

THE IMPLEMENTATION OF AN OPEN-SOURCE ERP ONLINE SOLUTION TO SUPPORT LABORATORY CLASSES AND STUDENTS ASSESSMENT IN HIGHER EDUCATION DURING COVID-19 LOCKDOWN

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Abstract

This article describes the implementation of an online Open-Source Enterprise Resource Planning (ERP) software solution to support the laboratory component of the theoretical/laboratory classes of the curricular unit “*Information and Communication Technologies in Distribution and Logistics Management*” of the degree in “*Distribution and Logistics Management*” and its contribution to the student assessment process, during the Covid-19 lockdown and resulting restrictions imposed to the normal functioning of presential classroom lessons in the period 2020-2022.

The curricular unit's program foresees the use of demonstrative and experimental methods to illustrate the role of Information and Communication Technologies (ICT) support to the fundamental area of the study cycle. An ERP software solution and a database from a simulation company are normally used in classroom-based classes to carry out laboratory exercises, where it is intended to highlight the role of ICT as a facilitator of supply chain processes and logistical activities.

The objective of implementing this online solution was to continue to ensure the teaching of the laboratory component, which was initially limited to use in the classroom. It was thus possible to continue helping students to develop their knowledge and practical technical experience in accordance with the curricular unit's program. The technological implementation of the solution and the training of the teachers involved had to be carried out in a very short period.

From a methodological point of view, an approach based on experiential learning was used and the ePortfolio, as instrument to assess the practical knowledge acquired. Demonstrations of the system with resolution of synchronous online laboratory exercises, online debate and clarification sessions, recordings with resolution of laboratory exercises for asynchronous viewing and the proposal of exercises to be integrated in the ePortfolio were used.

This article details the laboratory structure that was developed, taught, and evaluated to the students of the 2nd year of the degree course, at the School of Business Administration of the Polytechnic Institute of Setúbal, in Portugal.

The results of the students assessment in the laboratory component were positive, and the proposed solution contributed to the conclusion of the curricular unit. The ERP OPEN-Source solution was also evaluated by the students through a survey, and the results revealed a positive impact of the approach in the acquisition of knowledge and practical technical experience.

Keywords: Enterprise Resource Planning (ERP), Odoo, Open-Source, Online Education, ePortfolio.

1 INTRODUCTION

The degree course in “Distribution and Logistics Management” is taught at the School of Business Administration of the Polytechnic Institute of Setúbal in the daytime and afterwork regimes. This is a six-semester Public Polytechnic Higher Education course, which grants 180 credits according to the European Credit Transfer and Accumulation System (ECTS).

At the beginning of the 2nd semester of the 2019/2020 academic year, with the aim of preventing and limiting the probability of infection by SARS-CoV-2 in the Academic Community of the Polytechnic Institute of Setúbal (IPS), it is suspended on March 12, 2020, the teaching activity for a period of 15 days. During this period, teaching activities were planned, reinforcing alternative pedagogical approaches to classroom attendance.

On March 18, 2020, a state of national emergency is decreed in Portugal (Decree of the Republic President n.º14-A/2020). A period of confinement begins and resulting restrictions imposed on the normal functioning of face-to-face classes, which lasted until April 2022.

The curricular unit “Information and Communication Technologies in Distribution and Logistics Management” is taught in the fourth semester of the degree course, giving 5.5 ECTS, which corresponds to 148.5 total hours of work (5.5 ECTS x 27 hours). The typology of classes is theoretical/laboratory; 15 weekly classes, lasting 3 hours, totalling 45 hours of contact. The difference between the total working hours and the contact hours represents the hours in which students will have to carry out work independently, that is, 103.5 hours (148.5 – 45). Students can carry out the assessment of the curricular unit in two ways: continuous assessment throughout the semester or by written exam at the end of the semester.

The curricular unit program foresees the use of demonstrative and experimental methods to illustrate the role of Information and Communication Technologies (ICT) support in the fundamental area of the study cycle, namely, in Logistics Management. In this sense, an Enterprise Resource Planning (ERP) software solution and a database from a simulation company are normally used in classroom-based classes to carry out laboratory exercises, where it is intended to highlight the role of ICT as a facilitator of supply chain processes and logistics activities. It is intended that students acquire and develop knowledge and practical experience in the use of an ERP, according to the syllabus of the curricular unit.

In view of the urgent situation faced by the academic community, resulting from the SARS-CoV-2 pandemic, it was imperative to identify a solution that would allow distance learning, to ensure the teaching of the laboratory component, to students enrolled in continuous assessment.

The technological implementation of the solution and the training of the teachers involved had to be carried out in a very short period of time, so as not to condition the learning process and the knowledge assessment process. The selected online ERP Open-Source technological solution, Odoo, allowed to overcome two important barriers for the educational institution: the investment cost and the implementation time.

From the methodological point of view, we used an approach based on the theory of the learning experience proposed by Kolb [1] and the use of the ePortfolio as an instrument to evaluate the acquired practical knowledge, in line with the pedagogical framework proposed by Ruhi [2]. This article includes details of the laboratory structure that was developed and that was taught and evaluated.

The evaluation results were positive, and the proposed solution contributed to the completion of the course and to the acquisition of knowledge and practical experience by the students.

The article is organized as follows: in the next section the specifications of the curricular unit within the scope of this article are presented. Section 3 contextualizes the use of open-source ERP in education. Section 4 describes the implementation of the Odoo open-source ERP. Section 5 describes the methodology used to structure the pedagogical practices. In section 6, the assessment of the curricular unit and the students are described and, finally, the conclusions are presented.

2 SPECIFICS OF THE CURRICULAR UNIT

The learning outcomes and the study program of the curricular unit did not change during the covid-19 lockdown. However, in the transition to distance learning it was necessary to adapt the student assessment system, as we will see in sub-section 2.3. Online distance classes were taught using the

Microsoft Teams platform. To carry out the assessment tests, the Moodle platform was used simultaneously.

2.1 Learning Outcomes

As foreseen in the syllabus of the curricular unit “Information and Communication Technologies in Distribution and Logistics Management”: the knowledge, skills, and competences to be developed by the students are:

- Know and apply fundamental concepts of information and communication technologies (ICT) in the processes and activities underlying the Logistics Management and Supply Chain Management.
- In accordance with the System of Logistics Skills ECBL (European Certification Board of Logistics):
 - Develop analytical skills necessary for planning, selection, and organization of ICT in the economic sectors of the Modern Distribution and Logistics.
 - Contribute to organizational effectiveness, problem solving and decision making through appropriate use of information technology and communication sector specific.

On successful completion of this curricular unit, the student should be able to:

- Understands the importance and critical role of ICT in Logistics Management.
- Learn to frame the Logistics Information subsystems.
- Learn to identify, select, and use technologies and software to support specific processes.
- Acquire the skills related to ICT, in accordance with ECBL (European Certification Board Logistics), to understand the strategies and processes, the interrelationship between and within logistics networks, the functional capabilities of ICT.
- Define and optimize the logistics processes and their activities using ICT.

2.2 Syllabus

The curricular unit is intent to give a depth understanding of the following topics:

- Introduction to Logistics Information Systems Management.
- Nature and Categories of Information Systems.
- Integration of Information and Communication Technologies.
- Information systems and Information and communications technologies strategies in the Supply Chain.

2.3 Students assessment system

Since the Covid-19 lockdown, continuous assessment was structured in four evaluation moments, with individual assessment components (50%) and group evaluation (50%), namely:

- Two online mini tests (MT), individual assessment with a weighing of 30% for the final grade (15% each);
- One group work (GW) written, with online presentation and discussion with a weighing of 50% for the final grade;
- One ERP laboratory ePortfolio (ELP) group work with a weighing of 20% for the final grade for the final grade (the portfolio is built during online classes).

The calculation of the final grade of continuous assessment is as follows: $0,15 (MT1) + 0,15 (MT2) + 0,50 (WG) + 0,20 (ELP)$. If the final grade of the Continuous Assessment is less than 10 values, the student will not be approved.

3 OPEN-SOURCE ERP IN EDUCATION

The ERP system is characterized by a modular software package, constituting an integrated business computer system that aims to facilitate the flow of information between all company functions, helping the integrated management of organizational processes.

Due to its impact on increasing the competitiveness of companies, the popularity of ERP grew rapidly from the 1990s [3], mainly among large companies, more able to invest a significant amount of time,

energy, and resources in its implementation. The high costs inherent to the acquisition of hardware, software, training, system administration, maintenance and support stand out.

With the growing demand in the market for professionals who could work with these systems, schools also identified the importance of including ERP in improving their curricular offer, promoting learning in an experiential logic.

Currently, the benefits inherent to the use of ERP are no longer exclusive to large companies, because there are open-source solutions on the market that are available online, financially more accessible, among other advantages, which allows their adoption by small and medium-sized companies (SMEs) [4] [5] [6] [7]. This reality extends to educational institutions, where the cost of these types of solutions is usually the biggest barrier to their adoption [8].

It is important to mention that the Portuguese business fabric is made up mostly of SMEs, reinforcing the importance of students having contact with this type of solutions in the training offer. The total number of companies and by size can be seen in Table 1.

Table 1. Portuguese companies: total and by size [9]

Years	Dimension		
	Total	SME	Large
2019	1.335.006	1.333.649	1.357
2020	1.316.256	1.314.944	1.312

This article describes our experience in the implementation of the open-source ERP online solution, Odoo, to support the laboratory component of the theoretical/laboratory classes of the curricular unit “*Information and Communication Technologies in Distribution and Logistics Management*”. In the available literature, we find works that support the adoption of this solution, in SMEs [4] [7] [10] [11] [12], in school management [13] [14] or in the design of training offer [8] [15] by educational institutions.

4 ERP ODOO IMPLEMENTATION

In the period before the covid-19 lockdown, laboratory classes were provided in person, using commercial ERP software (proprietary code) installed on the computers supporting classes in a client/server logic (standalone mode), simultaneously supporting the layers of database, application, and client. With the covid-19 lockdown, this solution became unfeasible, and it was imperative to identify a new solution that would allow distance learning and simultaneously overcome two important barriers for the educational institution: the cost of the investment and the implementation time. In this sense, the ERP Open-Source Odoo technology solution, version 12 community, was selected.

It is an open-source ERP software with no licensing costs, incorporating multi-language document management features to speed up collaboration between departments and teams in organizations, allowing to work remotely through a web interface from any device connected to the internet. The platform is modular and integrated, allowing to add or eliminate features according to the organizations processes and activities.

For the implementation of the solution, we used an Odoo Gold partner in Portugal, whose name we do not reveal due to confidentiality agreement.

The implementation of the solution took seven weeks and included the configuration of the system, the training of teachers, the creation of the template database to support the classes and the creation of laboratory exercises. The implementation costs include functional consulting services, installation and configuration of the solution, teacher training and technical support. During this period, priority was given to teaching the theoretical component and solving exercises that were not directly dependent on the Odoo solution.

The solution was implemented and made available from the technological infrastructure of the Polytechnic Institute of Setúbal, being accessed by students through the internet browser (on campus or abroad). The solution's architecture was implemented in three layers, on a virtualized server. Fig 1 illustrates the implemented architecture.

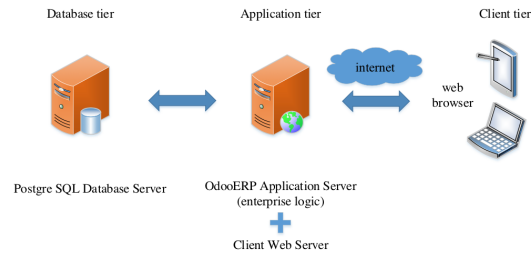


Figure 1. Odoo architecture implemented [7]

As for the most relevant technical information, we have: PostgreSQL Database System; Windows Server operating system; partition with 20 Gb storage; https secure communication; the following applications (modules) were installed: contacts and messages, calendar, sales, purchases, inventory and invoicing.

5 METHODOLOGY

From a methodological point of view, we used an approach based on the experiential learning theory proposed by Kolb [1] and the use of the ePortfolio as an instrument to evaluate the acquired practical knowledge, in line with the pedagogical framework proposed by Ruhi [2], specifically in the capstone project pedagogical practice. In the existing literature, we found a work with some similarities in the pedagogical approach, however, in a different scope, directed to a master's program course, of a more technological nature and focused on the life cycle of selection and implementation of an ERP [8]. In our curricular unit, we specifically intend to highlight the role of ICT as a facilitator of supply chain processes and logistical activities.

Table 2 summarizes the pedagogical practices that were adopted in the curricular unit and their mapping to the experiential learning processes, covering the cognitive modes, according to the structure suggested by Ruhi [2]. The practical simulations/interactive assessments were not introduced due to strong time constraints, but a strong bet was made on the Capstone Project, which we named ERP Laboratory ePortfolio.

Table 2. Experiential learning pedagogical practices in the curricular unit.

Pedagogical Practices	Learning Processes Experimentation	Concrete Experience	Reflective Observation	Reflective Observation	Active
	Cognitive Modes	Experiencing and Feeling	Watching and Reflecting	Thinking and Analyzing	Doing and Exploring
Lectures & Seminars					
Case Discussions					
Systems Demos & Screenshot Tutorials					
Walkthrough Assignments					
ePortfolio					

■ Primary Mapping ■ Secondary Mapping

We present the details of the pedagogical practices adopted:

- Lectures and seminars: reference books were indicated to support the theoretical part of the classes [16] [17]. The ERP, its features and functionalities were presented in online lectures by the professors and two online seminars were provided by the partner Odoo. The debate was promoted, and the sessions were recorded to enable future viewing.
- Case Discussions: Two case studies of using Odoo in companies to support logistics processes and activities were presented and discussed.
- Systems Demos & Screencast Tutorials: Multimedia resources related to the technical aspects of ERP systems, from ERP vendors on YouTube, were made available to students. Tutorials and documentation on the functioning of the Odoo system, applications and their operations are also available on the institutional website of Odoo. All step-by-step operations demonstration lessons were recorded for future viewing.
- Walkthrough Assignments: each group of students was assigned a template database and individual accesses, which they could later customize. In the demonstrations and in the laboratory, exercises proposed during the classes, the students were able to play different roles in the logistical processes, experiencing the complexity of planning and executing them and observing step by step the impact of their decisions.
- ePortfolio: In the curricular unit, ELP is intended to consist of the collection of resolutions of laboratory exercises (LAB), carried out weekly by groups of students based on the ERP Odoo solution, with delivery for assessment at the end of the semester. It is characterized by a list of exercise resolutions recorded in the template document provided, in chronological order, relating to weekly learning challenges, aiming to establish a critical reflection in search of improving the skills recommended in the curricular unit's program. The ERP laboratory ePortfolio is, therefore, a pedagogical tool for identifying the quality of the teaching-learning process through the assessment of student performance. For this purpose, we have provided an ERP Digital Portfolio Template in MS Word, in which students record: (1) all the steps taken in the Odoo ERP to solve the proposed exercises and the additional comments they consider important, (2) insert the captures of the ERP Odoo screen related to the resolution of the proposed exercises.

The laboratory exercises that were prepared to highlight the role of ICT as a facilitator of supply chain processes and logistical activities, using the Odoo ERP, are presented below. The resolutions of these laboratory exercises are integrated into the ELP and as mentioned before, have a weight of 20% in the final grade of the continuous assessment.

- LAB #1 – ERP Navigation and Configuration - It is intended that in this LAB students become familiar with basic navigation and system configuration. Students must perform the following tasks: (1) log in for the first time with their credentials and change the access password; (2) explore your user settings (e.g. language, time zone, signature for documents); (3) use chat and calendar; (4) explore the contact list and create contacts (personal and organizational) and (4) navigate the various modules to develop an integrated perspective of information management in Odoo.
- LAB #2 – Sales Process - In this LAB, students are intended to explore the sales process and its logistical activities and to understand the flow of information and the impact of decisions taken. Students must perform the following tasks: (1) create product and service sheets; (2) creating quote requests; (3) sales order creation (4) product shipment; (5) verify process-generated documentation among supply chain actors; and (6) understand the impact of transactions on inventory management and invoicing processes.
- LAB #3 – Purchase Process - In this LAB, students are intended to explore the purchasing process and the respective logistical activities and to understand the flow of information and the impact of decisions taken. Students must perform the following tasks: (1) create product and service sheets; (2) creating quote requests; (3) creation of purchase orders (4) receipt of product; (5) verify process-generated documentation among supply chain actors; and (6) understand the impact of transactions on inventory management and invoicing processes.
- LAB #4 – Inventory Management - In this LAB, students are intended to explore the inventory management process and its logistical activities and to understand the flow of information and the impact of decisions taken. Students must perform the following tasks: (1) carry out an inventory and record any discrepancies; (2) generate and interpret inventory and item movement reports; (3) creating warehouses and locations for inventory allocation; (4) performing inventory transfers between warehouses and/or locations; (5) record inventory

breaks and returns (6) understand the impact of transactions on inventory management and invoicing processes.

6 RESULTS

Table 3 presents the students assessment results in the last three academic years, who were evaluated and approved in continuous assessment. The results are divided into daytime regime (DR) and afterwork regime (AR). The second column presents the arithmetic mean of the ERP Laboratory Portfolio (AM ELP) results. The third column shows the arithmetic mean of the final grade (AM FG). The fourth column shows the number of students evaluated (STU EVAL). The fifth and sixth columns show the highest value grades (HV ELP) and the lowest value grades (LV ELP) of the ERP Laboratory Portfolio.

Table 3. Students Assessment Results

Academic Year	AM ELP	AM FG	STU EVAL	HV ELP	LV ELP
2019/2020 DR	13	14	48	18,68	8,43
2020/2021 DR	16	13	59	18,69	12,98
2021/2022 DR	17	14	44	19,06	14,44
2019/2020 AR	13	13	27	18,46	5,42
2020/2021 AR	17	12	40	19,00	15,10
2021/2022 AR	17	13	33	18,75	10,63

The results of the students assessment in the laboratory component were positive, and the proposed solution contributed to the conclusion of the curricular unit. It is verified that in the academic year 2019/2020, when the covid-19 lockdown and the implementation of the solution, the AM ELP is lower. This could be due to: (1) the impact caused by the transition of students and teachers to distance learning, (2) the teachers learning curve to the Odoo solution and (3) the introduction of the laboratory component later in the semester. However, the arithmetic mean of the final grade remained stable in the three academic years. It is verified that in the three academic years, high quality ELP were presented, with the 2019/2020 school year presenting the lowest grade ELP (LV ELP).

In the 2021/2022 school year, students were asked to respond to a survey with the aim of evaluating the approach used to acquire knowledge and practical experience. We obtained 51 responses, representing 61% of the total number of students enrolled in the curricular unit (table 4).

Table 4. Assessment by Students.

No.	Survey Questions	1	2	3	4	5
1	Assess your level of knowledge about the integration of processes in the supply chain (e.g., CRM, Returns Management, etc.), before having taught the course syllabus (1 being "very bad" and 5 "excellent ")	17,6	47,1	23,5	9,8	2
2	Assess your level of knowledge about the integration of processes in the supply chain (e.g., CRM, Returns Management, etc.), after having taught the course syllabus (1 being "very bad" and 5 "excellent").	0	0	31,4	58,8	9,8
3	Assess your level of knowledge about ERP systems before the course program has been taught (1 being "very bad" and 5 "excellent").	19,6	33,3	41,2	5,9	0
4	Assess your level of knowledge about ERP systems, after having taught the course syllabus (1 being "very bad" and 5 "excellent").	0	2	15,7	58,8	23,5
5	I learned a lot about information flows in logistics operations, using ERP Odoo (1 being "strongly disagree" and 5 "strongly agree").	3,9	2	17,6	47,1	29,4

6	The knowledge gained about the ERP system will help me in my future career (1 being "strongly disagree" and 5 "strongly agree").	0	2	9,8	37,2	51
7	Rate the difficulty in developing the ERP digital portfolio (1 being "very easy" and 5 "extremely difficult")	3,9	13,7	68,6	11,8	2

From the analysis of the results in table 4, we can conclude that the students level of knowledge about the integration of processes in the supply chain and about ERP systems had a very positive evolution. Most students also consider that they learned plenty about information flows in logistics operations using the Odoo ERP. Most students also consider that they have learned a lot about information flows in logistics operations using the Odoo ERP and that this knowledge can have an important impact on their professional future. These results positively evaluate the effectiveness of this approach based on experiential learning theory and in line with the proposed pedagogical framework. Most students (68.6%) consider that the difficulty in developing the ELP was moderate, with only 2% considering it extremely difficult.

7 CONCLUSIONS

This article describes the implementation of an ERP Open-Source online Odoo software solution, to support the laboratory component of theoretical/laboratory classes of a curricular unit within the scope of a degree course in "Distribution and Logistics Management" during Covid-19 lockdown. From the methodological point of view, an approach based on the theory of experiential learning proposed by Kolb [1] was used, in line with the pedagogical framework proposed by Ruhi [2] in the definition of pedagogical practices. This article includes details of the laboratory structure that was developed and that was taught and evaluated, with the intention of spreading successful practices in the academic community. This implementation is a future asset for students who can now develop their studies, using an ERP solution that is permanently available online, free of charge. Future work involves evolving the existing solution to the Odoo 15 Enterprise version, which has innovations in the field of logistics and distribution. It is also intended to install the e-commerce application, which was in high demand in the business environment, because of the need to digitize company's operations during the pandemic. We believe that it is also important to develop more laboratory exercises with different degrees of difficulty to help students develop knowledge and practical technical experience, which is increasingly valued in the job market.

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