

# Interconnected Enterprise Systems – A Call for New Teaching Approaches

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**Abstract.** Enterprise Resource Planning Systems (ERPS) have continually extended their scope over the last decades. The evolution has currently reached a stage where ERPS support the entire value chain of an enterprise. This study deals with the rise of a new era, where ERPS is transformed into so-called interconnected Enterprise Systems (iES), which have a strong outside-orientation and provide a networked ecosystem open to human and technological actors (e.g. social media, Internet of Things). Higher education institutions need to prepare their students to understand the shift and to transfer the implications to today's business world. Based on literature and applied learning scenarios the study shows existing approaches to the use of ERPS in teaching and elaborates whether and how they can still be used. In addition, implications are outlined and the necessary changes towards new teaching approaches for iES are proposed.

**Keywords:** Enterprise Systems, Enterprise Resource Planning, Systems of Engagement, Teaching, Higher Education.

## 1 Introduction

### 1.1 Enterprise Systems

Enterprise Systems (ES) are widely spread in today's businesses [1]. They build a prerequisite for digitizing a variety of essential business processes, stretching from attracting customers, order handling and production up to billing or service activities [2]. ES are packages of software applications that have a shared common database and aim to achieve full connectivity by supporting many, or even most, aspects of enterprises' information needs [3]. The most prominent type of ES are ERPS [4]. Their strength lies in the integration and automation of main operational business processes as to support the operational value chain, from customer inquiry to final payment and from purchase requisition to vendor billing [5].

Today, ES and particularly ERPS are considered commodities in a market that is still growing. According to Gartner [6], the worldwide ERPS sales volume grew overall by 7.1% in 2016. This growth originates on the one hand from small and medium enterprises (SMEs) just starting to adopt ES packages following the efforts of vendors

to provide small scale, less expensive solutions [7]. On the other hand, enterprises with mature ES enhance their existing landscapes with further investments. They acknowledge that technology has advanced tremendously in recent years and have a desire to adapt this progress in a next generation of ES [8].

The implementation of an ES is a high-effort and high-risk endeavor: Enterprises have to make relatively large investments to get the system set up and prepare the workforce to adopt and assimilate to an ES/ERPS [9]. Studies prove that the majority of ERP implementations do not deliver the expected benefits [4]. Instead, very often, they trigger a high potential for conflicts within the workforce [10]. It is, therefore, a prerequisite for an effective adaptation that ES users build a thorough understanding of the main principles and concepts [11]. Research confirms that training is one of the key factors to ensure a successful adoption and assimilation [8, 9, 12]. Since the 90s, universities and other higher educational institutions have incorporated ES into their curricula [13] in order to prepare future managers and IT professionals. To teach the complexity and large scope of ES, numerous teaching approaches exist [14].

## 1.2 Purpose and Objectives

This study elaborates the need for new teaching approaches following the advancement of ES to a next level. We claim that the traditional ERPS were transformed and are entering a new stage, called ‘interconnected ES’ (iES). This affects the existing teaching curricula as well as the approaches. To clarify the future developments of ERPS we have expanded Moore’s concept of Systems of Engagement (SoE) [15] in which SoE drive the future evolution of ES towards a networked ecosystem. Our main intention is to provide guidance to lecturers of ES in higher education. The purpose of the study is to (1) elaborate the evolution of ES or rather ERPS towards more collaborative and interactive systems, namely iES and to (2) raise awareness that a shift from an inside-out perspective to an outside-in perspective is in progress and must be taken into account. We aim to (3) delimit and enhance the existing ERPS/ES concepts towards an iES and (4) derive recommendations for new teaching approaches for iES in the current digital age.

## 1.3 Methodology

To conduct a rigor literature review we used procedural recommendations of Benbasat and Zmud [16] as well as Tranfield et al. [17]. We conducted a structured search in the Web of Science (all journals) and in Google Scholar (top journals). Then, we enriched the matches from scientific literature by adapting practical knowledge from practitioners (see study with ERP professionals conducted by Schneider [18]). The keywords used were among others ‘next generation’, ‘future’, ‘transformation’, ‘integrated’ combined with ‘ERP System’, ‘Enterprise Resource Planning’, ‘Enterprise System’. In addition, the keywords were combined with ‘teaching’, ‘higher education’, ‘training’ and ‘learning’.

In order to contribute to the discussions on the evolution of ERPS towards iES, we founded our iES-related research on the well-established concept of SoE [15]. This

concept is referenced by practitioners [19, 20] and by academia, e.g. to establish a new IT consumerization theory [21, 22] or an ERP transformation model [23].

The remainder of the paper is structured as follows: The next section, section 2, elaborates existing ways to teach ERPS at universities and higher education institutions. In section 3, we outline the evolution of ERPS/ES with the conclusion that a new paradigm from an inside-out to an outside-in perspective is breaking through. In section 4, we assess how lecturers should respond to the enhanced ES concepts. Key factors for teaching the commodity ERPS and the future-oriented iES are presented. In the final section, we draw a conclusion and show areas for further research.

## 2 Existing Teaching Concepts

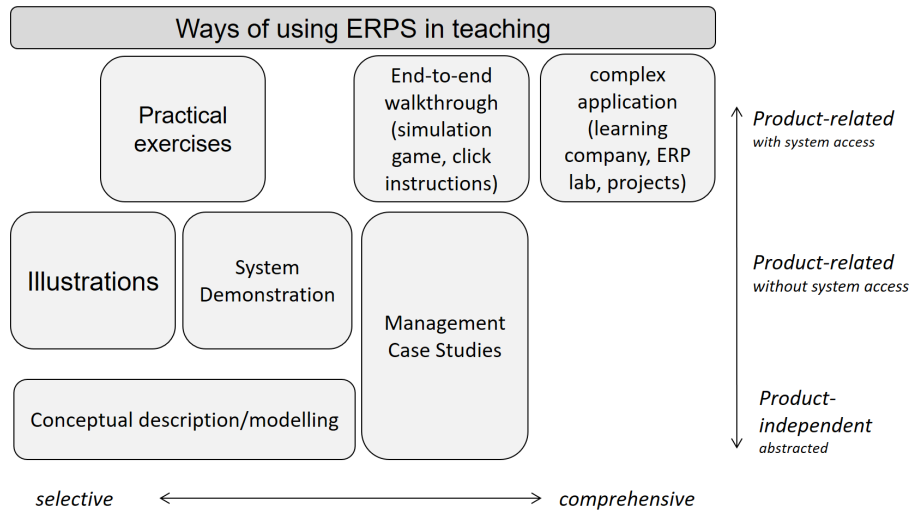
### 2.1 Classification Scheme

The different ways of teaching ERPS can be categorized along two axes. The first axis deals with the decision about how closely the learning process should be connected to a dedicated proprietary ERP product. In the case of hands-on approaches, the learners have direct access to one or more ERP solutions and the understanding is built up in a specific software context. Such a strategy has the advantage that learners take an active part and that they understand a proprietary solution.

However, the selection of an ERP product is not an easy task because there are many products from different large or small vendors available. Education aims to impart the general concepts and principles of a dedicated topic. Using a specific product always comes with the suspicion of privileging a certain vendor. In addition, working with an ES is usually costly. Although many ERP vendors provide free access to their products for universities (e.g. Microsoft, Odoo), the administrative effort for an education facility is substantial. User profiles have to be maintained, an infrastructure for the students has to be provided (hardware, network) and the first steps with the software have to be guided carefully to make sure the students can get accustomed to the user interface. Finally, lecturers need a profound expertise in the selected ERP product in order to use it for teaching and to cope with potential issues.

The complications of choosing a specific ERP solution may be overcome by teaching approaches that do not rely on a particular system access but instead focus on conceptual aspects, core components and principles on a more abstracted level. This can be designated as the indirect approach of teaching ERPS.

The second axis to classify the ways of teaching ERPS relates to the complexity of the chosen scenario. At the lowest end of the scale, the ERPS is embedded into the curriculum in a rather selective manner. At distinct points, related concepts and examples underpin the content to be taught. The lecturer's interventions related to ERPS are rather independent. At the highest end of the scale, teaching approaches aim for comprehensiveness. ERPS are an integral part of the curriculum that builds a broad storyline. Figure 1 shows a classification scheme with the two axes of ERPS usage (vertically) and complexity of the teaching approach (horizontally).



**Figure 1.** Classification scheme for teaching ERPS (based on Wilbers [24], Pongratz [14] and Schneider [18])

Within the classification scheme there are different teaching approaches arranged; the essential details are described in the following sections.

## 2.2 Teaching Scenarios

The most straightforward approach are product-independent teaching scenarios; the ERP-related principles are described abstractly without referring to a dedicated ERP product. An example of this teaching strategy can be found in one of Kurbel's books [25]. In order to conceptualize ERP structures and processes, modeling techniques can be applied; an example is the use of notations like business process model and notation (BPMN). This approach allows the lecturers to elaborate ERP content without referencing a dedicated vendor or system. The focus is set on conceptual understanding of ERP main principles and components [18]. Those abstract teaching concepts can be enriched with screenshots from any ERP solution. While illustrations are product-dependent, they help to visualize the theoretical ERP-principles and demonstrate the usage in a real world case.

Instead of showing rather static representations, a more comprehensive approach is the use of live demonstrations from any ERP software. Although the learners will not be able to gain hands-on experience, it makes it possible to show various functionalities in sequence, which represent the (graphical) user-system interaction. A less elaborated version of this learning approach involves the use of videos (e.g. on YouTube) instead of demonstrating the system in a live setting.

An alternative way to teach ERPS is the management case study approach; this one is also without direct system access. In general, a case study refers to a textual representation of a real world scenario. This enables the learner to take on a specific

role in which he or she has to deal with certain challenges. As in real life, the situations are not clearly defined but leave room for particular interpretations and various possible solutions [26]. A common case study scenario asks questions regarding a certain ERP architecture during the adoption phase or tackles management challenges during an ERP implementation (see examples on the-casecenter.org). The advantage of these case studies is their correspondence with realistic ERP projects. Thus, they confront the learners with similar problems that they may have to solve in their future jobs [27].

In case of direct access to an ERP solution, an alternative scenario would be to carry out practical exercises. For example, the learners would create a customer order or process a vendor payment. Whereas these tasks allow for hands-on experience, they only reflect limited steps within the software from a specific user perspective. As such, practical exercises may be more comprehensive compared to a simple illustration, but less encompassing than a live demonstration.

Another comprehensive teaching scenario considers the full scope of a company. One example is the execution of end-to-end walkthroughs with detailing of process steps from customer inquiry up to payment settlement and including aspects such as manufacturing, warehousing, financials and more. Main software vendors provide learning materials related to their ERP product. In the case of SAP, a complete business setting is provided for a (fictive) bicycle enterprise [28]. Another example of teaching, also related to SAP, involves an interactive simulation game, called 'ERPSim'. Various learning scenarios (manufacturing, logistics or distribution) exist that allow the participants to take an active part (e.g. as product manager) and to conduct hands-on tasks within the ERP software. The implications can be perceived thanks to a real-time simulation (solution accessible via <https://erpsim.hec.ca/>). This way, the students receive a comprehensive overview of the main supported processes in a proprietary ERPS. However, both examples focus on using an existing system and do not emphasize adapting the system to specific needs.

The most sophisticated ERP teaching setup involves complex scenarios that aim to replicate a real world system usage in an advanced manner. An example is the ERP laboratory of a German university in which ERP-related processes and tasks are connected to a physical representation in form of LEGO blocks. When material is withdrawn from the system inventory, the corresponding stock is also removed in the LEGO warehouse. The system processes are reflected in the physical world in form of a LEGO material flow [29]. This setting provides the learners with a comprehensive overview of the ERP capabilities and effects in the real world. In addition, the laboratory offers a platform for enhancing the existing system setup during student projects.

Next to simulations, 'learning enterprises' can also be classified as complex scenarios for ERP teaching. In those scenarios, learners work together in teams and create their own business within a secured setting. The 'business' runs on a real ERPS that applies transactional data and executes process activities [14].

### 3 Evolution of ERPS

The evolution of ERPS has always been connected to technical progress [7]. Based on the technological advancements enterprises aimed to adapt the existing ERPS to increase their operational effectiveness – a strong inward-looking orientation (inside-out perspective). For the current digital age, we claim that enterprises need to change their mind-set to a new outward-looking oriented paradigm (outside-in perspective).

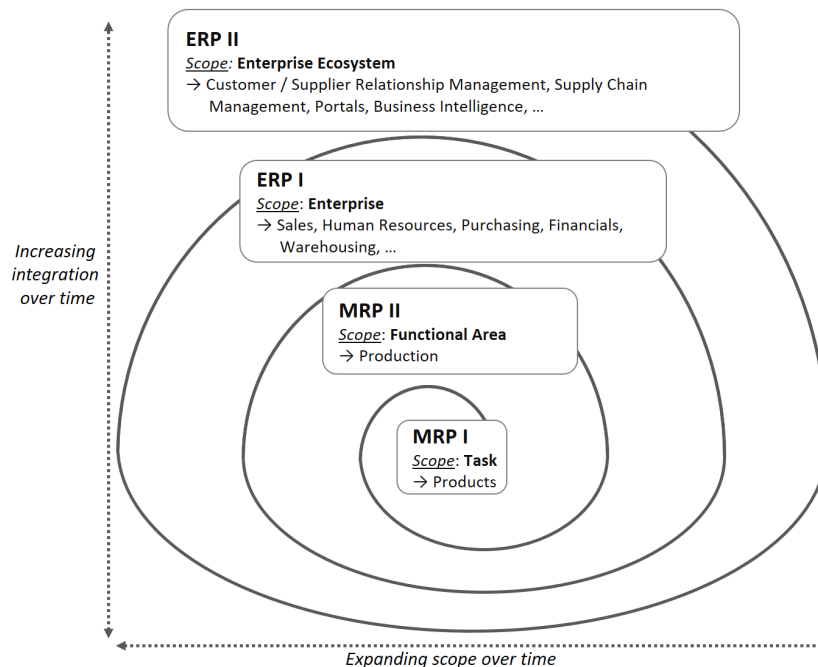
#### 3.1 Inside-Out: From MRP to ERP II

Long before the label ‘ERP’ was created, the evolution of ES began. It started in the 1960s with the rise of material requirements planning systems (MRP I). The main achievement was the so-called automated ‘explosion’ of a finished product into its sub-components. The resulting bill of materials allowed enterprises to plan their material purchases as well as production requirements. Soon in the 1970s, MRP I enlarged its scope and turned into a concept called manufacturing resource planning (MRP II), which included a top-down planning philosophy. On top of the materials perspective, MRP II incorporated the capacity requirements and related financials.

Over the years, the developments continued – with the integration of more processes and functionalities such as sales, management accounting, human resources and security-related functions. As such, the systems started to affect all main organizational entities of an enterprise instead of focusing on one specific functional area. This led to the creation of a new class of enterprise applications, namely ERPS or later ES [30].

Although academia and practitioners have used and are still using the expression ‘ERP system’ or its abbreviation ERPS, the products sold by vendors in the 1980s till the 2010s are not comparable to today’s state-of-the-art solutions.

Similar to MRP I/II, the ERPS concepts evolved. The original intra-organizational processes extended further and transformed into inter-organizational systems. New names were created like extended ERP or ERP II [31]. With the invention of the internet and service-oriented architecture, new key elements and enhancements were introduced such as web catalogues or business intelligence components [32]. Further valuable extensions were customer relationship management (CRM) and/or supply chain management (SCM) applications [1, 31]. In addition, functionality related to the enterprise’s overall ecosystem has been incorporated [8].



**Figure 2.** Expansion from MRP I through to ERP II – an ‘inside-out’ evolution

Figure 2 shows the evolution from MRPI, MRPII to ERP and ERP II and visualizes the continuous enlargement over time, both in terms of broadening the scope and increasing integration. An important milestone was the expansion to a full enterprise focus. With ERP II, the inside-oriented view was softened and external-oriented functionalities were added. As figure 2 illustrates, ERP concepts are continuously expanding, whereas the main imperatives of ERPS were not touched: For years, ERPS have been known for their stability, cost efficiency and secured and integrated database. The broadening of the ERPS scope has led to an opening towards a large user base. Also outside the ERPS, stakeholders were increasingly being connected (mainly customers and suppliers with CRM and SCM functionalities respectively).

### 3.2 Outside-In: From ERP II towards SoE

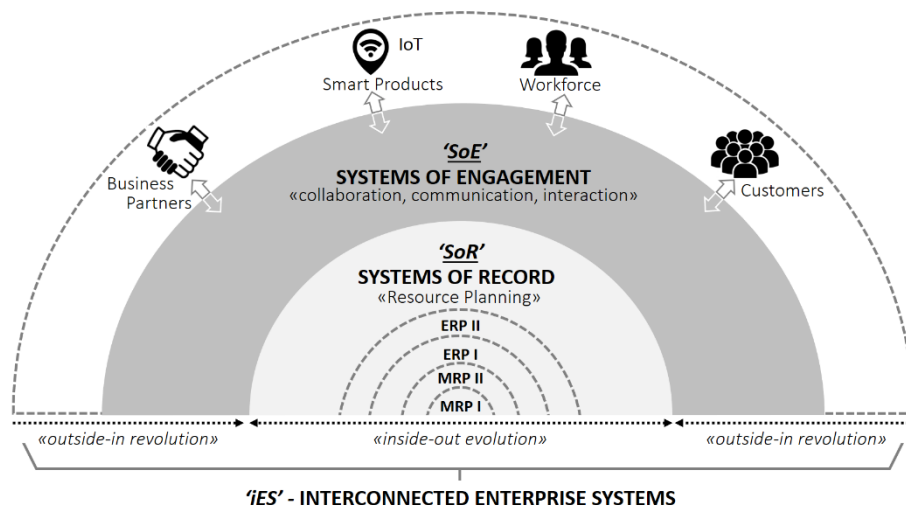
The emergence of digital opportunities also brings many new developments in the context of ERPS. In prior decades, IT innovations usually arose within large enterprises or public institutes and then made their way to SMEs. This sequence is no longer valid: Today, the young generation very often leads innovations, followed by (older) adults as well as SMEs and then large enterprises [33, 34, 35, 36].

Moore postulates the ‘consumerization of IT’ as a highly relevant factor in today’s business expressing itself on two significant aspects: The first concerns societal changes in relation to the upcoming generation, the digital natives. They are

accustomed to communicate and collaborate via mobile devices with web 2.0 functionalities and it is expected, that they will aim for a similar work life experience with e.g. easy-to-use tools and receiving information exactly at the time they need it [37]. The second aspect relates to productivity gains; it is expected that digitalization and thus IT will be the next significant driver for business growth and prosperity.

Accordingly, ERPS can be referred to as ‘Systems of Record’ (SoR) that paved the way for the automation of processes and outsourcing and led to operating efficiency and tremendous cost savings [15]. In the last decade, SoRs have more or less turned into a commodity, requiring enterprises to concentrate their resources on particular core competences as to differentiate and sharpen their strengths. In the digital age, collaboration between employees, divisions, suppliers and other internal and external parties will be an important success factor for the next wave of productivity.

By utilizing SoE, employees will be enabled to deliver the required conversion in view of the new ways of collaboration. It is expected that the next generation of employees will have the potential to elevate collaboration to a higher level. Significant breakthroughs will take place by applying collaboration tools, which promise easy and user-friendly access and use. The facilitation of the new way of working requires the support of various technical formats such as text, image, audio and video [15]. With regard to Moore’s concept, it is crucial to understand that the ‘old’ ES / ERPS – the SoR – will not disappear but SoE will enhance the existing enterprise IT landscape [15].



**Figure 3.** SoE as a new layer surrounding ES – an outside-in revolution (based on Asprien et al. [23])

Figure 3 shows in the inner circle the expansion starting from MRP I throughout the development phases to ERP II, which is more or less the general concept of ERPS. It represents the layer of SoR, which is based on one central database, focused on repetitive, transactional processing, high availability and comprehensive security



mechanisms. The new SoE layer surrounds the SoR; these are systems or services, which are focused on end-user interaction and ease-of-use. They support collaboration and communication across different enterprise levels but are not tied to the inside view. The interactivity can happen between employees, customers and business partners but also between smart products and devices.

This means that instead of a further continuous expansion of ERP II, the iES of the digital age is driven by a new phenomenon: The strong integration and people-centric view, which is following an outside-in paradigm. This evolution is inescapable because user and stakeholder expectations have changed and demand a new level of interactivity across the whole enterprise networked ecosystem. As indicated in figure 3, the people-centricity not only enhances the layers of ES, it also opens up to a much larger group of people and devices that are interacting. The classical ERP II setup has already tended to open system boundaries for well-known stakeholders like customers or suppliers. Moving forward, with all the smart products from the Internet of Things (IoT), not only human beings interact with the system, but also devices and products. Overall, instead of only dedicated and named business partners, also unknown stakeholders are in scope of future iES-interactions. However, it is important to stress that the ERPS is not the direct front-end to all these people and devices because this interface is mediated by the SoE layer.

## 4 Implications for Teaching

Based on the evolution of ERPS towards iES and in particular the mind-shift from an ‘inside-out’ to an ‘outside-in’ perspective, we will elaborate the teaching implications of shifting from ES towards iES in networked ecosystems. At first, we justify why the evolution of ERPS (as outlined in section 3) should be a subject of teaching. Next, we focus on existing ways to teach ERPS by suggesting enhancements related to SoE / iES. Finally we argue, that it is important to not only distinguish SoE as an add-on to SoR (or ERPS), but also that new teaching approaches are required.

### 4.1 Assess Maturity: Evolution of ERPS as a Teaching Subject

Universities and educational institutes introduce learners to new trends and technologies. Ideally, the acquired knowledge can be adapted to the business reality so that graduates will help ‘their’ enterprise to exploit technological advancements. However, in addition to contributing new ideas and creating a vision of a future business world regarding a networked ecosystem, it is essential to be able to diagnose the current state in a given enterprise environment.

Learners, therefore, need a sound knowledge of the ERPS/ES evolution stages, as the reality in the enterprises can be very diverse and stuck in old paradigms. While some enterprises are already entering the transformation towards iES, others might enhance their currently used classical ERPS with ERP II and further functionalities. Certain enterprises may not even use an ERPS at all and thus require guidance on how to implement an iES.

Since every enterprise is unique, there is not one common strategy to achieve the transformation towards an iES. For that reason, future IT professionals need to be skilled to determine the maturity level of an enterprise's application landscape. Based on that, next steps can be identified to manage the change from an inside-out to an outside-in orientation. Understanding the ERPS/ES evolution from MRP I up to today's iES – as shown in figure 2 – serves as an essential prerequisite.

#### **4.2 Inside-Out: Enhancing Existing Ways**

ES are complex and it takes a considerable effort to build a thorough understanding of the ERP-related principles and concepts. Therefore, teaching ERPS with a focus on the internal needs of an enterprise is a valid start to enter the topic. Gaining an insight into the processes and structures reflecting an enterprise, helps to build a base for delineating the scope of a classical ERPS.

However, we postulate that existing ways of teaching ES benefit from enhancements towards SoE or rather iES. When talking about classical ES, it is regarded as a commodity. Attracting learners for this topic is challenging, even though the labour market is in need of ERP professionals [38]. Adding some SoE-related engaging elements such as collaborating via social media, connecting to IoT devices or using mobile apps helps to initialize a mind-shift from an inside-out to an outside-in perspective and attracts in particular the new generation of learners.

Few examples exist where teaching already enters the SoE-world. Worth mentioning would be the curricula published by Prifti et al. [39] related to SAP ERP. They adapted the classical approach of end-to-end process execution by embedding it into the context of digital transformation. They start the learning journey with teaching business model innovation and digital innovation management. In addition, content related to IoT and sensor data is employed [39].

#### **4.3 Outside-In: Focus on Interconnection**

In order to teach the paradigm shift from an inside-oriented business perspective to an outside-oriented networked enterprise ecosystem, it is not sufficient to add to existing teaching approaches just some 'fancy' elements related to mobility or social media. More than that, a holistic view of iES needs to be established. However, when evaluating the existing approaches for ES/SoR teaching two shortfalls become obvious: First, the approaches show a lack of focus on a networked ecosystem, as it is standard in part already today and definitely will be in the future.

Consider the case of executing an end-to-end business process within an ERP product: In a common scenario, learners use the software to conduct the steps of a process chain such as fulfilling a customer order, starting from the inquiry throughout to the final payment settlement. This procedure helps to understand how a single business activity results in a complete business process serving an external customer. Even though, at some dedicated points within the process chain, the integration to other business functions like implications for the production unit or the purchasing department becomes visible but the whole setup is mainly driven by a straightforward,

chronological flow. Some more advanced teaching approaches, such as the ERP simulation game, incorporate some network effects. Nevertheless, the number of participants is restricted and does not reflect the openness of an ecosystem that includes IoT and social media.

The second shortfall relates to the lack of learners to influence the ES setup. The majority of teaching scenarios reduces the complexity by providing a pre-customized system of an imaginary enterprise. Learners move within the boundaries of given processes and interfaces. However, thinking about the future of iES, this scenario is obviously too restrictive. Instead of a closed enterprise perspective with clearly defined interactions (e.g. with customers and suppliers) a more interactive and open solution needs to be chosen. The current trend of classical ES moving towards the cloud will potentially be a key driver to realize such teaching setups (for example using cloud services like the ones based on Microsoft Azure Platform to gain hands-on experience with the interaction of ERP-, IoT- and analytical functionality).

One of the very promising, but also most challenging ways of teaching iES is a 'learning enterprise' scenario as described in section 2.2. It opens space for creativity by working on an own business idea. In the same way, it forces the learners to work from an outside-in perspective. Employees and business partners need to be attracted and supported by engagement and flexible interfaces. This is where SoE come into play. In addition, effectiveness needs to be considered, so that the IoT devices support a higher level of automation. By building an iES in a protected learning environment, learners gather valuable hands-on experience and get the chance to perceive business applications not as closed, unidimensional solutions, but as a means to support an enterprise's business tasks. Research conducted by Schneider [18] emphasizes that this understanding is essential for learners becoming an expert in the area of ERPS towards iES.

## 5 Conclusions and Outlook

The study has shown that ERPS, and ES in general, are opening their system boundaries. Characteristically, these systems mainly focus on enterprises' internal processes and provide functionality to support interfacing with some dedicated stakeholders. This is the 'classical' inside-out perspective. On the next level, iES will be the standard – based on open and networked platforms – which enables the interaction with a large amount of human and technical actors. Technological advancements like IoT, industry 4.0 or cloud computing are strong enablers, and business decision makers will not fail to incorporate this new generation of ES in their enterprises.

Therefore, the current learners – our future managers and IT professionals – need to build a deep understanding of ES, in particular ERPS and their evolution towards iES. As the study elaborated, higher educational institutes (can) use a variety of approaches to teach ERPS – they all differ in terms of product/vendor-dependence and comprehensiveness.

We argue that new/adapted curricula are needed, which reflect the networked character of interconnected ES. In particular, the learners should be enabled to actively shape an iES. Curricula should consider customizing iES according to different needs so that learners understand the potential of iES as a means to build a networked business ecosystem.

There is no doubt that the suggested teaching approaches are demanding. However, ERPS vendors are offering their systems as cloud-based solutions, which should facilitate their integration into teaching settings. Nevertheless, using a cloud environment and connecting it with different types of human and technical actors throughout a business network does not only open new potentials, but also comes along with some increased risks. Topics like (cyber) security, data protection as well as compliance requirements must be considered and need to be taught as part of a new era of interconnected enterprise computing.

Future research should go in two directions: firstly, new and challenging curricula and related learning environments should be developed and tested; these should focus on the digital transformation and the associated iES. Secondly, flanking activities should be integrated, such as security aspects, data protection and compliance requirements. Both require new curricula and learning scenarios that need to be developed and tested.

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