in all its forms, with special attention to apprenticeship-type training addressed to the aforementioned target sector. In light of this, this paper describes the methodology used to define the training programme, the training resources developed, the selection criteria used to select the most adequate technology for developing the training resources and the characterization of each of the developments.

Keywords

Training Programme, Moodle, ICT Tools, Technology Selection Criteria.

1. Introduction

It is commonly recognized that European Small and Medium-Sized Enterprises (SMEs) have limited resources compared to the large ones. This means that for this type of enterprises, it is difficult to get access to advanced Information and Communication (ICT) tools to support their daily operations. On the contrary, large enterprises are familiar with the use of different ICT tools that support their regular running and, moreover, human resources have deep knowledge about how to use them and how to translate the results obtained into real decisions. Additionally, large companies usually have in-house experts who can train employees on various aspects of the business. Normally, a calendar is worked out in advance in which various sessions are listed out and which employees can pick their business requirements to enhance personal training needs.

However, 99% of the enterprises in Europe are SMEs providing 75 million jobs. SMEs contribute to more than half of the total added value created by businesses in the European Union and they are also responsible for the majority of new

jobs created (ETSI, 2018). For this reason, SMEs and their human resources need special attention as they are the true backbone of the European economy, progress and competitiveness. Their capacity to improve the planning activities and also the human resources' knowledge makes them crucial for Europe's success in the global economy.

Nevertheless, the use of advanced ICT tools is not yet implemented within the European SMEs, particularly within the plastic industry, because of the lack of:

- Skills of the technical staff of plastic SMEs regarding advanced production and planning management.
- Digital skills of the technical staff of plastic SMEs needed for using tools in the ICT environment.
- Knowledge and/or practical experience about how advanced ICT tools can be used and what their outputs are.
- Collaborative and communication skills, allowing a better performance of the plastic industry SMEs.

To overcome the aforementioned barriers, it is necessary to increase the competences of the plastic industry SMEs technicians related to the enterprise process planning through the use of advanced ICT tools. To do this, it is vital to develop:

- The skills of the plastic industry SMEs technicians related to production, sourcing and delivery planning and also enhance the knowledge about the digital context.
- Practical-work based activities addressed to introduce advanced ICT tools within plastic SMEs.



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- Collaborative and communication skills of the plastic industry SMEs technicians along the supply chain.

Based on the previous requirements, the ICTPlast Project: “Development of a Training Programme on Advanced ICT Tools for enhancing Manufacturing Process Planning competences in Plastic Industries SMEs” (<http://ictplast.blogs.upv.es/>) is born. ICTPlast is a funded project in the Call: “Erasmus+ 2016 KA2 – Cooperation for Innovation and the Exchange of Good Practices Strategic Partnerships for vocational education and training” whose main objective is to obtain and improve high-level basic ICT/digital skills of technicians of plastic SMEs.

The paper describes the methodology used to develop the ICTPlast Project and its main achievements and characterization to improve the knowledge on advanced ICT tools for enhancing enterprise process planning competences in the plastic industry SMEs.

The paper is structured as follows. Section 2 offers an overview of the ICTPlast project detailing the phases of the methodology used to develop the training project, the results developed, and the characterization of each of the developments. Section 3 identifies the most critical plastic industry SMEs training needs. Section 4 describes the selection criteria used for the technology analysis used to develop the training materials. In the same way, section 5 offers a description of the main advanced ICT tools selected for each of the training modules. Section 6 provides a summary of the selection criteria used to decide on the most appropriate technology for the configuration of the e-training platform. Finally, section 7 provides the main conclusions.

2. ICTPlast Project Overview

ICTPlast project has its foundations on three main axes (Figure 1). Firstly, the methodology used for the development of the project solutions. This methodology is composed by three main phases:

- a) the first one is focused on the identification and characterization of the main plastic industry SMEs training needs, in order to focus the project developments on the most critical needs;
- b) based on this identification, the second phase consists of analysing the different existing advanced ICT tools that fulfil the training needs previously identified; and
- c) the last phase is in charge of analysing different e-training platform technologies (Learning Management Systems - LMS) based on some defined criteria to choose the most appropriate one to be aligned with the training needs.

The second axis is focused on the ICTPlast project developments that are principally four:

- a1) Training Materials. The training materials are resources supported by different formats, such as text-based information, presentations, videos, game-quizzes, and exercises. There are 6 modules focused on the identified training needs (section 3): materials inventory planning, aggregate production planning, master production schedule, production operations sequencing, demand forecasting, and vehicle routing. The training materials are available in 6 different languages (English, Italian, Spanish, Portuguese, Slovak and French). Based on the contents of these materials, the materials for trainees are also developed to support trainers with the training process.
- b1) Advanced ICT tools. This result consists of a complete set of tools to manage the planning activities of the plastic industry SMEs to solve problems identified in the training needs.
- c1) ICTPlast e-training platform. It is an integrated space with a set of interactive online services that provides the trainees, the ICT advanced tools and other resources (training materials, collaborative tools...) to support and enhance the enterprise process planning competences in the plastic industry SMEs.
- d1) Implementation of the practical training activities. This result is the cornerstone for the development of the complete training programme addressed to train the plastic industry SMEs technicians. The training activities are designed and scheduled as different sessions in which the main objective is to give visibility to the plastic technicians of a more real-world applied vision of the enterprise planning activities and its associated advanced ICT tools (Sanchis et al., 2018b).

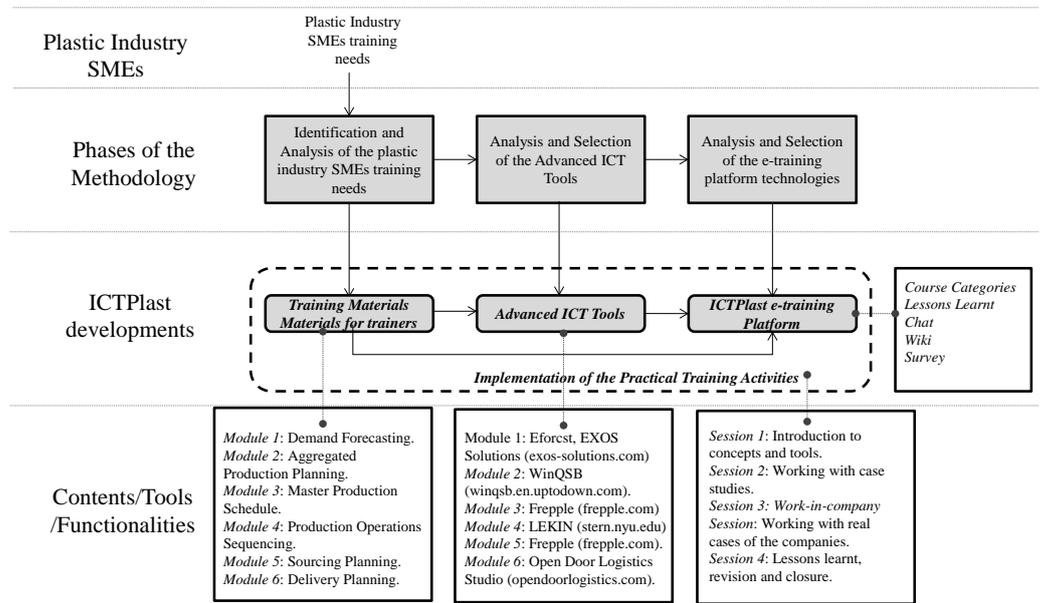
The last axis is related to the characterization of the previously defined ICTPlast developments based on the following issues:

- a2) Contents of the training materials. The contents are related to the identified training needs in 6 modules as it is shown in Figure 1.
- b2) Complete set of advanced ICT tools. These tools (Table 3) solve enterprise planning problems identified as critical for the plastic industry SMEs.
- c2) Functionalities of the ICTPlast e-training Platform. The e-training platform is designed with a set of functionalities that support trainees but also trainers in completing the training programme on advanced ICT tools for enhancing enterprise planning competences in the plastic industry SMEs.

d2) Sessions structure and schedule of the practical training activities. The number of sessions and the duration of each one are designed taking into account the lacks of the training needs in order to satisfy the learning objectives and shape the training programme.

Figure 1 shows the ICTPlast project overview based on the three axes: (i) the methodology used to develop the training project; (ii) the results developed and (iii) the characterization of each of the developments.

Figure 1 ICTPlast Project Overview.



3. Plastic Industry SMEs Training Needs

Technicians of plastic industry SMEs who are involved in planning activities have a lot of experience, gained along the years, and they know how to deal with the planning problems they usually face. However, they are not familiar enough with the use of ICT Tools to their work, within a new paradigm of manufacturing model, meaning a reduction of competitiveness of their companies.

These technicians must be trained in high-level ICT/Digital competences in order to get them into the new manufacturing models and allow them increasing the global industry efficiency, as well as their own performance.

In light of this, the first step to define the training programme on advanced ICT tools for enhancing manufacturing process planning competences in the plastic industry SMEs is to identify the main training needs so technicians can perform their daily planning tasks efficiently.

The analysis is performed from 3 main perspectives based on the Supply Chain Operations Reference model (SCOR) (APICS, 2014):

- **Source (S):** this type of training need is related to planning the amount of items to be ordered per pe-riods in a planning horizon.
- **Make (M):** this type of training need is focused on planning the amounts of items to be produced per periods in a planning horizon.
- **Delivery (D):** this type of training needs requires the planning of the amount of items to be delivered per periods in a planning horizon.

The main training needs from the plastic industry SMEs related to the planning activities are shown in Table 1. The training needs in Cursive are the ones that require special interest due to their importance and criticality for the plastic industry SMEs.

Table 1 Training needs of the plastic industry SMEs.

Training Needs	Description	S	M	D
Material Requirements Planning	System for calculating the materials and components needed to manufacture a product.	√		
Materials Inventory Planning	System to determine the optimal quantity of materials with the aim of aligning such plans with the enterprises capacity to produce goods.	√		
Aggregate Production Planning	System to determine the production, inventory, and work force levels to meet fluctuating demand requirements over a planning horizon.		√	
Master Production Schedule	System that supports enterprises to plan which products and related quantities to produce during a planning horizon.		√	
Production Operations Sequencing	System to plan the order of the operations to manufacture the different goods.		√	
Assembly Planning	System to schedule the finished goods in a make-to-order or assemble-to-order environment.		√	
Demand Forecasting	Predictive system addressed to prognosticating consumer demand for goods or services.			√
Vehicle Routing	System to find the optimal set of routes for a fleet of vehicles delivering goods or services to various locations			√
Order Promising	System to plan the fulfilment of customers' orders accomplishing with the service levels and other requirements such as delivery date, and quality standards, among others.			√

4. Training Materials and Materials for Trainers

4.1. Training Materials

The main objective in the development of the training materials is to deliver high-quality material quickly and

cost-effectively that satisfy the training needs identified. The training materials developed within ICTPlast are online video presentations interactively developed. They are available through the ICTPlast e-training platform. Users may play the presentations the times they need and when they wish.

Figure 2 shows an example of the training material of “Module 2. Aggregate Production Planning”.

Figure 2 Example of the online video presentation of ICTPlast Module 2.



To develop these training materials, two main technologies are identified. Firstly, text-to-speech technology is critical to add explanations as spoken sound versions to the training materials. The selection of the more suitable technology is based on the review performed by Sanchis et al., (2018b), who analyze different text-to-speech technologies. But the analysis performed within ICTPlast covers the analysis of additional text-to-speech technologies (more than the ones analysed by Sanchis et al., 2018b). Balabolka (www.cross-plus-a.com/balabolka.htm), eSpeak (espeak.sourceforge.net), Festvox (festvox.org/), From Text To Speech (www.fromtexttospeech.com/), Ivona (ivona.com), Natural Reader (www.naturalreaders.com/), MaryTTS (mary.dfki.de), TextAloud (nextup.com), TTSReader (ttsreader.com/), Text

to Voice Internet Browsers Extensions (add-on) (readaloud.app/), WordTalk (www.wordtalk.org.uk), and YAKiToMe! (www.yakitome.com) (alphabetically ordered) are analyzed. Table 2 shows the criteria used for selecting the most suitable technology to develop the ICTPlast training materials. It is worth mentioning that one of the most important criteria is the voice quality. To select the technology, this criterion is much more important (has received a greater weight in the weighting procedure). This criterion takes into account aspects such as naturalness (natural voices in a number of languages), fluency (speed and volume, control of the reading by inserting pauses), and comprehension (pitch control, pronunciation...).

Table 2 Text-to-speech technology selection criteria

Name	Rationale	Preferred Values
Open-source	It is advisable open-source solutions; however this criterion depends on the voices quality.	Open source taking into account the voice quality.
Voice quality	The voice should be completely understandable and very comparable to the human voices.	Natural, fluent, correct pronunciation, understandable, and similar to human voices.
Sound file generation	It is suitable that the selected technology offers different sound files.	.aif, .au, .mp3, .mp4, .ogg, .wav, .wma.
Adjustments	It is recommendable that the selected technology provides several options to adjust the text-to-speech outputs.	Volumne, rate, robot, whisper, stadium and chorus.
Number of languages	It is convenient that the text-to-speech technology offers as many languages as possible, considering at least the 6 languages in which the training materials are developed.	English, Italian, Spanish, Portuguese, Slovak and French.
Operating systems	It is advisable that the solution is compatible with the most important operating systems.	Linux, Mac OS but preferably Windows.
Format texts	It is interesting that the solution supports the most common format texts.	.doc, .docx, .eml, .epub, .html, .ods, .odt, .pdb, .prc, .pdf, .rtf, .txt, .xls, and .xlsx.

Taking into account the criteria of Table 2, the text-to-speech technologies are assessed. In this assessment, it is also applied a simple weighted criteria method to give more importance to those criteria that are critical for the development of the training materials. Based on this, the technology of TextAloud (nextup.com) is chosen. TextAloud is a solution that offers the interface to convert the written text into natural-sounding speech through the technology Ivona (ivona.com). These technologies provide different options to make the voice natural with the possibility of changing the tone and speed, and selecting several different accents of the speaking voice. Moreover, it makes use of AT&T's natural voice technology what confers a very high voice quality that is one of the most important features appreciated by ICTPlast. Finally, to convert the static training materials into dynamic ones, compilation technologies are assessed. In this case, Articulate (articulate.com) is the selected one because it allows to configure web courses from different training resources. The compiled training material is Sharable Content Object Reference Model (SCORM) (ADL, 2001) compliant, guarantying interoperability among different LMS.

4.2. Materials for Trainers

These materials are supporting documentation for trainers in order to help them in their training sessions. The materials are used to plan, conduct and implement the training programme. The materials for trainers include information related to the 6 training modules based on the previously identified training needs of the plastic industry SMEs. The materials for trainers developed are based on three key overarching principles: clarity (to have a clear understanding of the training purposes, target group, aims and objectives, learning outcomes, process plan, responsibilities, evaluation, etc); consistency (once there is clarity on aims and objectives, the design and details of methods, and training approach and techniques, it is important that the materials for trainers, and also for trainees, stay consistent with what the training is trying to achieve and stay focused on the main purpose); and commitment (to guarantee that the training programme is implemented as planned fulfilling the expected objectives).

5. Advanced ICT Tools

The best way for acquiring new knowledge and capabilities is to be directly trained in the use of the proper ICT tools applied to real and own enterprises problems. In this way, trainees are motivated to learn as they are giving response to their daily problems and they get the maximum profit from the training programme. For this reason, ICTPlast promotes work-based learning, with a training methodology fully based on "learning-by-doing" and focused on the application of the concepts and tools to real cases of each plastic industry SMEs. For each of the modules, different ICT tools are analysed based on some general criteria and specific ones depending on the target objectives pursued for each of the advanced ICT tools.

The general selection criteria include the analysis of aspects such as: open source tools (the source code is released under a license that allows to be used, modified and/or shared under defined terms and conditions); easy navigation (the tools options and interfaces are designed ergonomically and user-friendly); time calculation (the necessary time spent to offer viable solutions is limited and respects the users requirements); among others. Otherwise, the specific selection criteria depend on the characteristics of the planning problems to be solved and the expected results to be obtained. For this reason, the specific selection criteria definition is particular for each of the advanced ICT tools.

After assessing the general and specific selection criteria, the following advanced ICT tools (Table 3) are selected in line with the 6 different training modules:

Table 3 Advanced ICT Tools selected

Module	Advanced ICT tools	Description
Module 1: Demand Forecasting	Eforest, EXOS Solutions (ex-os-solutions.com)	Expert system for demand forecasting that calculates, from the historical data, accurate forecasts of the products portfolio of a company.
Module 2: Aggregate Production Planning	WinQSB (winqsb.en.uptodown.com)	System to solve aggregate planning problems in three forms: simple model, transportation model and general linear programming model. It allows to specify the availability of overtime, backorder, subcontracting, lost-sales and hiring and dismissal of resources.
Module 3: Master Production Schedule	Frepple, (frepple.com)	Intelligent system that generates finite-capacity production plans and schedules constrained by resource capacities, personnel availability, material availability and lead times.
Module 4: Production Operations Sequencing	LEKIN, Stern School of Business (stern.nyu.edu)	Scheduling system with 6 workspace environments: single machine, parallel machines, flow shop, flexible flow shop, job shop, and flexible job shop that allows to be applied to different contexts.
Module 5: Sourcing Planning	Frepple, (frepple.com)	Smart system to dimension the inventory levels through the computing of safety stocks and reorder quantities for raw materials, intermediate products and end products.
Module 6: Delivery Planning	ODL Studio, Open Door Logistics (opendoorlogistics.com).	Open source desktop application for performing analysis of locations, sales territory design and, mapping and vehicle fleet routing and scheduling.

6. ICTPlast e-training platform

After identifying the main plastic industry SMEs training needs, and the advanced ICT tools that give response to these identified training needs, it is vital to set up a virtual environment to host the training materials and allow the development of the practical training activities. The virtual environment of the ICTPlast Project is an e-training platform configured based on the following two steps:

1. Technology analysis and selection. Different LMS are analysed in order to select the one that best matches with the training programme.

2. e-training platform design. The design of the e-training platform consists of defining the different functionalities necessary to satisfy the learning requirements based on the LMS selected.

Currently, in the market, there are many LMS that can be used for designing e-training platforms that provide features very close to the training needs identified in section 3. The following criteria are specified to perform the analysis and selection of the most suitable LMS (Table 4).

Table 4 Advanced ICT Tools selected

Name	Rationale	Preferred Values
Cost	Considering the wide range of solutions, this criterion establishes the preference for inexpensive solutions.	Free solution
Open Source	The source code should be accessible, in order to have control over the solution.	Yes
Established solution	The selected solution shall have some years of existence.	More than 5 years
Wide community of users	The selected solution should have a wide community of users that guarantees that the solution is widely tested, and there is many people working on solving detected issues.	More than 5000 forum users.
Recent new releases	This criterion establishes that the portal solution to be selected has to be a non-dead product.	Less than 6 months

The LMS analysed are Administrate (www.getadministrate.com), ATutor (atutor.github.io/), Britix (www.bitrix24.com), Classroom (www.youtestme.com), Cornerstone LMS (www.cornerstoneondemand.co.uk), Docebo (www.docebo.com), Dokeos (www.dokeos.com/), eFront (www.efront-learning.com), Eliademy (eliademy.com/), Firmwater LMS (try.firmwater.com), Forma LMS (www.formalms.org/), ILIAS (www.ilias.de/), Moodle (moodle.org), OpenOLAT (www.openolat.com/), Opigno (www.opigno.org/en), ScholarLMS (www.scholarlms.com), and TalentLMS (app.talentlms.com).

The LMS selected is Moodle as it accomplishes the selection criteria defined in Table 4 positively. Moodle (MOODLE, 2018) is a learning platform designed to provide trainers and trainees with a single robust, secure and integrated system to configure customized learning environments. Its main characteristics are: (i) it is a proven and trusted LMS, (ii) designed to support both teaching and learning; (iii) easy to use; (iv) free with no licensing fees; (v) continuously up-to-date; (vi) with multilingual capabilities; (vii) provides a tool-set to support both blended learning and 100% online courses; (viii) highly flexible and fully customizable to individual needs; (ix) modular set up and interoperable design; (x) scalable to any size of training community; (xi) robust, secure and private; (xii) it can be used on any device; and (xiii) supported by an active international community, a team of dedicated full-time developers and a network of certified Moodle Partners.

Once that the technology for the LMS is selected, the second step is to design the e-training platform, based on the plastic industry SMEs training needs. The following functionalities are configured:

- Course categories. The platform classifies the training materials as templates (addressed to trainers as patters to design other training materials), active (training material in progress) or closed (training material archived and ready to be used when necessary).

- Lesson learnt. Online forum discussion where trainees can have discussions with each other or with trainers on course-related topics.
- Chat. It is similar to the Lesson learnt, but in this case, the chat allows trainees to discuss in real-time.
- Wiki. A collaborative developed space where trainers and trainees add and edit content on course-related topics.
- Survey. Different specific questionnaires where trainees can provide their opinion about different aspects of the training programme.

Once that the training needs are identified, the training materials developed, the advanced ICT tools selected, the material for trainers defined and the e-training platform configured, it is time to design the practical training activities. Its implementation consists of performing 4 training sessions for each of the 6 modules organized as follows:

- Session 1. Introduction to concepts and tools.
- Session 2. Working with case studies.
- Session 3. Work-in-company Session. Working with real cases of the companies.
- Session 4. Lessons learnt, revision and closure.

These practical training activities are performed both through the e-training platform but also face-to-face based on the blended learning paradigm.

7. Conclusions

ICTPlast promotes work-based learning, with a training methodology fully based on "learning-by-doing" and focused on the application of the concepts and tools to real cases of each company. It offers different training resources to efficiently implement the training programme on advanced ICT tools with the main objective of enhancing the enterprise process planning competences in the plastic industries SMEs. To do so, the ICTPlast project develops:

- Training materials. As supporting documentation for the trainees focused on 6 main training needs detected: materials inventory planning, aggregate production planning, master production schedule, production operations sequencing, demand forecasting, and vehicle routing.
- Materials for trainers: Auxiliary materials addressed to trainers in order to help them to implement the training programme.
- e-training platform. An online working space in which the trainees could get access to resources and documentation and they could also perform and deliver tasks.

The training programme on advanced ICT tools is defined based on an analysis of most worrisome planning problems of the plastic industry SMEs, what facilitates the identification of the main training needs. These training needs are the foundations for defining the training resources of the ICTPlast programme. Moreover, it is worth mentioning that the implementation of the training programme is performed by the definition of the practical training activities that includes 4 sessions.

However, the definition of the different training resources is not an easy task, as it is critical to also identify the most appropriate technology for the development of each training resource. This paper shows an overview of the selection criteria used for this purpose and the results of this selection.

Future work is related to the definition of additional training resources addressed to different sectors, or even though, in order not to start from scratch, the customization of the existing training resources to fulfil particular training needs.

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