



PERSIST.

Whitepaper for IO4

Design of module-based
course concept for PSM with
Gamification elements based on the
outcomes of the Delphi studies



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1. Introduction: Design of module-based course concept for PSM with Gamification elements based on the outcomes of the Delphi studies

1.1. Building on the outcomes of IO1, IO2 and IO3

This report addresses the fourth intellectual output (IO4) of the PERSIST Erasmus+ project, which is to design a Purchasing and Supply Management (PSM) course that reflects the skills and competencies required by PSM in the era of Industry 4.0. The previous IOs (IO1 and IO2) used a systematic literature review on Industry 4.0 skills and competencies within PSM and multiple explorative World Café studies to identify and describe future roles and skills within PSM in the era of Industry 4.0. A Delphi study in IO3 identified and defined six future roles and nine future skills needed by PSM to deal with the new technologies and ways of working brought about by Industry 4.0. These future roles are Process Automation Manager, Data Analyst, Supplier Onboarding Manager, Master Data Manager, System Innovation Scout and Legislation Specialist, with the suggested future skills being: Data Analytics skills, Strategic Management skills, Supply Network Management skills, E-Procurement Technology skills, Robotic Process Automation (RPA) skills, Digital Contract Management and Legal skills, Digital Partnership Management skills, Digital Negotiation skills and Digital Leadership skills.

An integrated approach has been taken to project PERSIST, and so the findings from previous IOs, i.e. the future roles and skills have been used as the basis for this IO and underpinned the development of the PERSIST PSM Industry 4.0 course concept. To develop a motivating and interesting experience for students, the course will use gamification elements and playful interaction concepts. The last intellectual output of this project (IO5) will operationalise these into a tangible modular format course that a range of PSM educators can use.

1.2. Research objective of the gamified course

IO4 aims to develop a modular course that can be used within university study programs and professional training to educate future PSM skills in the era of Industry 4.0. The first step in IO4 is developing a course structure in which the results of IO3 can be meaningfully and purposefully integrated. In addition, the course structure reflects a relationship to a practice-based PSM process to generate a high acceptance among educators from different countries and universities. This was used as the basis for developing the overall course structure before analysing what knowledge, skills, and competencies are required in specific modules and how gamification elements can be used to support their delivery meaningfully.

Although the course is modular in structure, an overall storyline was developed to provide orientation for participants and reflect tasks and activities from a real business environment. In addition, this approach ensures that the course is not just a collection of gamified learning objects and this practice focus ensures that the participants are optimally prepared for future tasks and requirements they may face in industrial contexts.

1.3. Research Questions

To meet the objectives of this IO, the following two research questions will be addressed:

RQ1: What structure should the gamified course for developing future PSM skills in the era of Industry 4.0 have?

RQ2: How should the Didactical, Organisational, Content and Technical concepts be designed for the gamified course?

In addressing RQ1 and providing a robust and accessible structure for the course, a classical PSM process was used to underpin the different modules and provide participants (both students and educators) with a recognisable framework to position the different subject areas. The process maps of Van Weele (2014) and Schiele (2019) were used. Second, the skills identified in the previous IOs and validated in the Delphi study were used to inform the content and course structure development.

To address RQ2, i.e. the design of the didactical, the concept, content and technical concepts were based on the experiences of the project partners and specific research on best practice examples from other areas that, for example, make use of gamified learning concepts

Some of these concepts were relevant for the entire course, e.g. the technical concept for using uniform software solutions and the organisational concept for the balanced workload distribution in the form of ECTS credits. Other concepts, such as the content design of the individual modules, are module-specific. The concept of dividing the course into several content modules and using the four concepts mentioned above for the design gives a solid basis and orientation for the development of the gamified course.

1.4. Structure of the white paper

Having connected the work of IO4 to the previous three IOs and presented its objectives, an overview of the theoretical background follows in the second section. The theoretical background consists of an overview of applications, challenges and potentials of gamification and different types of PSM process models.

In the third section, the methodological procedure of IO4 is explained; several interactive workshops were conducted, in which the brainwriting method was used. The course concept is further described by didactical, organisational, content, and technical concepts. In the fourth section, the overall storyline and the concepts for the five defined modules are described and these are the results and outputs of IO4. The fifth section concludes with a discussion of the results and a description of the final IO5 of project PERSIST.

2. Theoretical background:

This section describes the theoretical background on gamification in e-learning (2.1), the characteristics and possibilities of a gamified MOOC (2.2), and widely adopted PSM process models (2.3).

2.1. Gamification in e-Learning

To understand the concept of gamification, we first looked at different definitions of the term and, as there is no one universally agreed one, a range of complementary definitions are shown in Table 1.

Table 1: Definition of Gamification

Definition	Author(s)
"[...] gamification grafts elements that make video games fun and effective and applies them to any learning environment."	(Al-Towirgi, Daghestani, & Ibrahim, 2018, p. 193)
"The use of game elements (mechanics, dynamics and aesthetics) in a field (education, marketing etc.) that is not a computer game."	(Bernik, Radošević, & Bubaš, 2017, p. 711)
"Gamification, that is, application of video game principles to other domains, motives through both means, so as to stimulate students "to learn, stimulate new skills, and create a fun and interactive learning environment with fewer limitations of time and space in this increasingly informational society."	(de Oliveira, Cavalli, Dias, & de Oliveira, 2018)
"The central concept behind gamification is to integrate game elements in a non-game environment. Furthermore, increasing the potential to improve student engagement and motivation encourages researchers to develop and adopt gamification in educational contexts with various approaches [11]. Gamification tends to improve student engagement in virtual learning environments by using several game elements such as badges, points, levels, and leaderboards [12]–[14]."	(Hasan, Nat, & Vanduhe, 2019, p. 89834)
"Gamification is the process of incorporating game elements into education in an effort to increase student engagement."	(Jen & Said, 2018, p. 845)
"Gamification is the usage of game mechanics, dynamics, aesthetics and game thinking in non-game systems. Its main objective is to increase user's motivation, experience and engagement. For the same reason, it has started to penetrate in e-learning systems."	(Strmečki, Bernik, & Radošević, 2015, p. 1108)
"Gamification, however, focuses not on a learning game, but on creating a game experience in a certain learning content or activity. It applies gaming elements and mechanics that affect students' emotions, feelings, thoughts, and behaviors in order to achieve the set learning objectives."	(Tuparov, Keremedchiev, Tuparova, & Stoyanova, 2018, p. 2)

After defining the term Gamification, the different ways to implement and operationalise this concept are presented and identified as Gamification Elements in Table 2. In contrast to Game Elements, which

describe overarching properties of a game, Gamification elements focus on the specific implementation of gamification, although some authors also refer to game mechanics. It should be noted that other gamification elements are also described, depending on the author.

Table 2: Gamification elements (Seaborn und Fels 2015; Saputro et al. 2019)

Gamification element	Definition
Points	Numerical units indicating progress
Badges	Visual icons signifying achievements
Leaderboards	Display of ranks for comparison
Progression	Milestones indicating progress
Status	Textual monikers indicating progress
Levels	Increasingly difficult environments
Rewards	Tangible, desirable items
Roles	Role-playing elements of character
Profile	User profile
Performance graphs	Visualisation of student activity
Teams	Groups of students that are structured to fulfil the relevant goal
Social Feedback	Students' interaction with other student activities
Quests	Predefined targets that students should reach by achieving activities
Chats	Enables students to chat with each other

Purpose and advantages of Gamification

A disadvantage of e-learning is that it is limited in conveying emotion and motivating students. Learning Management Systems (LMS) are mostly static and offer little opportunity for interaction and so Gamification can therefore be helpful to "[...] achieve the main objectives of e-learning which are: "high efficiency, engagement, satisfaction and motivation of learners [43]" (Al-Towirgi et al., 2018, p. 195). Involving and engaging students should play a central role in developing effective and interesting learning materials, as students' interaction and active participation improve learning (Hasan et al., 2019).

E-learning is similar to traditional learning in that the students need the motivation to start learning and continue learning consistently (Strmečki et al., 2015, p. 1108). Presenting learning content in a gamified environment makes learning more entertaining and promotes interest in the content to be taught (Begosso et al., 2018, p. 226).

Tuparov et al. describe, for example (Tuparov et al., 2018, p. 1):

"The fast development of technologies and changing of students' ways of learning requires involvement of different teaching and assessment approaches enhanced by information and communication technologies."

The pure transfer of knowledge should be enriched and supported by the technological possibilities that are currently available by making learning an experience and adapting it to the reality of young people today.

Challenges of Gamification

Although there is a consensus on the benefits of gamification, there are also challenges in using and implementing gamification elements. For example, de Armas, Vizcarra, Dantas, Kofuji, and Seabra (2019, p. 1) state that the costs of developing and implementing gamification elements are high and students need guidance to successfully use gamification and not be left alone (Hasan et al., 2019, p. 89833).

Even though gamification can generally increase motivation, this does not apply equally to all users. Some students do not like to play games and do not need any additional motivation to learn new content. In this regard, Strmečki et al. (2015, p. 1109) state:

"There are individuals among us who do not like to play games, do not need additional motivation, consider it a waste of time or simply do not like to compete with others. All types of people and their learning habits must be considered when designing a modern e-learning system with gamified elements."

2.2. Gamified MOOCs

When traditional MOOCs are enriched with gamification elements, they are called gamified MOOCs (Bakar, Yusof, Iahad, & Ahmad, 2017, p. 185). The use of gamification elements is intended to compensate for the disadvantages of a traditional MOOC. These disadvantages are, for example, that many participants do not complete a MOOC in its entirety, but leave at some point before the end (Klemke et al. 2018). At this point, gamification elements that increase the motivation of the participants can be helpful to achieve the learning goals (Khalil, Wong, de Koning, Ebner, & Paas, 2018, p. 1629). Similarly, Saputro et al. describe that among the many advantages of a MOOC, the disadvantages are, for example, the effectiveness rate. They cite the lack of motivation and passivity shown by participants in e-learning as reasons for this. The solution is an interactive version of a MOOC, for example, integrated into a learning management system (Saputro, Salam, Zakaria, & Anwar, 2019).

The following statement highlights the importance of gamification elements in a MOOC (Antonaci, Klemke, Kreijns, & Specht, 2018, pp. 172-173):

"Based on an analysis of "565 course iterations from 261 different courses, with a combined 12.67 million course registrations from 5.63 million learners" [1, p. 130], it appears that the majority of people who enrol in a MOOC never enter the course (52% of the study sample), and those who do join, are mainly active during the first two weeks, after which their level of activities drops sharply [1]. We argue that a drop in activity levels may be partly due to a lack of user engagement, and MOOCs may benefit from a gamified intervention targeted at increasing engagement."

The advantages of a gamified MOOC are the increased perceived enjoyment of completing the MOOC and, if applicable, the achievement of a flow state and, therefore, an improved learning experience for the participants (Bakar et al., 2017, p. 186).

The possibility of direct feedback in gamification elements allows students to learn directly from their own mistakes and their ability to determine the speed at which they complete the gamified MOOC. Furthermore, a gamified MOOC can also increase the participants' creativity compared to conventional MOOCs (Rincón-Flores, Montoya, & Mena, 2019, pp. 600-601).

2.3. Gamification in Learning Management Systems (LMS)

When gamification is used in Learning Management Systems (LMS), it is also called a "G-LMS - Gamified Learning Management System". Gamification elements can be easily integrated into a G-LMS (Villagrasa, Fonseca, Redondo, & Duran, 2014, p. 39). Katsigiannakis and Karagiannidis (2017) discovered with two groups of students that achievement badges made the educational process more engaging in terms of frequency, recency, duration of use, participation, and activity completion. For example, the engagement score of students was 19.7% higher in a gamified Moodle learning environment (Katsigiannakis & Karagiannidis, 2017).

2.4. PSM process models

Different Purchasing and Supply Management (PSM) process models were considered to give the skills and roles identified in IO3 a structure for the course. A process model for structuring the course has the advantage that students will recognise a process that they already know from their previous studies or experience, and a PSM process can also be used to provide consistent storytelling by creating a coherent narrative through the learning journey. Finally, using a PSM process model as the basis for an overall course structure facilitates the development of individual modules and makes it possible to define an order in which the modules can be logically arranged. PSM process models can be classified into different categories of models. There are linear process models, cyclic models, hybrid linear-cyclic process models, strategic process models and decision process models (Bäckstrand, Suurmond, van Raaij, & Chen, 2019).

Linear process models

The majority of the models presented in the literature illustrate the PSM process as a linear sequence of interconnected activities that follow a time-based order, e.g. as per the frequently used linear models of Van Weele (2014) and Schiele (2019), which is shown in Figure 1 and clearly illustrates the main activities in a PSM process.

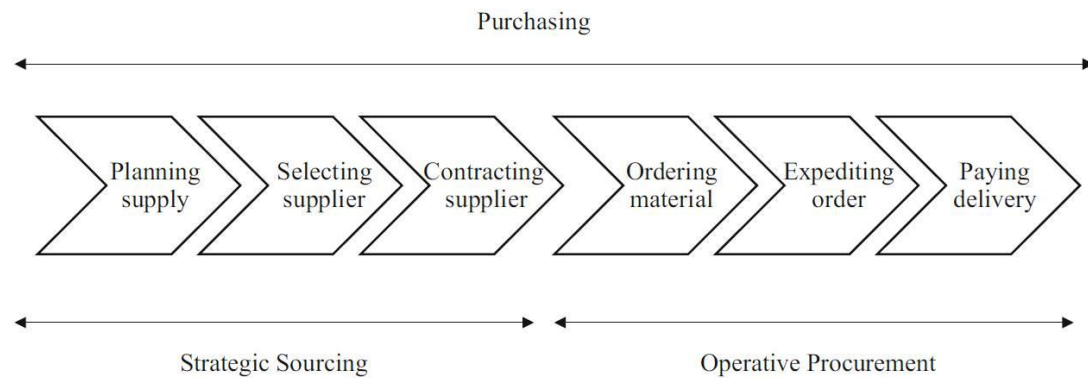


Figure 1: PSM model by (Schiele, 2019)

Cyclic models

Linear process models are suitable for structuring one-off or project-specific purchasing processes. However, PSM departments often already have experience in procuring the required goods or services and know potential suppliers, and this knowledge should be referred to in the purchase situation. Based on this, cyclical models were developed, in which after the process phases have been run through, the process starts again from the beginning for the next purchase (Bäckstrand et al., 2019). Two examples of cyclic models are the model of Monczka, Handfield, Giunipero, and Patterson (2016) and the model of Schiele (2019), shown in **Fehler! Verweisquelle konnte nicht gefunden werden..**

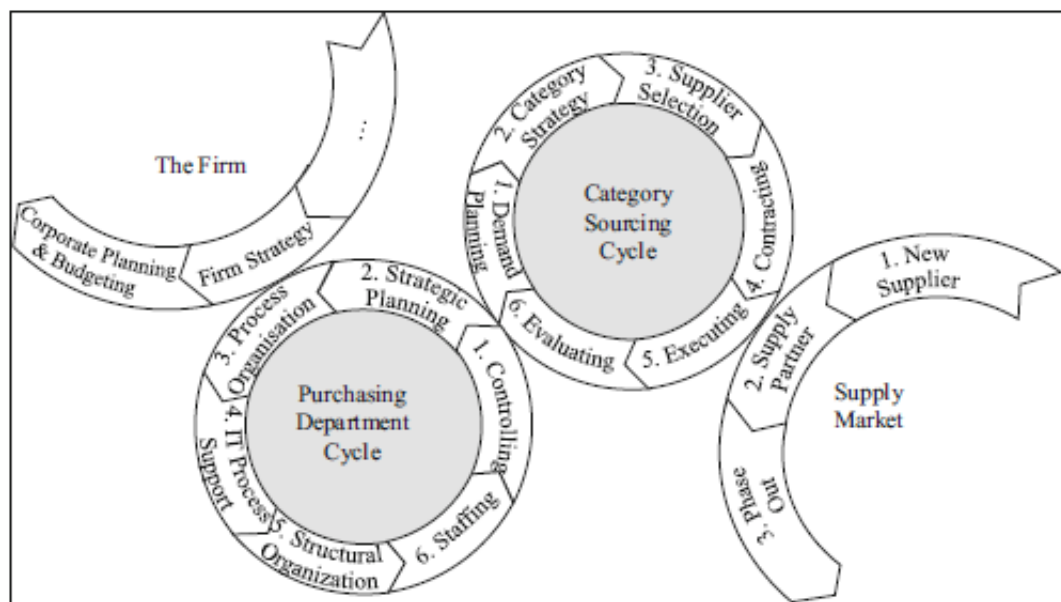


Figure 2: Purchasing year cycle by (Schiele 2019)

Hybrid linear-cyclic process models

In addition to linear and cyclical process models, hybrid forms of these model variants can also be found in the literature. According to Johnsen, Howard, and Miemczyk (2014), the process model can be classified as a model consisting of two linear subprocesses and a process cycle based on the screening and review of new suppliers as the management of the current supplier base.

Strategic process models

Compared to the other models, strategic process models are more strategically oriented and illustrate the long-term planning process of a PSM department. In contrast to cyclical models, the operational and tactical activities are not shown in these and the central component in this concept is managing the supplier base. Through the company's strategic positioning, the goal is to establish an integrated, coordinated and global PSM department within the company.

Decision Process Models

Decision process models represent another category of models, in which the process steps are influenced by decisions made and depend on decision choice and different actions taken accordingly (see for example the model of Aissaoui, Haouari, and Hassini, 2007).

3. Methodology

As PERSIST operates an integrated approach to the development of its outputs, the work in IO4 is based on the results of the previous IOs. In particular, the findings on the use of gamification elements from the first two IOs and the competencies and roles identified for PSM in the context of Industry 4.0 from IO3 will be used.

The overall scope of IO4 is the: „Design of module-based course concept for PSM with Gamification elements based on the outcomes of the Delphi studies“, with its goal being to transfer the results of IO3 into a modular course concept, including gamification elements. The output of IO4 forms the basis of the input into IO5, the final one of the project, which is the course operationalisation in the form of a: „Specification of Learning Objective for a module-based course concept with gamification elements on Industry 4.0 in PSM“.

This section describes the procedure for designing the modular course concept. A PSM process model has been used as the underlying structure as these are already known to a wide range of students and educators and provide a comprehensible structure that will facilitate orientation through the course. A range of PSM models described in section 2.4 is available for selection, but the linear process model of Van Weele (Bäckstrand et al., 2019; Van Weele, 2014) was selected since it is the most established and easily accessible one.

As already described for implementing IO4 in the application, the four sub-concepts didactical, organisational, content and technical concepts are specified for the course concept. This procedure has already proven successful based on the experience of the project participants in designing university courses. A requirements survey was carried out within the project consortium to design the four sub-concepts, i.e. the Didactical, Organisational, Content and Technical concepts. This should ensure that the solution concept meets the requirements of all partners and that the developed gamified elements can be used in teaching at all partner universities without any problems. Although the collected requirements represent a solid basis, it may be that not all requirements can be fulfilled and considered equally.

In the following sections of this white paper, the procedure in the interactive creativity workshops within the project consortium is described first. Then the requirements and goals of the course concept for the didactical, organisational, content and technical concepts are explained in separate sub-sections.

3.1. Interactive Creativity Workshops

At the beginning of IO4, five modules were defined based on Van Weele's PSM process model. The nine identified skills from IO3 were subsequently arranged thematically across these. The initial breakdown of the module descriptions was as follows:

- Module 1: Introduction and strategic digital leadership
- Module 2: Supply requirements using data and technology
- Module 3: Sourcing and evaluating suppliers in the digital age
- Module 4: Selecting suppliers
- Module 5: Advanced automation in operational procurement

The content and titles of the modules were iteratively developed throughout IO4. The final status of the five modules is described in section 0.

Three Creativity Workshops were held to develop the content of the five modules jointly and to develop an overall storyline:

- Creativity Workshops 1 (15.04.2021)
- Creativity Workshops 2 (23.04.2021)
- Creativity Workshops 2 (18.05.2021)

Creativity Workshops 1 and 2 aimed to collect ideas for describing and designing the five modules, and the creativity technique brainstorming was used. Technically, the workshops were implemented on Padlets (<https://Padlet.com/>), a separate Padlet was created for each module, and three categories were specified for each module: Storytelling, Tasks, and Game elements. For each of these three categories, the participants' ideas were collected and noted. There was a brainstorming phase for each participant, and then the aspects were discussed. An example of one of the five Padlets is shown in Figure 3 and the other four Padlets looked similar for the respective modules.

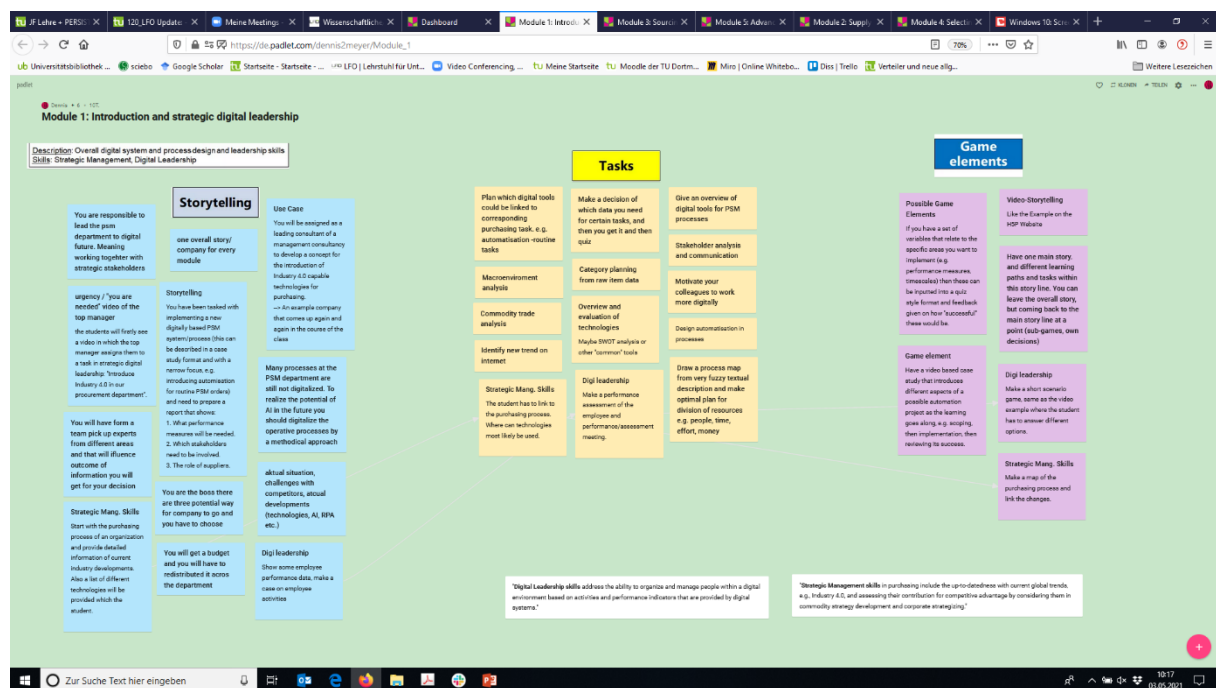


Figure 3: Screenshot of Padlet from creativity workshop

The goal of the third Creativity Workshop was to collect ideas to create the Overall Story. An overall story should be developed for the course so that realistic practice-based situations can inform the gamification approach and that all five modules use the same information as a basis, such as the company, colleagues, and products of the company, trends and challenges in the development of the company. The technical implementation of the third Creativity Workshop was done with the help of the software Miro (<https://miro.com/app/dashboard/>). Methodologically, the method Use Case Diagram (UML) was chosen to describe System, Actors and Relationship.

The brainwriting method was used, with teams of two researchers each providing ideas on the three areas of System, Actors and Relationship. After 15 minutes, the notes were passed on to another group and exchanged among themselves, thus successively generating a refined set of results. At the end of the run-throughs, the results were presented, and a vote was taken on which elements should be used best. A section of the Miro Board from the third Creativity Workshop is shown in Figure 4.

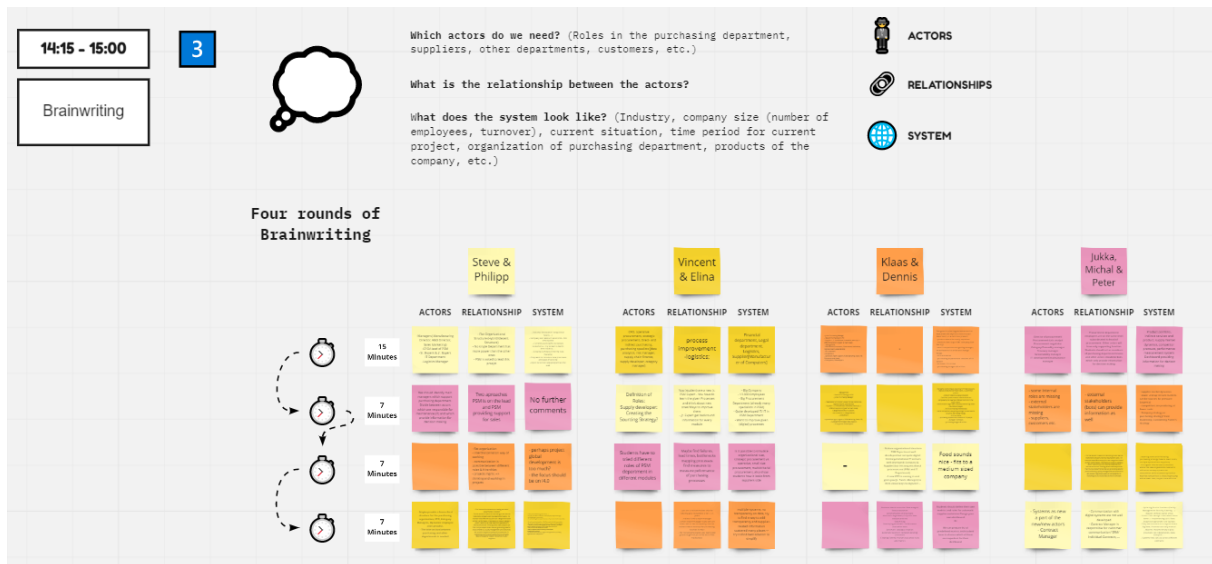


Figure 4: Screenshot of Miro board from the creativity workshop

3.2. Didactical concept

Table 3 shows the requirements for the didactical concept.

Table 3: Requirements didactical concept

Education approach	<ul style="list-style-type: none"> • Practical training of skills (self-learning) + Additional lectures (in-depth content) • Combination of offline & online education
Student-centred learning	<ul style="list-style-type: none"> • Students acting self-dependently and collaborative in a protected environment • Students to be active • Yes, it should be possible for students from different universities to form a team and work together. Maybe also create a contest between the teams from different universities.
Gamification	<ul style="list-style-type: none"> • Achieve high motivation of participants through the targeted use of gamification in a virtual learning environment • The course should be fun, and stealth learning should be central to the gamified elements

	<ul style="list-style-type: none"> • Within gamification, competition and collaboration are success factors and should be implemented in the game • Gamification elements could be leveraged in a virtual learning environment rather than in the classroom
Learning objectives	<ul style="list-style-type: none"> • Formulating from a student's perspective • Are achievable and suit the expected time investment • Specific to the PSM field, especially digitalisation / Industry 4.0 in PSM

The collected requirements for the didactical concept were then consolidated and summarised in the following core principles:

- Using Gamification Elements (Badges, Leaderboards, et cetera)
- Using Gamified Elements (H5P Games, et cetera)
- Game Design: multiple learning paths & Leveling
- Using Constructive Alignment for Learning Objectives
- Enabling Self Studying
- Roles used as Badges

The curriculum of the whole course consists of five modules, each of which has a scope of one ECTS so that the whole course has a scope of five ECTS (see Table 4). The scope of five ECTS should enable the course to be used without problems in as many higher education institutions as possible. However, it is not necessarily required to work through all five modules, but rather, building on the introduction and Overall Story in Module 1 (which is recommended in each case), individual modules can be taken from the course independently and used for own courses.

Table 4: Course curriculum

Module	ECTS
Module 1: Introduction to PSM in an Industry 4.0 environment (introduction)	1
Module 2: The foundation for advanced automation in PSM (technologies in PSM)	1
Module 3: eSourcing activities to select suppliers in I4.0 (eSourcing)	1
Module 4: eProcurement to facilitate operative procurement activities in I4.0 (eProcurement)	1
Module 5: Data analytics for Industry 4.0. purchasing (eData analytics)	1
Total	5

3.3. Organisational concept

Table 5 shows the requirements for the didactical concept.

Table 5: Requirements organisational concept

Execution	<ul style="list-style-type: none"> • Individual modules should also be feasible independently of the whole course. We would like to use the elements as an addition to our current courses to educate the future skills • It should be possible to conduct the course in an online environment (mainly online). However, we use a hybrid education approach at our institute, combining the online gamified elements and in-class lectures • It should have presence phases (may be done online through teleconferences) in order to establish collaboration • The course should be able to be started at any time, not only at a certain frequency • Six weeks duration or/ and continuous enrolment
ECTS and Grades	<ul style="list-style-type: none"> • 3, 5 or 6 ECTS are assigned to modules (e.g., one module = 1 ECTS). → one ECTS for each domain? • Examination: Through different types of submission, e.g., writing a report on developing and explaining a strategy, analysing data, et cetera, we would also include written exams including multiple choice and open questions • Grades from 0-5 or accepted/rejected; both OK
Collaboration	<ul style="list-style-type: none"> • In both situations, online or offline, a collaboration between the students should be possible

The structure and scope of each module are similar so that students can easily understand and recognise the different requirements across all five modules. Each module was divided into three sections: 1) Start, 2) Core and 3) Closing. The division is shown in Figure 5.

In the first section, students are introduced to the module and provided with a recorded micro-lecture and additional reading materials to work through the material independently. This introductory session also gives the students an understanding of the overall content of the module. In the core section, which takes up the most significant part of each module, further recorded micro-lecture(s) and additional reading materials are provided if necessary, for example, to explain tools and methods specific to the content area of the module. To provide a coherent narrative, the module-specific challenges are presented in the context of the overall course case example. The previously described methods and knowledge must then be applied in various gamification elements. A realistic industry-based situation is created by directly applying the methods in the specific case example, and the students get immediate feedback on their responses to various activities. The learned knowledge is checked in the third section, but the gamification elements are often done directly. If necessary, a formalised test can be given at the course end or at each module end, for example, to assign grades.

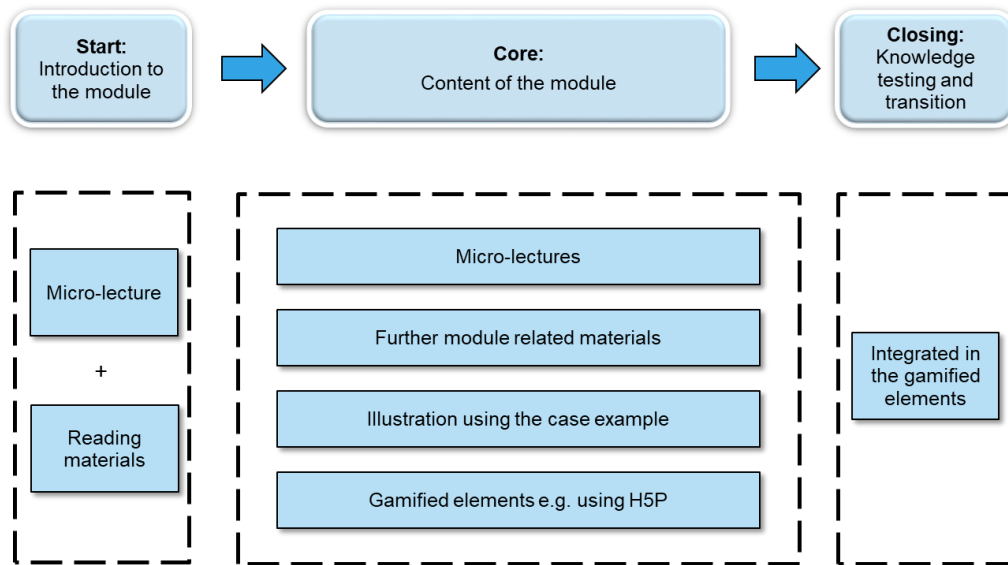


Figure 5: Organisation of each module

The collected requirements for the organisational concept were then consolidated and summarised in the following result:

- 5 Modules – 5 ECTS
- Target Group: Master Students (but also usable for Practitioners)
- The course can be used asynchronously/can be started at any time
- The course was mainly conducted in an online environment
- Self-Studying: Possibility of Presence Phase (Each partner should decide)

3.4. Content concept

The requirements analysis results for the content concept showed that there needed to be an overall storyline, but the skills and roles from IO3 needed to be assigned to the individual stage activities of van Weele's purchasing process to form the course structure.

Based on the first version of the five modules described in 3.1, the assignment of the nine skills to the PSM process steps according to Van Weele (2014) and Schiele (2019) was refined and is shown in Figure 6.

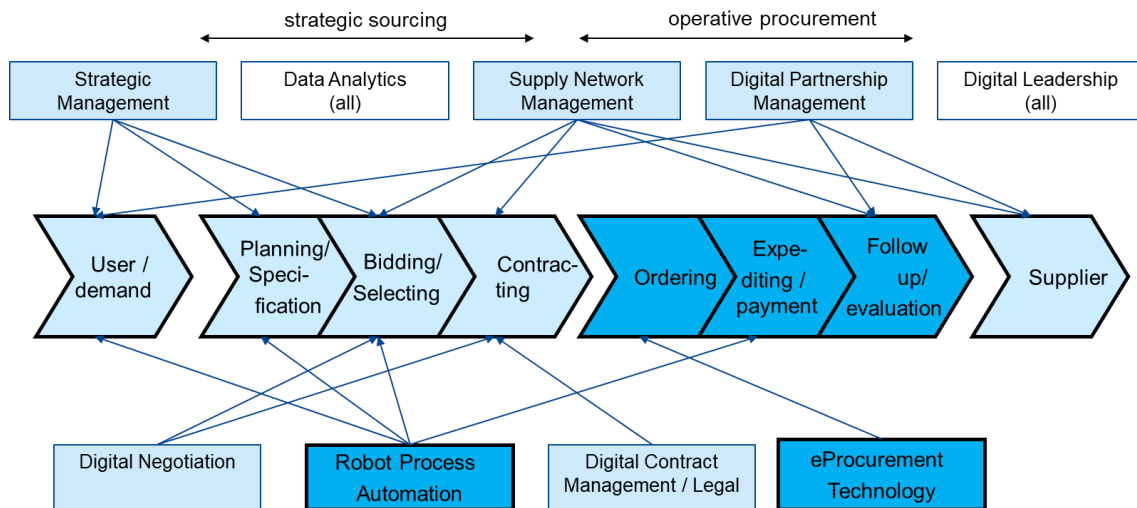


Figure 6: The technological influence on the PSM process and related skills

The final overview of the modules, a short description, and the responsibility for the development in the project consortium and the assigned skills are shown in Figure 7.

Module 1: Introduction to PSM in an Industry 4.0 environment (introduction - Edge Hill) Description: Overall digital system and process design and leadership skills Skills: Strategic Management (PSM and I4.0), Digital Leadership
Module 2: The foundation for advanced automation in PSM (technologies in PSM - TUD) Description: Using technology to manage ordering and the supplier relationship Skills: Data Management (master data), Robotic Process Automation, Digital Partnership Management
Module 3: eSourcing activities to select suppliers in I4.0 (eSourcing - UT) Description: Selecting and negotiating with suppliers, using relevant legal frameworks Skills: Supply Network Management, Digital Negotiation, Digital Contract Management and Legal,
Module 4: eProcurement to facilitate operative procurement activities in I4.0 (eProcurement - LUT) Description: Establishing an organisation's requirements Skills: Data Analytics, Robotic Process Automation, eProcurement Technology
Module 5: Data analytics for Industry 4.0. purchasing (eData analytics – EUBA) Description: Technology informed eProcurement techniques to identify and evaluate suitable suppliers Skills: Data Analytics, eSourcing evaluation, eProcurement evaluation Technology, towards AI

Figure 7: Organisation of the different modules

The collected requirements for the content concept were then consolidated and summarised as follows:

- 5 Modules arranged in the PSM process (Padlets)
- Overall Storyline is given
- Overall Course Learning Objectives

- Module: Introduction to the storyline + Basics
- Learning Objectives for each module based on the Courses ones
- Each partner responsible for 1 Module + 1-time Co-Responsibility

3.5. Technical concept

The technical concept elaboration covered areas such as, in which environment the gamified course can be developed and made available so that all project partners can access the course without any problems, deciding which gamification elements were the most suitable and identifying software for creating the videos for the micro-lectures.

First, an inventory of the Learning Management Systems (LMS) used at the project partners was conducted. The result was that Twente uses the LMS Canvas (Blackboard in the past), LUT, EUBA and TUDO Moodle and Edge Hill Blackboard. Therefore, the range of LMSs used is relatively heterogeneous, so a single solution was not immediately identifiable.

However, the solution to which LMS to select arose when answering the question about the integration of gamification elements and the possibility of using H5P was identified. Some of the project partners already had experience with H5P elements and developing these can be done in all standard LMS and also directly in the browser on the homepage of H5P (<https://h5p.org/>). In particular, created H5P elements can be exported and imported into LMSs as desired. This solution, therefore, solved the first question of the technical concept of using a single LMS. Gamified elements will also be developed outside of H5P, but these will be made freely available as they are created, for example, with standard office software such as Excel. Figure 8 shows an excerpt of the possible H5P elements.

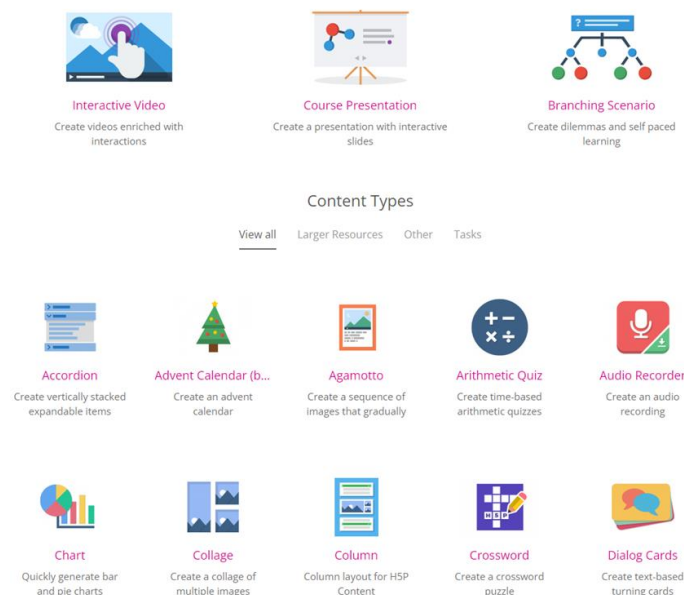


Figure 8: H5P examples (<https://h5p.org/content-types-and-applications>)

Developing the technical concept also determined that a 'light' and a full version of the course would be created as a project output. The 'light' version provides the materials (PDFs, micro-lectures, H5P elements, Excel files, et cetera) on the project homepage so that the materials can be used by all interested persons, universities and professionals. The full version will be for teaching purposes (e.g. in Moodle) and the feedback will be organised in the form of points, for example, holistically. However, this requires an existing LMS, into which the course can be integrated.

To enable a uniform and professional presentation of content in the five modules, the software Vyond (<https://www.vyond.com>) can also be used to create short videos. Vyond is an established software for creating videos and enables a user-friendly presentation of content and different actors, as they are present in the developed overall case.

The collected requirements for the technical concept were then consolidated and summarised in the following result:

- The whole concept described in Whitepaper & Games Online (Light Version) - the actual course is realised in our Learning Management Systems (Full Version)
- H5P as universal gamified Elements + Possibility of Using other Tools (Excel, Web-based Games)
- Powerpoints slides can be used to teach basic information (e.g. first introduction to PSM in I4.0) - If Videos are needed for self-studying, Sound recording only without image recording (less effort)

4. Results

This section describes the results of IO4. First, the developed overall storyline is described in 4.1 and then the concepts of the five modules are presented in 4.2 to 4.6.

4.1. Overall Storyline

As discussed earlier in this paper, an overarching storyline was created to provide a coherent narrative for educators and students navigating through the five modules. It also allows the different module developers from the project partners to relate the teaching materials and associated activities to this narrative, and it allows the students to develop their skills, knowledge, and understanding systematically.

As the start point of the development process, through brainstorming and intra-project member discussions, it was decided to create a fictionalised company with specific characteristics (as shown in Figure 9) that aims to implement several technologies and ways of working associated with Industry 4.0 to allow it to generate competitive advantage within the industry it operates within.

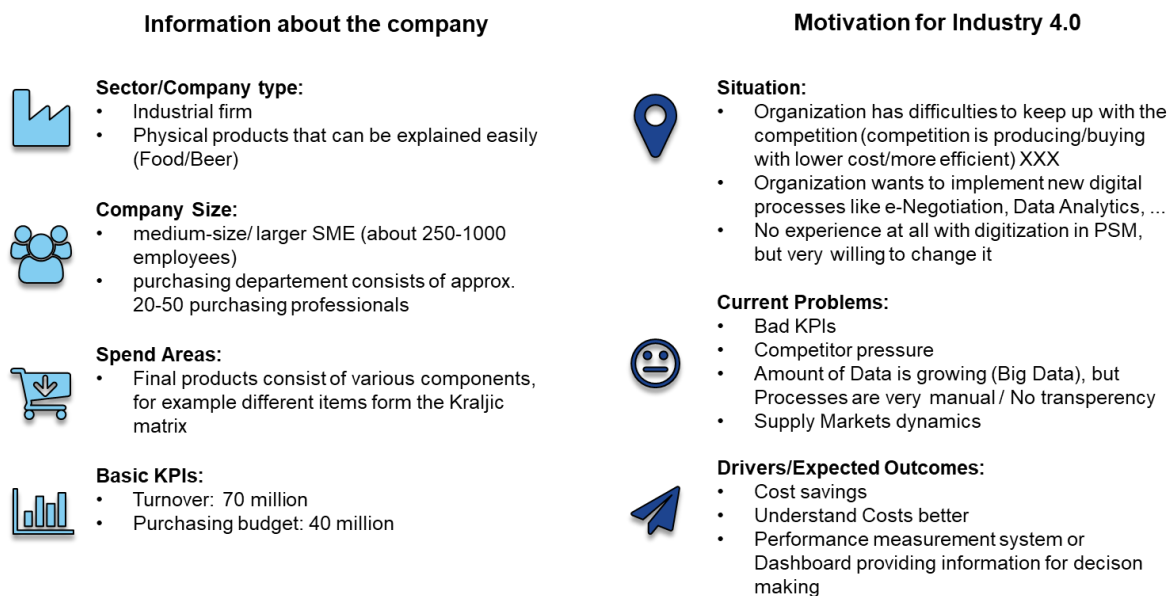


Figure 9: Fictionalised company characteristics

To provide further context, a stakeholder and organisational structure map was created, and these individuals/organisations could then form the basis of a specific focus in the learning materials (Figure 10).

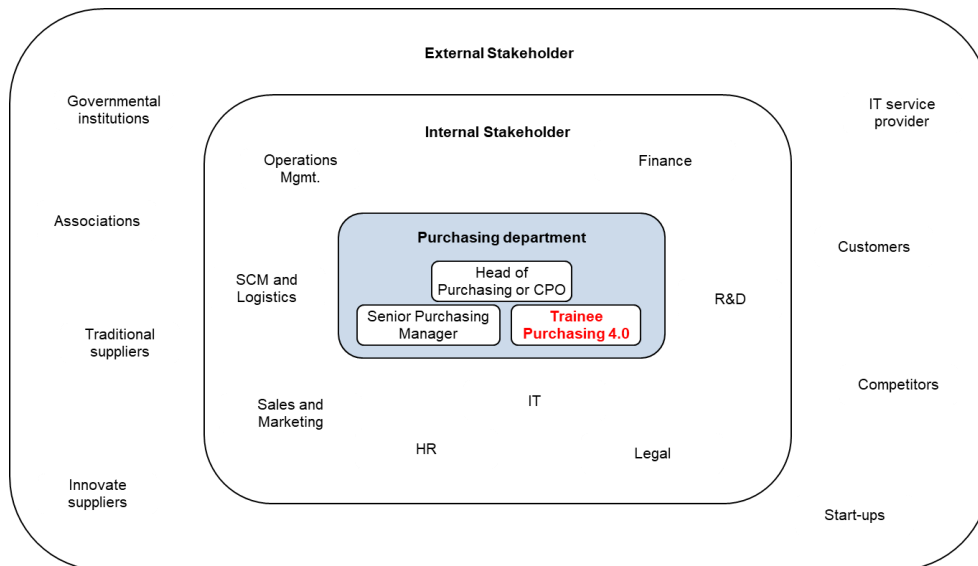


Figure 10: Stakeholder and organisational structure map

Although a wide range of students is expected to find this course helpful, it was decided to base the storyline on an apprentice starter at the company, who needs to complete a designated training programme (i.e. the modules) in order for them to progress. This approach ensures the fundamentals of PSM and how these, and more sophisticated PSM activities, related to Industry 4.0 technologies and practices. The storyline shown below establishes the company's and the market's context, details of the PSM activities and the apprenticeship programme:

A warm welcome from PERSISTCo's senior management to the Purchasing and Supply Management (PSM) apprenticeship training programme, and we wish the student every success on the range of modules the student is going to study. This document provides information and background on the training programme, company, food industry and details of the spend categories that PERSISTCo currently buys.

The apprenticeship training programme

This programme is exciting and critical for the company as we are looking to develop and implement several Industry 4.0 technologies (such as data analytics) to help us compete with companies that are starting to produce goods at lower costs to buy more efficiently. In addition, we have set up a new centralised PSM department to try and improve our key performance indicators, deal with the growth in the amount of data and automate several purchasing related processes. We have recruited employees like the student to support the Head of PSM with our change towards more digitisation in PSM, and this is fully backed and endorsed by senior management.

The training will see the student take modules in the following areas:

Table 6: Modules overview

Module	Title	Description	ECTS
1	Introduction to PSM in an Industry 4.0 environment	Overall digital system and process design and leadership skills	1
2	The foundation for advanced automation in PSM	Using technology to manage ordering and the supplier relationship	1
3	eSourcing activities to select suppliers in I4.0	Selecting and negotiating suppliers, using relevant legal frameworks	1
4	eProcurement to facilitate operative procurement activities in I4.0	Technology informed eProcurement techniques to identify and evaluate suitable suppliers	1
5	Data analytics for Industry 4.0. purchasing	Establishing an organisation's requirements	1

One way to complete the course is to work through modules 1 to 5, one after the other. Another option (which we recommend) is to go through the course according to the scheme shown in Figure 11. The scheme is to be read from left to right. Module 1 on the left is the starting point and the basis for the other modules. In the next step (middle), it is recommended to complete all Basic Levels of Modules 2-4 and then choose either Path 1 or Path 2 first. Thus, if the student chooses Path 1, the student will first specialise in Data Analyst with Expert Levels 2 and 5. Then, on Path 2, the student will specialise in Supplier Onboarding Manager by completing Expert Levels in modules 3 and 4. In the same way, the student can first choose Path 2 and then complete Path 1. Figure 11 displays the flow between the different modules.

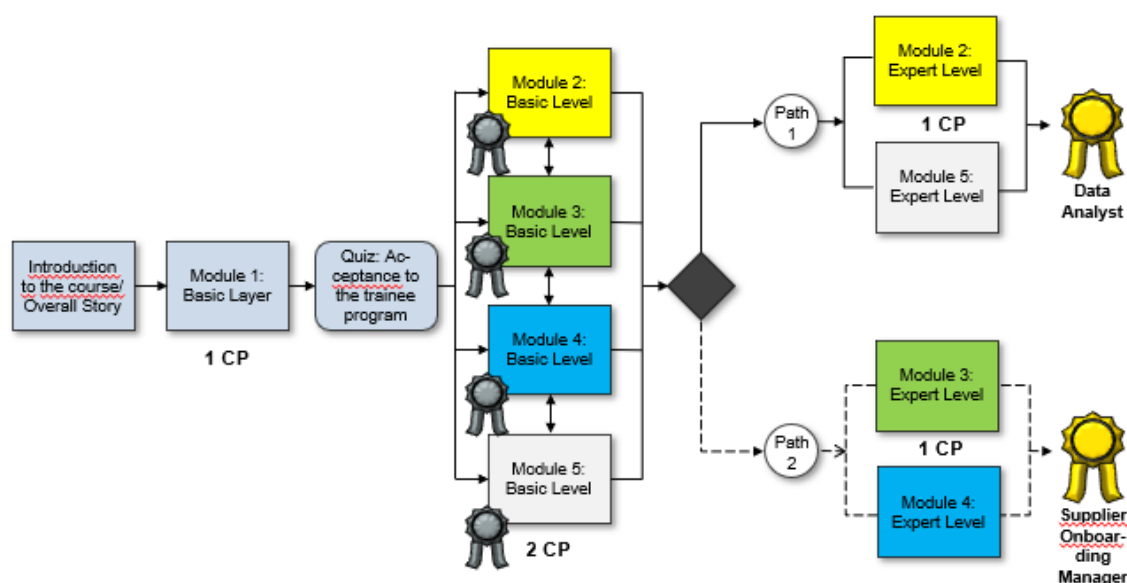


Figure 11: Flow between different modules

Studying these modules will equip the student with the necessary skills and competencies to be a valuable member of the PERSISTCo team and eventually lead to a management position within the PSM department.

PERSISTCo background

We thought it would be helpful to provide the student with some key facts about PERSISTCo before the student starts the programme, and the student can use these to help with the study on the different modules. PERSISTCo supplies a range of different types of bread to large retailers who then sell directly to consumers, and more details are shown in Table 7.

Table 7: PERSISTCo supplies

Company name	PERSISTCo
Sector/Company type	Food production
Location	European based with production operations in 5 countries (Netherlands, Germany, Slovakia, Finland and the United Kingdom)
Company size	500 employees (SME)
Turnover	€70m
Purchasing department	25 employees (managed by a Head of PSM, with a Senior Purchasing Manager, 2 Purchasing Managers, 5 Senior Buyers, 8 Buyers, 4 Assistant Buyer and 4 Purchasing Apprentices)
Purchasing spend	€40m (more details below)

The food industry

The food industry has undergone and will continue to be affected by changes, which can be summarised as below, and PERSISTCo aims to use its new Industry 4.0 tools, processes and ways of working to adapt to these changes:

1. Safety standards in a post-Covid-19 world.
2. Sustainability.
3. Changing habits: The rise of plant-based foods and healthy food/body and increased purchasing food that lasts.
4. The disruption of the just-in-time supply chain model.
5. More significant investments in food manufacturing software.
6. More significant investments in automation.
7. Transparency.

SOURCE: www.unleashedsoftware.com/blog/10-global-food-processing-industry-trends-for-2021

PERSISTCo has also just signed a significant two-year contract with another major food retailer and will need to develop its ways of working to meet the challenges arising from the increased volume of sales this has brought about and to ensure that this contract is renewed after the two years is up.

Supply market

From a supplier perspective, PERSISTCo's external spend can be broken down into the following categories shown in Table 8 (areas of spend):

Table 8: PERSISTCo's areas of spend

Spend category	Spend value (€m)	Number of suppliers
Raw food materials	18	24
Transportation	7	3
Warehousing	3	1
Marketing services (media buying, agency fees)	2	5
Professional services (consultancies, advisors)	1	4
MRO (maintenance, repair and operations)	3	6
Information technology (hardware, software)	2.5	1
HR-related services (recruitment, training)	1	2
Utilities (gas, electricity, water)	2	3
Stationery	0.5	3
Totals	40	52

In addition, this spend has been categorised using Kraljic's matrix, a tool to classify the importance of suppliers' products and services and can be used to highlight supply chain weaknesses, support strategy development and minimise supply disruption.

Further details of the matrix and how it is used can be found at the enclosed link:

www.cips.org/knowledge/procurement-topics-and-skills/supplier-relationship-management/kraljic-matrix/#:~:text=The%20Kraljic%20Matrix%20is%20a,development%20and%20minimise%20supply%20disruption

A recent survey by several PERSISTCo's suppliers revealed dissatisfaction with how they have been dealt with, including late payments and consistently changing supply requirements. It is hoped that the new ways of working should improve these relationships and lead to better outcomes for both PERSISTCo and its supply base.

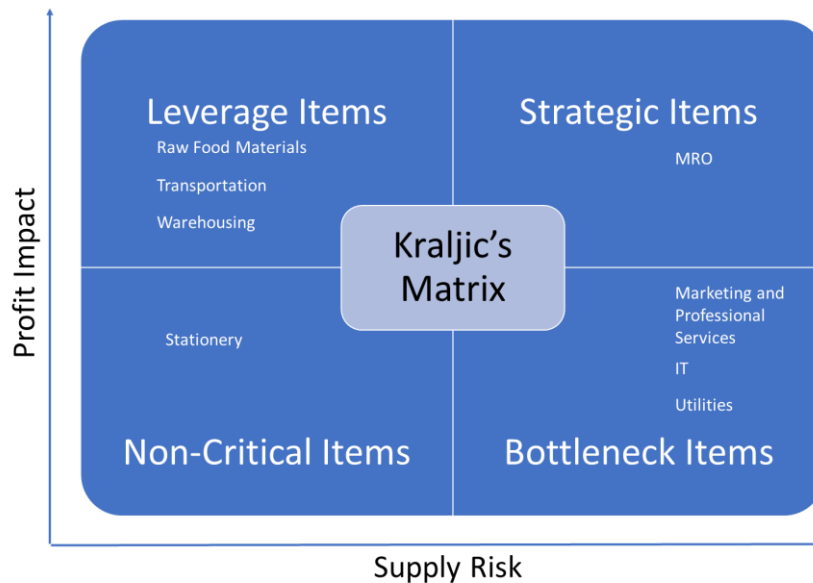


Figure 12: Kraljic's matrix (Kraljic, 1983)

Module 1 - Introduction to PSM in an Industry 4.0 environment

The first training module will prepare the student for the more Industry 4.0 focused ones later in the course. This module is entitled "Introduction and strategic digital leadership" and will cover the following elements to establish some core concepts. These elements will start from fundamentals and do not assume any prior knowledge, but if the student has experience of them, then they will provide a helpful refresher:

1. Introduction to Purchasing and Supply Management, with the learning outcomes:
 - a. Identify the primary role, benefits, processes and aspects of a PSM department
 - b. Understanding the difference between consumer and commercial buying activities
 - c. Explain opportunities and challenges when acting as the interface between internal customer requirements and external supply networks
2. Introduction to Digital Leadership, with the learning outcomes:
 - a. Identify the critical aspects of leadership
 - b. Explain how digital leadership can be used to deliver digital transformation
3. Introduction to Industry 4.0, with the learning outcomes:
 - a. Identify the main technological drivers behind the industrial revolutions
 - b. Understand the impact of past technological revolutions on PSM practices
 - c. Explain opportunities and challenges when adapting to the ongoing technological revolution

So the student can progress onto the following modules and gauge the learning levels. There is a quiz at the end of each element. In addition, there is a short game at the end of element 1, which requires the student to make some critical decisions that are about to be taken in a PSM exercise for PERSISTCo

to identify and then contract with a new supplier for the supply of a critical piece of food packaging equipment.

The individual modules of the course are now discussed in more detail, and these are presented in a consistent and structured format using a module descriptor template approach.

4.2. Module 1: Introduction to PSM in an Industry 4.0 environment (Edge Hill)

Module Aim

Introduce the overall structure and flow of the course provide an introduction to the core concepts of Industry 4.0, Purchasing and Supply Management and Digital Leadership.

Intended learning outcomes

By successful completion of the module, the student will be able to demonstrate:

1. Summarise how the overall structure of the course fits together and the interrelationships between the different modules.
2. Illustrate how the key characteristics of Industry 4.0 affect Purchasing and Supply Management.
3. Explain how digital leadership skills may be used in a Purchasing and Supply Management context.

Content

This module provides the overall storyline for the course, which is based on students working through an apprenticeship training programme at PERSISTCo, a medium-sized food production company. The overall course equips them with the knowledge, skills, and competencies required to develop and implement various Industry 4.0 technologies, processes, and ways of working into the purchasing and supply management function at PERSISTCo. To provide a solid basis for the other modules in the course, the Introduction and Strategic Digital Leadership module also provide students with an understanding of the core concepts used in the course, such as Industry 4.0, purchasing and supply management and digital leadership. The module is divided into the following teaching and learning components:

1. Introduction to the overall course and the module.
2. Purchasing and Supply Management.
3. Industry 4.0.
4. Strategic Digital Leadership.
5. Assessment via an online game.

Gamification elements, learning activities and teaching methods

Each module component had a recorded lecture, and supporting materials were identified. Online multiple choice quizzes (MCQ) will be used to assess learning at the end of every teaching and learning component with an online game to assess purchase decision making at the end of the module to recreate acceptance onto the apprenticeship training programme.

A template summarising module 1 is presented in the appendix in Table 9.

4.3. Module 2: The foundation for advanced automation in PSM (TUDO)

Module Aim

Using technology to manage ordering and the supplier relationship

Intended learning outcomes

By successful completion of the module, the student will be able to:

1. Understand how Industry 4.0 technologies and trends can be used in operational procurement.
2. Apply some simple applications to make use of RPA in operational procurement.
3. Analyse the impact Industry 4.0 will have on traditional operational procurement.

Content (description of the situation)

Game 1: Basic - I4.0 technologies for operational procurement

- Show the process steps in operational procurement.
- Present different Industry 4.0 technologies that could influence these process steps (e.g. AI, BCT, 5G, Cloud Computing, Additive Manufacturing)
- Task/game: Assignment of the technologies to the individual process steps + explanation of why these are suitable.

Game 2: Using E-Procurement Technologies & Platforms for faster & cheaper ordering of small products

- Demonstrate the added value of e-procurement solutions by showing the process of ordering simple products.
- Understanding for Product costs and Process costs
- Advantages of E-procurement solutions like E-Ordering (Sell-Side/ E-shop, Catalog-based marketplace/ intermediary, Buy-Side/ Desktop purchasing)

Game 3: Mini Case Study - Usage of RPA in operative Procurement

- Introduction to RPA (Interactive Content)

- Empowerment for Implementation (Interactive Content)
- RPA in operational Procurement (Interactive Content)
- Mini Case Study: Implementation of an RPA for PERSISTCo (e.g. Excel Makro)

Gamification elements, learning activities and teaching methods

- Interactive Content, like Interactive Book
- Excel Makro to demonstrate how RPA can support the automation of operational processes

A template summarising module 2 is presented in the appendix in Table 10.

4.4. Module 3: eSourcing activities to select suppliers in I4.0 (UT)

Module Aim

Selecting and negotiating with suppliers, using relevant legal frameworks and I4.0 technologies

Intended learning outcomes

By successful completion of the module, the student will be able to:

1. Understand the concept of a supply network, which is transparently shaped by Industry 4.0 technologies
2. Understand simple contract management tasks at the buyer-supplier interface
3. Apply some simple applications to make use of digital negotiation

Therefore, module 3 will focus on the following three skills which have been identified within IO3 of the PERSIST project:

- **"Supply Network Management skills** in purchasing relate to a coherent and integrated understanding of the vertical and horizontal supply chain of goods and services, which allows management of the supply chain from economic, social, and environmental perspectives."
- **"Digital Contract Management and Legal skills** to implement legislative and other legal requirements into automated purchasing processes, utilising, for example, blockchain technology and smart contracts to create and maintain transparency in the supply chain."
- **"Digital Negotiation skills** include negotiating within a digital environment, e.g., E-Sourcing technologies and auctions, where Industry 4.0 negotiation focuses on machine negotiation and digital market places."

Content (description of the situation)

1. Micro lecture 1 – Concept supply network

- a. The module starts with a micro lecture addressing the concept of the supply network, where the case company will be used as an example. The micro lecture is provided as a short recorded video. The importance of supply network management will be addressed within the micro lecture and various supply network structures described. As for reading material, a PDF addressing the lecture content is provided. Further, the case study is introduced as a realistic example using the Vyond software.
 - b. Next, the purchasing task to select two suitable suppliers for two commodities will be introduced. The student will be guided through a supplier selection process for (two) different commodities. This process will follow a logical tree. The first decision is based on introducing three different suppliers (short case introduction), and the student needs to select the most suitable supplier. Based on the selected supplier, new decisions will be available.
2. Micro lecture 2 – Different supplier-buyer interfaces
 - a. After selecting suppliers, a second micro lecture introduces different supplier-buyer interfaces. Here, the student learns how different relationships are formed based on the different commodities. The short video ends with a transition to the addressed case. As for reading material, a PDF addressing the lecture content is provided.
 - b. Next, the student will be guided through a decision tree, where the students need to select the suitable technological interfaces for the two suppliers. These interfaces also connect to the type of contract used for the specific supplier.
3. Micro lecture 3 – Digital negotiation
 - a. Different digital negotiation techniques will be introduced. Applying the different negotiation approaches depends on the characterises of the sourced product and involved supplier. Possible approaches are introduced using a micro lecture and listed within a provided PDF document. Further, the case example is used to illustrate a realistic negotiation situation.
 - b. Next, the student will negotiate the prices with the two selected suppliers for the different commodities. Here, the negotiation will be based on the previously defined prices of each supplier. The aim is to simulate an actual negotiation situation using digital technologies.
4. Multiple choice quiz:
 - a. At the end of module three, the student will take a multiple-choice quiz based on the three micro-lectures described above (e.g., 3x7 questions).

Gamification elements, learning activities and teaching methods

- h5p branching scenario
- Multiple choice quiz
- Reading materials provided as PDF
- Recorded micro-lecture videos
- Realistic illustration using video (Vyond) to introduce the case example

A template summarising module 3 is presented in the appendix in Table 11.

4.5. Module 4: eProcurement to facilitate operative procurement activities in I4.0 (LUT)

Module Aim

Make strategic decisions about purchasing orders based on the internal demand of raw materials and inventory management data set.

Intended learning outcomes

By successful completion of the module, the student will be able to demonstrate:

1. Analysing internal demand data for different products
2. Evaluating order schedule and order size that is cost-effective and serve well
3. Create strategies for inventory management and compare them
4. Explain how a simple automated inventory management algorithm could work

Content (description of the situation)

The trainee is receiving the task of planning purchasing order strategy for four products. The production department has stated the estimated demand for those raw materials next year. The trainee is asked to set the proper order size, schedule, et cetera. The company is planning automated orders, and trainees are asked to plan how the automated orders could work logically. For instance, which conditions (inventory level, timing) are order inputs.

Gamification elements, learning activities and teaching methods

Gamification elements consist of three elements. Story description (video or written material in which the situation is described). The data set is given beforehand for analysis. If needed, analysis tools could be shown (skill levels and tools vary, but students can choose what they prefer). Furthermore, when students choose their strategy for each product, they get simulation results to which outcomes their strategy could lead (HP5 quiz with outcome graphs). The expert level is writing a report and analysing data (graphs, perhaps simulation of inventory levels).

A template summarising module 4 is presented in the appendix in Table 12.

4.6. Module 5: Data analytics for Industry 4.0. purchasing (EUBA)

Module Aim

This module aims to improve the decision-making of purchasing managers and stimulate procurement processes innovation uptake. Managers should improve their skills and competencies in understanding the digitalisation of procurement processes in two dimensions:

1. Data-driven decision making
2. Automatisisation of procurement-related decision making.

Managers will increase their awareness of different types of data used for data-driven decision making, its potential, risks, and circumstances in the following domains:

1. Market information,
2. Supplier performance analysis,
3. Data-driven E-negotiation efficiency management
4. Data-driven procurement efficiency validation and reporting (use of data for KPI)

Data analytics skills will be focused on:

1. Data understanding,
2. Data processing,
3. Data transformation,
4. Data visualisation

Intended learning outcomes

By successful completion of the module, the student will be able to demonstrate:

1. Identify suitable indicators and alerts for data-driven procurement making
2. Suitable dashboard proposition for the procurement department
3. Visualisation of procurement performance results
4. Data application for decision making to improve performance efficiency and reduce suppliers' behavioural risks a market risk
5. Setting rules for automatisisation of procurement processes

Content (description of the situation)

The module has two parts the primary level and the advanced level. The basic level lecture should cover topics like understanding procurement data and how to acquire them, quality and standardisation of procurement data, creation of various procurement reports, and automatisisation. The advanced level lecture deals with anomalies and mistakes in procurement data, recommending and alerting systems in procurement, cartels, and unfair practices. Tutorials will enhance every lecture with practical exercises.

Gamification elements, learning activities and teaching methods

The gamification element should be based on competition between students. Students will search for settings with the most significant savings based on historical data. From an extensive historical database of auctions and tenders, students will use filters in excel to find settings that will provide the

highest possible average savings. A template summarising module 5 is presented in the appendix in Table 13.

5. Discussion:

5.1. Contribution to existing PSM courses and curricula at universities

One of the starting points of this research project is the inadequate preparation of students in PSM for successfully operating in the Industry 4.0 environment. The earlier IOs of this project identified relevant Industry 4.0 PSM skills, through a literature review and empirically collected in World Cafés and a Delphi study and these were consolidated into five modules in a harmonised manner. The formulation of the headings of the five modules (see Figure 13), and the more detailed description of the respective concepts in section 4 and the appendix, enables PSM educators to match their course offerings with those generated from the project outputs. The modular structure of the course has been chosen to enable educators to select individual modules to add missing components to an existing course, although the authors' recommendation is to complete the entire course according to the scheme in Figure 11.

In addition to presenting relevant content for PSM in Industry 4.0, this content is also designed according to innovative didactic concepts, namely gamification. The concepts developed contain different gamification elements so that the students can be engaged through varied practice-focused tasks. The design of the concepts of the five modules is consistently oriented towards solutions that many universities can use after completing the project. A light version and a full version will be made available for this purpose. In the light version, each material created (micro lecture, H5P element etc.) can be viewed and played through the browser separately. In the full version, linking of the individual modules and H5P elements is planned, in which continuous feedback points can be collected. However, the prerequisite for the full version is the existence of an LMS (e.g. Moodle, Canvas, et cetera). Since every university should have an LMS, this is not a significant hurdle for interested educators.

Module 1: Introduction to PSM in an Industry 4.0 environment <u>Description:</u> Overall digital system and process design and leadership skills <u>Skills:</u> Strategic Management (PSM and I4.0), Digital Leadership
Module 2: The foundation for advanced automation in PSM <u>Description:</u> Using technology to manage ordering and the supplier relationship <u>Skills:</u> Data Management (master data), Robotic Process Automation, Digital Partnership Management
Module 3: eSourcing activities to select suppliers in I4.0 <u>Description:</u> Selecting and negotiating with suppliers, using relevant legal frameworks <u>Skills:</u> Supply Network Management, Digital Negotiation, Digital Contract Management and Legal,
Module 4: eProcurement to facilitate operative procurement activities in I4.0 <u>Description:</u> Establishing an organisation's requirements <u>Skills:</u> Data Analytics, Robotic Process Automation, eProcurement Technology
Module 5: Data analytics for Industry 4.0. purchasing <u>Description:</u> Technology informed eProcurement techniques to identify and evaluate suitable suppliers <u>Skills:</u> Data Analytics, eSourcing evaluation, eProcurement evaluation Technology, towards AI

Figure 13: Overview of developed modules

5.2. Contribution to PSM employees to enable them to operate successfully in an Industry 4.0 environment

The contribution of the PERSIST project is also relevant for PSM employees who are already working in practice and future practitioners as engagement with the materials will better prepare them for the upcoming challenges in PSM in the era of Industry 4.0. The input from the empirically-based findings of this project (especially the Delphi study in IO3) clearly shows that those skills identified by experts as being relevant have only been represented to a limited extent in existing training programs. Therefore, enhanced levels of knowledge and understanding should be developed through the implementation of and participation in the developed modules.

The developed course has a total scope of 5 ECTS and an effort of one ECTS per module, which can also be completed around working commitments and this should make the course attractive to a broad target group. This effort should not be an obstacle, but rather the content is presented in a concentrated way, and the skills are developed in an application-oriented manner with the help of the H5P elements.

The advantages of digital learning formats combined with gamification elements can also be an interesting example for training programs in practice. Participants can complete the course at their pace, motivation is usually very high due to direct feedback and from participants experiencing success, and the micro-lectures and mini-games mean that the time required is much less compared to seminars lasting several days.

5.3. Limitations and future research

This section describes the limitations of the IO4, specifically in addressing the identified skills and challenges of developing H5P elements. Although an attempt was made to cover all identified and

relevant skills, the effectiveness of the five modules will be shown by the first validations planned for the near future and, adjustments may be necessary. In addition, the level of detail of the content in the five modules is limited to 1 ECTS each, so the topics can, of course, only be introduced and exemplary applications presented. Of course, it should be noted that there are entire qualifications based solely on subjects such as data and data analytics.

The development of the H5P elements was initially a challenge for the project team, as there was little experience with them at the beginning. However, this hurdle was quickly overcome, and the first H5P elements were successfully implemented, and all project partners were able to access them. Another challenge is using the H5P elements. An LMS must be available to the user (usually for universities and students) so the decision was taken to also offer a light version. In this version, the individual elements (micro-lectures, games, etc) can be used on an individual basis to gain subject-specific knowledge and understanding, but the context and the coordinated feedback in the form of points can only be realised in an LMS.

As soon as the modules have been developed in a first draft, the first evaluations with students will show how effective the modules are and whether the expected goals are achieved through gamification elements. These evaluations will cover how comprehensibly the content is presented, whether the students can complete the course independently (sufficient guidance) and how the developed gamification elements (e.g. H5P) influence the students' motivation. Furthermore, it would be interesting to prepare a central skill (e.g. data analytics) in a single course with, e.g. 5 ECTS in a higher level of detail and use gamification elements.

6. Next steps within the PERSIST Erasmus+ project

IO5 of the PERSIST project will primarily focus on the operationalisation and implementation of the five designed modules. For this purpose, the content will be prepared, micro-lectures recorded, H5P elements developed and further applications implemented (for example, with Excel macro tools or simulations in Python). Once the first versions of the modules are available, they will be tested extensively with several student groups at several universities, and particular emphasis will be given to student feedback.

Finally, the developed materials in the form of the light version will be made available on the project PERSIST homepage and a full version (also available on the PERSIST project homepage, but the elements have to be imported into an existing LMS). During the upcoming activities, feedback from PSM educators will also be collected to inform the IO5 activities.

Acknowledgements

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Appendix

Template Module 1

Table 9: Template Module 1

1	Module title	Introduction to PSM in an Industry 4.0 environment
2	ECTS credits	1
3	Class contact time: 6 hours	
4	Independent study time: 18 hours	Total Hours: 24 hours
5	Module coordinator	Dr Steve Kelly & Dr Peter Vangorp
6	<p>Module Aim</p> <p>Introduce the overall structure and flow of the course provide an introduction to the core concepts of Industry 4.0, Purchasing and Supply Management and Digital Leadership.</p> <p>Intended learning outcomes</p> <p><i>By successful completion of the module, the student will be able to demonstrate:</i></p> <ol style="list-style-type: none"> <i>1. Summarise how the overall structure of the course fits together and the interrelationships between the different modules.</i> <i>2. Illustrate how the key characteristics of Industry 4.0 affect Purchasing and Supply Management.</i> <i>3. Explain how digital leadership skills may be used in a Purchasing and Supply Management context.</i> 	
7	<p>Content</p> <p>This module provides the overall storyline for the course, which is based on students working through an apprenticeship training programme at PERSISTCo, a medium-sized food production company. The overall course equips them with the knowledge, skills, and competencies required to develop and implement various Industry 4.0 technologies, processes, and ways of working into the purchasing and supply management function at PERSISTCo. To provide a solid basis for the other modules in the course, the Introduction and Strategic Digital Leadership module also provide students with an understanding of the core concepts used in the course, such as Industry 4.0, purchasing and supply management and digital leadership. The module is divided into the following teaching and learning components:</p> <ol style="list-style-type: none"> 1. Introduction to the overall course and the module. 2. Purchasing and Supply Management. 3. Industry 4.0. 4. Strategic Digital Leadership. 5. Assessment via an online game. 	

8	<p>Gamification elements, learning activities and teaching methods</p> <p>Each module component had a recorded lecture, and supporting materials are identified in section 11 of this module descriptor.</p> <p>Online multiple choice quizzes (MCQ) will be used to assess learning at the end of every teaching and learning component with an online game to assess purchase decision making at the end of the module to recreate acceptance onto the apprenticeship training programme.</p>			
9	Assessment (may use multiple assessments)			
	Form of Assessment	% weighting of module	Size of the assessment	ILOs assessed
	MCQ1	25	5 questions	2
	MCQ2	25	5 questions	3
	MCQ3	25	5 questions	2
	Online game	25	1 hour	All
10	<p>Feedback to students:</p> <p>Via correct response to MCQs and additional reading material for response to the online game.</p>			
11	<p>Learning resources & key texts</p> <p><u>Introduction to Purchasing and Supply Management</u></p> <p>Arjan van Weele College Tour Purchasing videos:</p> <p>Introduction to Purchasing: https://www.youtube.com/watch?v=eB_1Z6oC5ZU</p> <p>Purchasing Process Management: https://www.youtube.com/watch?v=2fbGHsnZaBw</p> <p>Chartered Institute of Procurement and Supply (CIPS) for a wide variety of helpful information: https://www.cips.org/</p> <p>Introductory Chapter: Purchasing and Supply Management https://www.intechopen.com/chapters/66342</p> <p>Project PERFECT Purchasing and Supply Management (PSM) Fundamentals MOOC: https://www.oncampus.de/weiterbildung/mooc/perfect?lang=en</p> <p>Why purchasing must become supply management: https://hbr.org/1983/09/purchasing-must-become-supply-management</p> <p><u>Introduction to Digital Leadership</u></p> <p>What is leadership: https://www.mindtools.com/pages/article/newLDR_41.htm</p> <p>What is leadership, and who is a leader: https://www.chieflearningofficer.com/2020/01/06/what-is-leadership-and-who-is-a-leader/</p>			

	<p>Kane, G., Phillips, A.N., Copulsky, J. & Andrus, G. (2019) "How Digital Leadership Is(n't) Different. MIT Sloan Management Review.</p> <p>https://sloanreview.mit.edu/article/how-digital-leadership-isnt-different/</p> <p>Leadership in the Digital Realm: What Are the Main Challenges?</p> <p>https://www.intechopen.com/chapters/69892</p> <p><u>Industry 4.0</u></p> <p>The Fundamentals And Impact Of Industry 4.0:</p> <p>https://www.forbes.com/sites/forbesbusinesscouncil/2020/07/24/the-fundamentals-and-impact-of-industry-40/?sh=e0344c01a331</p> <p>What is Industry 4.0—the Industrial Internet of Things (IIoT)?</p> <p>https://www.epicor.com/en-uk/resource-center/articles/what-is-industry-4-0/</p> <p>Industry 4.0:</p> <p>https://www.twi-global.com/what-we-do/research-and-technology/technologies/industry-4-0</p> <p>Procurement 4.0: Are you ready for the digital revolution?</p> <p>https://www.strategyand.pwc.com/gx/en/insights/procurement-4-digital-revolution.html</p> <p>Industry 4.0 for Procurement:</p> <p>https://www.cips.org/knowledge/procurement-topics-and-skills/procurement-technology/industry-40-for-procurement/</p> <p>Procurement And Industry 4.0:</p> <p>https://www.forbes.com/sites/forbestechcouncil/2021/03/08/procurement-and-industry-40/?sh=50656c9061ba</p> <p>Industry 4.0 and Procurement 4.0:</p> <p>https://link.springer.com/chapter/10.1007/978-3-030-35979-9_2</p>
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Template Module 2

Table 10: Template Module 2

1	Module title	The foundation for advanced automation in PSM
2	ECTS credits	1
3	Class contact time	Total Hours: 6
4	Independent study time	Total Hours: 18
5	Module coordinator	Dennis Meyer, Florian Paffrath, Michael Henke
6	<p>Module Aim</p> <p><i>Using technology to manage ordering and the supplier relationship</i></p> <p>Intended learning outcomes</p> <p><i>By successful completion of the module, the student will be able to:</i></p> <ol style="list-style-type: none"> <i>1. Understand how Industry 4.0 technologies and trends can be used in operational procurement.</i> <i>2. Apply some simple applications to use RPA in operational procurement.</i> <i>3. Analyse the impact Industry 4.0 will have on traditional operational procurement.</i> 	
7	<p>Content (description of the situation)</p> <p><i>Game 1: Basic - I4.0 technologies for operational procurement</i></p> <ul style="list-style-type: none"> • Show the process steps in operational procurement. • Present different Industry 4.0 technologies that could influence these process steps (e.g. AI, BCT, 5G, Cloud Computing, Additive Manufacturing) • Task/game: Assignment of the technologies to the individual process steps + explanation of why these are suitable. <p><i>Game 2: Using E-Procurement Technologies & Platforms for faster & cheaper ordering of small products</i></p> <ul style="list-style-type: none"> • Demonstrate the added value of e-procurement solutions by showing the process of ordering simple products. • Understanding for Product costs and Process costs • Advantages of E-procurement solutions like E-Ordering (Sell-Side/ E-shop, Catalog-based marketplace/ intermediary, Buy-Side/ Desktop purchasing) <p><i>Game 3: Mini Case Study - Usage of RPA in operative Procurement</i></p> <ul style="list-style-type: none"> • Introduction to RPA (Interactive Content) • Empowerment for Implementation (Interactive Content) 	

	<ul style="list-style-type: none"> • RPA in operational Procurement (Interactive Content) • Mini Case Study: Implementation of an RPA for PERSISTCo (e.g. Excel Makro) 			
8	Gamification elements, learning activities and teaching methods <ul style="list-style-type: none"> • Interactive Content, like Interactive Book • Excel Makro to demonstrate how RPA can support the automation of operational processes 			
9	Assessment (may use multiple assessments)			
	Form of Assessment	% weighting of module	Size of the assessment	ILOs assessed
	Game 1	33,33	Tbd.	
	Game 2	33,33	Tbd.	
	Game 3	33,33	Tbd.	
10	Feedback to students The students get feedback on their work with the H5P elements.			
11	Learning resources & key texts <ul style="list-style-type: none"> • TRIPATHI 2018, p. 9f. • Brettschneider, 2020, p.1097, p. 1105 • Devarajan, 2018, p. 12 • Koch & Fedtke, 2020, p. 88 • Axmann & Harmonko, 2020, p. 559 			

Template Module 3

Table 11: Template Module 3

1	Module title	eSourcing activities to select suppliers in I4.0
2	ECTS credits	1
3	Class contact time: total hours	Total Hours: 6
4	Independent study time: total hours	Total Hours: 18
5	Module coordinator	Vincent Delke, Holger Schiele, Klaas Stek
6	<p>Module Aim - Selecting and negotiating with suppliers, using relevant legal frameworks and I4.0 technologies</p> <p>Intended learning outcomes</p> <p><i>By successful completion of the module, the student will be able to:</i></p> <ol style="list-style-type: none"> 4. Understand the concept of a supply network, which is transparently shaped by Industry 4.0 technologies 5. Apply some simple applications to make use of RPA in operational procurement. 6. Analyse the impact Industry 4.0 will have on traditional operational procurement. <p><i>By successful completion of the module, the student will be able to demonstrate:</i></p> <ul style="list-style-type: none"> • Supply Network Management skills • Digital Contract Management and Legal skills • Digital Negotiation skills 	
7	<p>Content (description of the situation)</p> <p>The module is divided into three parts (here addressed as micro-lectures 1-3) and one multiple-choice quiz to test the learning outcome. The three main parts will be organised similarly. First, each part starts with a short micro lecture addressing the content and reading material provided as PDF. Second, a short video using the Vyond software will introduce the case example. Here, a link between the case and the content of the micro lecture is central. Third, the student will apply the knowledge gained within a gamification element as the branching scenario and negotiation.</p>	
8	<p>Gamification elements, learning activities and teaching methods</p> <ul style="list-style-type: none"> • h5p branching scenario • Multiple choice quiz • Reading materials provided as PDF • Recorded micro-lecture videos • Realistic illustration using video (Vyond) to introduce the case example 	
9	Assessment (may use multiple assessments)	

	Form of Assessment	% weighting of module	Size of the assessment	ILOs assessed
	Multiple-Choice quiz	100	21 questions	1-3
10	<p>Feedback to students</p> <p>Feedback is provided within the gamification elements. Here, correct choices will be indicated within the branching scenario and quiz.</p>			
11	<p>Learning resources & key texts</p> <p>Tbd.</p>			

Template Module 4

Table 12: Template Module 4

1	Module title	eProcurement to facilitate operative procurement activities in I4.0		
2	ECTS credits	1		
3	Class contact time: total hours	Total Hours:		
4	Independent study time: total hours	Total Hours:		
5	Module coordinator	LUT University/Elina Karttunen		
6	Module Aim Make strategic decisions about purchasing orders based on raw materials' internal demand and inventory management data set.			
	Intended learning outcomes <i>By successful completion of the module, the student will be able to demonstrate:</i> <i>1. Analysing internal demand data for different products</i> <i>2. Evaluating order schedule and order size that is cost-effective and serve well</i> <i>3. Create strategies for inventory management and compare them</i> <i>4. Explain how a simple automated inventory management algorithm could work</i>			
7	Content (description of the situation) A trainee is receiving the task of planning purchasing order strategy for four products. The production department has estimated demand for those raw materials for next year. The trainee is asked to set the proper order size, schedule, et cetera. The company is planning automated orders, and trainees are asked to plan how the automated orders could work logically. For instance, which conditions (inventory level, timing) are order inputs.			
8	Gamification elements, learning activities and teaching methods Gamification elements consist of three elements. Story description (video or written material in which the situation is described). The data set is given beforehand for analysis. If needed, analysis tools could be shown (skill levels vary and tools, but students can choose what they prefer). Furthermore, when students choose their strategy for each product, they get simulation results to which outcomes their strategy could lead (HP5 quiz with outcome graphs). The expert level is writing a report and analysing data (graphs, perhaps simulation of inventory levels).			
9	Assessment (may use multiple assessments)			
	Form of Assessment	% weighting of module	Size of the assessment	ILOs assessed

	Quiz	50	Preparing for it 10 h + quiz 1h	1, 2, 4
	Expert analysis report	50	15h	3
10	<p>Feedback to students</p> <p>The quiz will include instant feedback about choices. Each report gets written brief feedback from the teacher; the assessment is (Approved/Fail).</p>			
11	<p>Learning resources & key texts</p> <ul style="list-style-type: none"> • Spreadsheets (minimum), statistical software (advanced level), access to students • Pulungan, Reza & Nugroho, Pulung & Maidah, Nova & Atmojo, Tri & Hardo, Putut & Pawenang, Panggih. (2013). Design of An Intelligent Warehouse Management System. (Obligatory) • Acar D, Gal G, Öztürk MS, Usul H. A Case Study in the Implementation of a Continuous Monitoring System. <i>Journal of Emerging Technologies in Accounting</i>. 2021;18(1):17-25. doi:10.2308/JETA-17-04-29-9 (Advanced-Expert –optional) • Devon K. Barrow, Nikolaos Kourentzes. Distributions of forecasting errors of forecast combinations: Implications for inventory management, <i>International Journal of Production Economics</i>, Volume 177,2016, Pages 24-33, https://doi.org/10.1016/j.ijpe.2016.03.017. 			

Template Module 5

Table 13: Template Module 5

1	Module title	Data analytics for industry 4.0. purchasing
2	ECTS credits	1
3	Class contact time: 6	
4	Independent study time: 18	Total Hours: 24
5	Module coordinator	EUBA, Michal Tkáč
6	<p>Module Aim</p> <p>To improve the decision making of purchasing managers and stimulate procurement processes innovation uptake. Managers should improve their skills and competencies in understanding the digitalisation of procurement processes in two dimensions:</p> <ol style="list-style-type: none"> 1. Data-driven decision making 2. Automatisisation of procurement-related decision making. <p>Managers will increase their awareness of different types of data used for data-driven decision making, its potential, risks, and circumstances in the following domains:</p> <ol style="list-style-type: none"> 1. Market information, 2. Supplier performance analysis, 3. Data-driven E-negotiation efficiency management 4. Data-driven procurement efficiency validation and reporting (use of data for KPI) <p>Data analytics skills will be focused on:</p> <ol style="list-style-type: none"> 1. Data understanding, 2. Data processing, 3. Data transformation, 4. Data visualisation 	
	<p>Intended learning outcomes</p> <p><i>By successful completion of the module, the student will be able to demonstrate:</i></p> <ol style="list-style-type: none"> 1. Identify suitable indicators and alerts for data-driven procurement making 2. Suitable dashboard proposition for the procurement department 3. Visualisation of procurement performance results 4. Data application for decision making to improve performance efficiency and reduce suppliers' behavioural risks a market risk 5. Setting rules for automatisisation of procurement processes 	
7	Content (description of the situation)	

	<p>Basic:</p> <p>Lecture 90 min</p> <ol style="list-style-type: none"> 1. Understanding of procurement data and how to acquire them 2. Quality and standardisation of procurement data 3. Creation of various procurement reports and automatisisation <p>Tutorial 90 min</p> <ol style="list-style-type: none"> 4. Explanation of the game and rules 5. Practical exercises of concepts presented in the lecture <p>Advanced:</p> <p>Lecture 90 min</p> <ol style="list-style-type: none"> 1. Anomalies and mistakes in procurement data 2. Recommending and Alert systems in procurement 3. Cartels and unfair practices <p>Tutorial 90 min</p> <ol style="list-style-type: none"> 4. Evaluation of the results of the game 5. Creation of automated rules 6. Lessons Learned 			
8	<p>Gamification elements, learning activities and teaching methods</p> <p>The gamification element should be based on competition between students. Students will search for settings with the most significant savings based on historical data. From the extensive historical database of auctions and tenders, students will use filters in excel to find settings that will provide the highest possible average savings.</p>			
9	Assessment (may use multiple assessments)			
	Form of Assessment	% weighting of module	Size of the assessment	ILOs assessed
	Quiz	50%	(10 hours preparation) 20 minutes	1,2,3
	Assignments	50%	8 hours	4,5
10	<p>Feedback to students</p> <p>Students will get instant feedback regarding their answers to quiz questions. Students will get points based on their work on assignments, and they will be able to compare results between them</p>			

11	<p>Learning resources & key texts:</p> <ul style="list-style-type: none"> • Spreadsheets (minimum), statistical software (advanced level), access to students • Handfield, R., Jeong, S., & Choi, T. (2019). Emerging procurement technology: data analytics and cognitive analytics. <i>International journal of physical distribution & logistics management</i>. • Nguyen, T., Li, Z. H. O. U., Spiegler, V., Ieromonachou, P., & Lin, Y. (2018). Big data analytics in supply chain management: A state-of-the-art literature review. <i>Computers & Operations Research</i>, 98, 254-264. • Hallikas, J., Immonen, M., & Brax, S. (2021). Digitalizing procurement: the impact of data analytics on supply chain performance. <i>Supply Chain Management: An International Journal</i>. • Dráb, R., Štofa, T., & Delina, R. (2020). Analysis of the efficiency of electronic reverse auction settings: big data evidence. <i>Electronic Commerce Research</i>, 1-24. • Rahimi, I., Gandomi, A. H., Fong, S. J., & Ülkü, M. A. (Eds.). (2020). <i>Big Data Analytics in Supply Chain Management: Theory and Applications</i>. CRC Press. • Baily, P., Farmer, D., & Jessop, D. (2020). <i>Procurement Principles and Management in the Digital Age 12e</i> Pearson Education. • Jelassi, T., & Martínez-López, F. J. (2020). <i>Strategies for E-Business: Concepts and Cases on Value Creation and Digital Business Transformation</i>. Springer Nature.
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References

- Aissaoui, N., Haouari, M., & Hassini, E. (2007). Supplier selection and order lot sizing modeling: A review. *Computers & operations research*, 34(12), 3516-3540.
- Al-Towirgi, R., Daghestani, L., & Ibrahim, L. (2018). Increasing students engagement in data structure course using gamification. *International Journal of e-Education, e-Business, e-Management and e-Learning Increasing*, 8(4), 193-211.
- Antonaci, A., Klemke, R., Kreijns, K., & Specht, M. (2018). Get Gamification of MOOC right! *International Journal of Serious Games*, 5(3), 61-78.
- Bäckstrand, J., Suurmond, R., van Raaij, E., & Chen, C. (2019). Purchasing process models: Inspiration for teaching purchasing and supply management. *Journal of Purchasing and Supply Management*, 25(5), 100577-undefined. doi:10.1016/j.pursup.2019.100577
- Bakar, N. F. A., Yusof, A. F., Iahad, N. A., & Ahmad, N. (2017). *Framework for embedding gamification in Massive Open Online Course (MOOC)*. Paper presented at the 2017 International Conference on Research and Innovation in Information Systems (ICRIIS).
- Begosso, L. R., Begosso, L. C., da Cunha, D. S., Pinto, J. V., Lemos, L., & Nunes, M. (2018). *The Use of Gamification for Teaching Algorithms*. Paper presented at the FedCSIS (Communication Papers).
- Bernik, A., Radošević, D., & Bubaš, G. (2017). *Introducing gamification into e-learning university courses*. Paper presented at the 2017 40th International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO).
- de Armas, C. d. A., Vizcarra, I. G. G., Dantas, D. L., Kofuji, S. T., & Seabra, A. C. (2019). *Analysis of Gamification Elements in the Virtual Learning Environment Context*. Paper presented at the 2019 IEEE World Conference on Engineering Education (EDUNINE).
- de Oliveira, L. C., Cavalli, V. T., Dias, Á. M., & de Oliveira, M. A. (2018). Gamification for online training of court professionals in a Labour Court in São Paulo, Brazil (TRT-2): what can be implemented in Moodle 2.5. *EccoS Revista Científica*(46), 171-190.
- Hasan, H. F., Nat, M., & Vanduhe, V. Z. (2019). Gamified collaborative environment in Moodle. *IEEE Access*, 7, 89833-89844.
- Jen, L., & Said, S. (2018). Application of gamification in introduction to programming: A case study. *PEOPLE: International Journal of Social Sciences*, 4(3).
- Johnsen, T. E., Howard, M., & Miemczyk, J. (2014). *Purchasing and supply chain management: A sustainability perspective*: Routledge.
- Katsigiannakis, E., & Karagiannidis, C. (2017). Gamification and game mechanics-based e-learning: a moodle implementation and its effect on user engagement. In *Research on e-Learning and ICT in Education* (pp. 147-159): Springer.
- Khalil, M., Wong, J., de Koning, B., Ebner, M., & Paas, F. (2018). *Gamification in MOOCs: A Review of the State of the Art*. Paper presented at the 2018 IEEE global engineering education conference (educon).

- Kraljic, P. (1983). Purchasing must become supply management. *Harvard business review*, 61(5), 109-117.
- Monczka, R. M., Handfield, R. B., Giunipero, L. C., & Patterson, J. L. (2016). *Purchasing and supply chain management*: Cengage Learning.
- Rincón-Flores, E. G., Montoya, M. S. R., & Mena, J. (2019). *Engaging MOOC through gamification: Systematic mapping review*. Paper presented at the Proceedings of the Seventh International Conference on Technological Ecosystems for Enhancing Multiculturality.
- Saputro, R. E., Salam, S., Zakaria, M. H., & Anwar, T. (2019). A gamification framework to enhance students' intrinsic motivation on MOOC. *Telkomnika*, 17(1), 170-178.
- Schiele, H. (2019). Purchasing and supply management. In *Operations, Logistics and Supply Chain Management* (pp. 45-73): Springer.
- Strmečki, D., Bernik, A., & Radošević, D. (2015). Gamification in E-Learning: Introducing Gamified Design Elements into E-Learning Systems. *J. Comput. Sci.*, 11(12), 1108-1117.
- Tuparov, G., Keremedchiev, D., Tuparova, D., & Stoyanova, M. (2018). *Gamification and educational computer games in open source learning management systems as a part of assessment*. Paper presented at the 2018 17th International Conference on Information Technology Based Higher Education and Training (ITHET).
- Van Weele, A. J. (2014). *Purchasing and Supply Chain Management: Analysis, Strategy, Planning and Practice* (6 ed.). Andover, UK: Cengage Learning EMEA.
- Villagrasa, S., Fonseca, D., Redondo, E., & Duran, J. (2014). Teaching case of gamification and visual technologies for education. *Journal of Cases on Information Technology (JCIT)*, 16(4), 38-57.