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Connecting universities with entrepreneurship through digital learning platform: functional requirements and education-based knowledge exchange activities

Received 15 July 2019
Revised 16 February 2020
7 April 2020
Accepted 14 April 2020

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Abstract

Purpose – Studies on academic entrepreneurship (AE) agree on the significant impact that Universities can have on entrepreneurial development. AE deploys through fundamental activities, like the start-up of new companies and the connection of the University with Enterprises. The purpose of this paper is to analyse the role of digital learning platforms (DLP) to connect Universities and Enterprises effectively. Although the literature has extensively investigated DLP, there is a lack of understanding of the role of DLP in supporting digital AE. This paper focuses, in particular, on the functional requirements that have to distinguish the development of DLPs supporting education-based activities of knowledge transfer between academia and enterprise.

Design/methodology/approach – The research is carried out, adopting a case study methodology. A single and holistic case regarding a DLP developed for the strategic and exclusive deployment of AE activities is proposed to describe and discuss the functional requirements of such Platform.

Findings – The DLP is a virtual learning space in which Enterprises and Universities can interact. The definition of design requirements is crucial for the efficacy of DLPs and needs to be carefully supported. Various criteria are proposed, respect to the various stakeholders engaged in DAE learning platform (Universities, Enterprises, students, employees), and according to the short- and long-term objectives of Universities and Entrepreneurship connection.

Originality/value – The paper explores an original case of DLP established in AE, to connect Universities and Enterprises. The research also sheds light on the under focussed typology of AE activities regarding education-based knowledge exchange. They are currently unaddressed by the literature on AE.

Keywords Academic entrepreneurship, Digital academic entrepreneurship, Digital learning platform, MOOCs functions, Enterprise university

Paper type Research paper

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The authors thank the Consortium of Universities and Enterprises who performed the project BAEKTEL, and the Education, Audiovisual and Culture Executive Agency (EACEA), who funded it in the context of the EU programme TEMPUS IV, *6th Call for application*.

International Journal of Entrepreneurial Behavior & Research
Vol. 26 No. 7, 2020
pp. 1525-1545
Emerald Publishing Limited
1355-2554
DOI 10.1108/IJEBR-07-2019-0434

Introduction

The role and mission of the University have evolved in the last decades. Nowadays, universities play an essential role in catalysing local development through their activities such as transfer of knowledge and technology to the market, supporting the education of people and workers, contributing to the growth of local socio-economic wealth.

Particularly in the last decades a wide range of entrepreneurial activities performed by universities, labelled in the so-called 'third-mission' of the universities, have nurtured the development of a research stream identified as Academic Entrepreneurship (AE).

AE assumes that Universities through the implementation of research-driven entrepreneurial activities, the transfer of knowledge to the companies, the commercialization of technology, and other external activities can have an impact on entrepreneurship development, on the local wealth growth and the University's sustainability. AE involves activities such as the start-up of new companies and the connection of the University with Enterprises. However, more recently, researchers are theorizing on the phenomenon of AE, trying to understand the overall dynamics, the specific constructs and the general concepts underpinning it. In this view, a specific perspective acquiring the attention of scholars is the AE involving Digital Technologies.

This paper aims to contribute to understanding how to best exploit Digital Technologies in AE (Etzkowitz and Leydesdorff, 2000; Rippa and Secundo, 2018). The purpose is to detect the functional elements of a digital learning platform (DLP), aiming to support education-based knowledge exchange activities between Academia and Enterprise, by leveraging on the multiple, multi-sided network effects of digital platforms. The key research question is: What are the functions that a DLP has to integrate to link Academia and Enterprises successfully?

Although the literature has extensively investigated DLP, there is a lack of understanding of the role of DLP in supporting digital AE. Adopting a single case study methodology (Baxter and Jack, 2008; Yin, 2009), focusing on a DLP called BAEKTEL (*Blending Academic and Entrepreneurial Knowledge in Technology Enhanced Learning*) the key functional dimensions that a DLP has to present are outlined. The paper is structured as follows. In the first section, the conceptual issues of AE and Academic Engagement are introduced. In the second section, the DLPs supporting knowledge exchange between University and Enterprises are presented. Section three introduces the research methodology and the reasons for choosing a depth-case study to draw insights about the functionalities that have to distinguish a DLP supporting education-based knowledge exchange between Universities and Enterprises. Section four presents the finding of the empirical investigation. Section five proposes a discussion of the findings and section six closes with the conclusions.

Theoretical background

AE and education-based knowledge exchange

Traditionally academia developed activities of research and education, according to its missions of enhancing the scientific knowledge and contributing to higher education. These two fundamental goals of academia have been extended in the last decades according to the new paradigm of Entrepreneurial University (Etzkowitz, 2004; Gibb *et al.*, 2013; Rothaermel *et al.*, 2007). Indeed, increasingly universities are looking for ways of increasing their financial sustainability and make a better impact on entrepreneurship and society. So, Universities have embraced the entrepreneurial paradigm and recognized among their fundamental role the one so-called 'third mission' – also known as Third Stream Activity (Fuller and Pickernell, 2018; Gibb *et al.*, 2013; Perkman *et al.*, 2013). As a result, Universities are not only engaged in performing long-term research activities but also interact with industry (Etzkowitz and Leydesdorff, 2000; Laredo, 2007).

The 'Entrepreneurial University' concept deploys in force of the mutually beneficial effects of knowledge exchange between University and Industry (Etzkowitz, 2004; Etzkowitz and Leydesdorff, 2000), driven by activities approached and managed with entrepreneurial spirit by academics. Then a spiral model of innovation, rather than a linear one, effectively captures the multiple reciprocal linkages at different stages of the capitalization of knowledge (Etzkowitz, 1994; Etzkowitz and Leydesdorff, 1995). The Entrepreneurial University concept becomes then the scientific 'envelope' into which explore the University–Industry relations as theorized by the Triple-Helix model (Etzkowitz and Leydesdorff, 2000).

In the on-going debate about Entrepreneurial University, two main research streams can be recognized: *Academic Entrepreneurship* (Etzkowitz, 2004; O'Shea *et al.*, 2004; Siegel and Wright, 2015) and *Academic Engagement* (Fuller and Pickernell, 2018; Perkman *et al.*, 2013; de Wit-de Vries *et al.*, 2019).

AE is the research stream focusing on the University's activities aimed at the commercialization of knowledge and technology, which has a market value (Louis *et al.*, 1989; O'Shea *et al.*, 2004). AE is the set of activities by which scholars develop research-oriented ideas or products, and bring them to market to gain funds, influence, or reputation of individuals or institutions (Louis *et al.*, 1989). It involves among other activities patenting, licensing, joint ventures, spin-off, supporting start-ups, creating new firms, technology transfer through incubators and science parks (Agrawal, 2001; Rothaermel *et al.*, 2007). Within this range of activities Fuller and Pickernell (2018) identified four categories. Three out of the four categories of activities are related to spin-offs [(1) *Staff spin-off activity*, (2) *Non-HEI Owned Spin-Off Activity*, (3) *Graduate Start-up Activity*], and one is related to university knowledge creation, exchange and exploitation activities. They called this one *University Knowledge Exploitation Activity* (e.g. contract research, disclosure, patent application) (Fuller and Pickernell, 2018).

Academic engagement, instead, focuses on no-commercial activities carried out by academics in the accomplishment of the entrepreneurial mission of University. These activities have no direct commercial exploitation for the University. Academic engagement is closely aligned with traditional academic research activities, and it is pursued by academics to gain access to research assets, like research inputs, research ideas and agendas (Perkman *et al.*, 2013).

Academic engagement aims to catalyse local cultural, social and economic development (Perkman *et al.*, 2013). It involves collaborative research, contract research, sponsored research, consulting and informal relationships for university-industry knowledge transfer, providing *ad hoc* advice, networking with practitioners, and other forms of knowledge exchange, are practices of a greater importance as they allow to put in place the fundamental knowledge interactions between University and Enterprises (Fuller and Pickernell, 2018; Perkman *et al.*, 2013; Rothaermel *et al.*, 2007; de Wit-de Vries *et al.*, 2019).

The academic engagement has the nature of a research-based partnership (Perkmann and Walsh, 2007; de Wit-de Vries *et al.*, 2019). It is characterized by high relational involvement of academics with industry personnel, academic-industrial blended teamwork, project-based, and shared output. However, it can also include other collaborations with limited interaction or that require little or no new research.

Although Academic Engagement and Academic Entrepreneurship are two main research streams, they do not represent the whole system of activities performed by entrepreneurial Universities (Laredo, 2007).

According to the literature the third-mission activities performed by universities concerning the external environment can be seen in three dimensions: technology transfer and innovation, continuing education, social engagement (E3M, 2010; Etzkowitz and Leydesdorff, 2000; Laredo, 2007; Rippa and Secundo, 2018). Accordingly, AE can be considered as an entrepreneurial activity in which University could be involved (Rippa and Secundo, 2018; Rothaermel *et al.*, 2007), regardless of the aim (commercial or not). As a result,

the boundaries between Academic Entrepreneurship and Academic Engagement are blurred (Fuller and Pickernell, 2018; Rippa and Secundo, 2018; Rothaermel *et al.*, 2007). Widening the interpretation, the AE includes activities related to social and economic benefits of the ecosystem in which the University operates, including the creation of students and alumni start-ups, equipping of students with entrepreneurial education and training, job creation in the local region (Siegel and Wright, 2015).

A dimension of the AE is the related exchange of knowledge between University and Enterprises. This typology of activities includes, but not limited to, contract education and contract training, knowledge advice, testimonial lectures of companies' expert in academic courses, design of ad-hoc training and education programs for companies, exchange of knowledge resources and technical contents. The relevance of exposing academic educational activities with industry to better support students' learning has been discussed (Lin and Bozeman, 2006). However, the understanding of the education-based knowledge exchange activities has not received sufficient attention in the literature (Perkman *et al.*, 2013).

The exchange of knowledge between University and Industry is a critical driver of innovation and growth (Perkman *et al.*, 2013; Schiuma and Carlucci, 2018). Researchers benefit from the knowledge of the industry, as it can inspire new research directions and provides additional funding (D'Este and Perkman, 2011). Besides academics can benefit from the knowledge exchange with enterprises to update and align teaching contents with industry topics and trends. Furthermore, entrepreneurs and companies' experts can take, from academics' knowledge, inspirations and theoretical grounding for their projects and business ideas.

In the AE, the set of activities aimed at supporting and facilitating the process of education-based knowledge exchange employing activities like teaching, managing the interactions, sharing data and know-how can be facilitated by digital technologies (de Wit-de Vries *et al.*, 2019). Indeed, digital technologies are permeating educational activities and affect the quality and the quantity of the knowledge exchanged and the stocks of knowledge in both University and Enterprises.

DLPs to support education-based knowledge

In parallel to Academic Entrepreneurship studies, the growing interest of Enterprises toward the key knowledge sources has pointed out the importance of University–Industry relationships. Enterprises are looking to University envisaging strategic access to knowledge resources. In this perspective, Digital Technologies are allowing to overcome the limitations imposed by traditional models and channels of knowledge exchange, and are opening up to new models of University–Enterprise connections (Hull *et al.*, 2007; Kraus *et al.*, 2019; Nambisan, 2017; Williams *et al.*, 2008; Zaheer *et al.*, 2019).

The goals of the connections supported by digital technologies are of strategic importance to assist current employees (workforce, or managers) with lifelong learning, to inspire entrepreneurs with academics' findings and knowledge, and to enhance the education of University's students (prospective employees of the enterprises). Indeed, the cultivation of talents during University education and the training of employees is of strategic importance for enterprises (Chen, 2019). To attain these strategic goal enterprises are seeking to join networks of Knowledge exchange with Universities.

The participation to networks of knowledge exchange with University and enterprises, with a connection node operated by a DLP, allows enterprises to cut costs, gain efficiency in the process of learning, increase quality and originality of the acquired knowledge. A DLP provides the advantages of network effects (Brokaw, 2014), by accessing same-side (enterprises') knowledge sources, and cross-side (universities') ones.

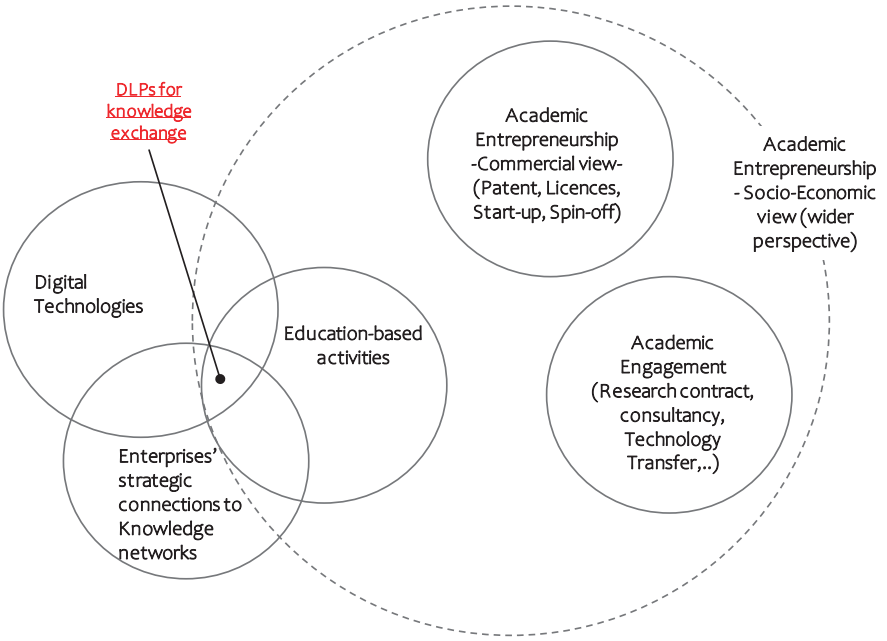

Figure 1.
Mapping Academic Entrepreneurship dimensions and positioning the role DLP to connect University and Enterprise

Although these education-based activities are part of the AE (Fuller and Pickernell, 2018; Rippa and Secundo, 2018; Rothaermel *et al.*, 2007), there is a lack of understanding of the characteristics that such DLPs should present to support education-based knowledge exchange activities between University and Industry (see Figure 1).

Digital Technology has its essence in the digitalization of data and information, which enables to move and elaborate, by the mean of an Internet connection, hardware and software, unlimited quantity information services.

All the Digital technologies–social media, mobile, business analytics, Internet of things, big data, advanced manufacturing, 3D printing, cloud and cyber-solutions, MOOCs, artificial intelligence (Fisher and Reuber, 2011; Rippa and Secundo, 2018) – are made up of three elements: artefacts, infrastructure, platforms (Nambisan, 2017). Artefacts are the digital components, applications, media contents, that are embedded in a new product or service, providing a specific functionality or value to the end-user. Digital Infrastructure is the digital technology tool and system allowing the communication, collaboration or computing (Nambisan, 2017). The digital platform is a system combination of architecture and services able to host a complimentary product or service, which include digital artefacts (Tiwana *et al.*, 2010).

(Parker *et al.*, 2017) argue that the digital platforms provide matches among producers and consumers and facilitate the exchange of goods, services or social currency, enabling value creation for all through the digital technology. It is possible to consider a DLP as a combination of interacting functions (Nambisan, 2017; Williams *et al.*, 2008):

(1) Architecture of interacting recipients of data,

(2) Services to access, retrieve, select and combine of digital artefacts in response to users' request,

(3) Hosting of digital artefacts.

DLPs can connect University and Entrepreneurship supporting a range of activities and particularly the knowledge exchange through education-based initiatives. The traditional exchange of knowledge occurred by the mean of physical products (such as books, reports, drawings, and technical designs) or social interactions (such as teaching lessons, training, and coaching); by the mean of DLPs, the exchange of knowledge overcomes physical and organizational limitations and constraints concerning quality and budget. DLPs easily support the exchange of academicians' knowledge with students and employees, as well as experts from industry, can share their knowledge with university students (that can also be seen as prospective employees), talents, and scholars (researcher and lecturers). DLPs can be deployed to deliver single knowledge contents, as well as MOOCs, courses designed to meet a large number of learners geographically dispersed (Stuchlikova and Kosa, 2013). So DLPs can be acknowledged as effective systems to support education-based knowledge exchange between University and Enterprise. DLPs can be seen as a system connecting the University and Industry to support education-based knowledge transfer activities. Despite the potential role of DLPs, there is a lack of understanding of the range of services that they can integrate to connect universities and enterprises. The definition of the possible services represents a new demand for the design and experimentation of platforms' functions to support the education-based knowledge transfer of University–Industry relationships (see Figure 2).

The functional design of the DLP can involve the trade-off among functions, depending on the number and heterogeneity of learning demands. A wide range of studies has highlighted the relevance of the personalization of DLPs services, according to the diversity of users-learners, backgrounds, user's learning styles, thematic areas which impact on the functional and system design (Cirulli *et al.*, 2016; Elia *et al.*, 2009; García-Peñalvo *et al.*, 2017; Secundo *et al.*, 2008). In this light xMOOCs and cMOOCs are extreme typologies of a spectrum of DLPs solutions which respond to theoretical, ideal learning styles of the user: constructivism versus connectivism (Elia *et al.*, 2009; Mazni and Abdulkadir Osman, 2019; Secundo *et al.*, 2008). The MOOCs, whose aim is the balance of opposed pedagogical models, result in hybrid-MOOCs (h-MOOCs) (García-Peñalvo *et al.*, 2017).

The process of understanding users involves abstraction of why different stakeholders perform certain activities, what their constraints and preferences are, and how trade-offs of their competing needs can best be balanced (Law *et al.*, 2012).

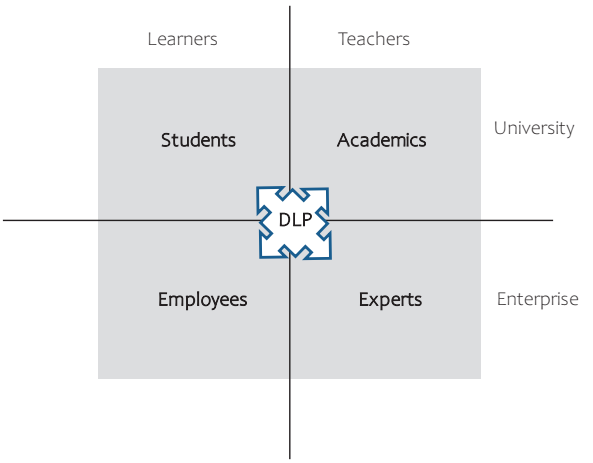

Figure 2.
Stakeholders of the education-based knowledge transfer

An important meta-function of the DLP is their capacity to support a Responsive Open Learning Environment (Law *et al.*, 2012). Indeed, a DLP should enable the composition and federation of different learning services into a single Personal Learning Environment as well as an integrative approach for services, tools, and data relevant for the learning context of the learner.

Personalization of services is a crucial feature of DLPs because it also consists in the possibility of designing and delivering personalized learning paths according to different users and their diverse learning needs (Cirulli *et al.*, 2016; García-Peñalvo *et al.*, 2017).

The functional requirements of a DLP, for each group of stakeholders, can conflict (Wateridge, 1998) such as when users of a DLP have varied needs and habits (such as learning styles, disciplinary background). Therefore, the definition of functional requirements is crucial.

Functional requirements of a DLP

The key stakeholders involved in the learning process through a DLP are the learners and the producers of knowledge (such as lecturers). The formers can be university students or employees/entrepreneurs; the latter can be university scholars as well as enterprises' experts.

The majority of research has focused on the learner perspective, emphasizing the learner experience of MOOCs.

Assumed that DLPs are architecture and services able to host digital knowledge artefacts (Nambisan, 2017) we focus on functional requirements that a DLP should present to best support education-based knowledge exchange between Universities and Enterprises. The key elements to be acknowledged are hosting nodes, architecture, and services of a DLP.

The crucial driving objective for informing the functional requirements of a DLP is the Project purpose (Couillard, 1995; Davis, 1995). It is the effect DLP wants to deliver to users. For this reason, the platform should comply with specific functions.

Two platforms with the same digital artefacts can behave significantly different in the market due to their different functions (Williams *et al.*, 2008). In order to disclose the functional requirements of a DLP in an AE, it is considered the case of education-based activities supported by DLP to exchange knowledge between learners and lecturers, coming from universities and enterprises. This study assumes a stakeholder perspective in the functional design of a DLP, i.e. to consider learners (students and employees) and lecturers (academics and experts).

Since the adoption of a Requirement Model for E-Learning System design is crucial (Cirulli *et al.*, 2016; Law *et al.*, 2012; Mazni and Abdulkadir Osman, 2019) this study aims precisely to detect and model the critical functional elements.

Research methods

To understand the functional characteristics that a DLP should present to best support education-based knowledge exchange between Universities and Enterprises, a case study-based methodology has been adopted (Baxter and Jack, 2008; Yin, 2009). The reasons justifying the choice of adopting a case-study methodology are as follows:

(1) The focus of the study is to answer a 'how' question, so it is not needed (and it is not of interest) to manipulate the behaviour of involved entities; besides the study wanted to analyse the functional requirements of DLPs in the contextual conditions, specifically, the project Blending Academic and Entrepreneurial Knowledge in Technology Enhanced Learning (BAEKTEL);

(2) The case study method can be considered appropriate for this research because it allows empirical investigation of a contemporary phenomenon within its real-life

context using multiple sources of evidence (Glaser, B., Strauss, 1967; Saunders *et al.*, 2009; Yin, 2009).

(3) The method is suitable for early, exploratory research where the variables are not known, and the phenomenon is not yet completely understood (Baxter and Jack, 2008).

Case study research is 'an approved method when addressing the questions of why and how' (Mehman and Teuteberg, 2016) (p. 883). In our case, the fundamental question is: *how does a DLP support education-based networks of knowledge exchange between University and Enterprises?*

Case studies are widely adopted by scholars to build a theory or when they are conducting preliminary investigations on any new phenomenon (Mehman and Teuteberg, 2016; De Toni *et al.*, 2016). Case studies are an appropriate method when the purpose is to investigate a contemporary phenomenon using two primary sources of evidence, i.e. archival data and systematic interviewing (Yin, 2009). However, the findings of a case study are not expected to be widely generalizable but to contribute more substantially to the formulation of new hypotheses and to enable subsequent investigations according to other research designs. Specifically, it is adopted a Single case typology (Baxter and Jack, 2008; Yin, 2009).

The research context: BAEKTEL [1]

Blending Academic and Entrepreneurial Knowledge in Technology Enhanced Learning (BAEKTEL) is a project funded by the European Union under the TEMPUS program (sub-program 'Joint Projects', Action 'Higher Education and Society'). The objective of the project was to prototype a DLP to facilitate education-based knowledge exchange between the Balkan Universities and the Enterprises. The main feature is that all digital artefacts (knowledge resources) are Open Educational Resources (OERs) (Cirulli *et al.*, 2016; Unesco, 2009, 2012).

BAEKTEL's OERs include full courses, single knowledge resources, modules, textbooks, videos, tests, software and any other tool used to support free learning. In such a way, OERs can support the development of formal and informal learning. Prospective users of the platform can be University stakeholders (students, lecturers, researchers) and enterprises' stakeholders (employees, experts, managers, consultants) even entrepreneurs themselves.

Producers and providers of the OERs are, as well, from University and Enterprises: academics (both professors and researchers), and enterprises' experts/entrepreneurs.

BAEKTEL platform acts as a multisided platform (Brokaw, 2014; Hagiu and Wright, 2015; Parker *et al.*, 2017) whose transactions are based on knowledge objects give-and-take. The knowledge features that make unique and specific the BAEKTEL platform are listed as follows:

(1) *Open Educational Resources (OERs)* - All the knowledge resources are OERs;

(2) *Blended knowledge* - The platform blends knowledge artefacts coming from Academia (i.e. theoretical knowledge resources) and Enterprise (Expert knowledge resources);

(3) *Technology Enhanced Learning (TEL)* - Any knowledge artefact exchanged throughout the platform is digital (such as video lessons, case studies, audio, digital texts), then learning is wholly and exclusively enabled by the DLP.

The broader objective of BAEKTEL project was to foster partnerships between Universities and Enterprises, supporting knowledge exchange for the mutual benefit of both parts. By blending academic and entrepreneurial knowledge within a multisided DLP (BAEKTEL), through OERs, allow University and Enterprise to remove any physical and organizational

barrier. This effectively allows to fulfil 'expert knowledge' gaps insisting on University, and theoretical, just-in-time, task-relevant knowledge, as required by Enterprise (see Figure 3).

The Platform has been developed by a Consortium of Universities and Enterprises (Table 1).

Data collection and analysis

The stages of development of BAEKTEL have been accompanied by the codification of the main intermediate applied-research results. In compliance with the rules of the Tempus Program, and following the BAEKTEL's approved plan (WP.7 'Dissemination'), continuous and consistent dissemination of research results has been performed along with the whole duration of the Project, lasted 41 months (from December 2013 to April 2017).

All the project documents produced by the nine academic partners and the enterprises have been collected and stored in the Project repository. The documents were mostly internal documents accompanying and supporting the development. Once collected all the documents, they were reviewed by the authors, who extracted all qualitative, relevant data. Two of the authors were also part of the BAEKTEL project team. This enhanced accuracy and coherence of the information gathered. Also, the participation in the project enabled a rich and insightful reading of the sources, by considering 'on-field' information and dynamics, not reported by the project documents and data.

The data collection was enriched with the addition of other data from other sources, like project meeting minutes. Combination and triangulation of multiple sources of data (Yin, 2009) secured for the best validity possible.

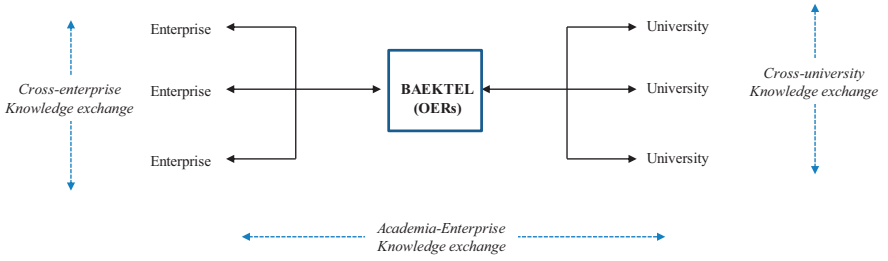

Figure 3.
The conceptual model of The DLP BAEKTEL

Partners' type	Partner's name
Academia	University of Belgrade, Belgrade, Serbia
	University of Kragujevac, Kragujevac, Serbia
	University of Nis, Nis, Serbia
	University of Basilicata, Potenza, Italy
	University of Banja Luka, Banja Luka, Bosnia Herzegovina
	University of Tuzla, Tuzla, Bosnia Herzegovina
	University Mediteran, Podgorica, Montenegro
	University of Ljiublijana, Ljubljana, Slovenia
	Technical University of Iasi, Iasi, Romania
Enterprise	NIS Petroleum Industry of Serbia, Novi Sad, Serbia
	Arcelor Mittal Prijedor, Prijedor, Bosnia Herzegovina

Table 1.
BAEKTEL–the performing consortium

Findings

In line with the prescribed components of digital technologies–infrastructure, platform and artefact (Nambisan, 2017; Rippa and Secundo, 2018; Tiwana *et al.*, 2010; Zaheer *et al.*, 2019) – the functional dimensions and key functions that characterize BAEKTEL are presented below. They set the basic functional characteristics a DLP should present to best support education-based knowledge exchange as they have emerged by the analysis of the case study.

Infrastructure

Infrastructure is the combination of digital technology tools and systems whose interaction allows the hosting and the exchange of OERS among a number of connected users. Main functional dimensions are: the Network, the Metadata portal, the Node.

The nodes provide the hosting of digital artefacts, so they make the knowledge OERs available to the network. Besides the local nodes of University/Enterprises, there is a Central node that works just as Metadata Portal. It stores all the metadata describing all the OERs. They provide all the essential information of a single OER or aggregated for all. This way, it allows centralized search, browses, and statistics regarding all the OERs dispersed in the network of nodes.

The central node also features the Metadata Portal. It is a web application for the management, the browse and search of metadata, and the web services for terminological and linguistic support. The functional requirements of the BAEKTEL's Infrastructure are as follow.

(1) *Networking*. This functional dimension attains to the collaboration and communication among the nodes. The digital infrastructure of BAEKTEL consists of a network of (six) nodes, which host OERs at the six Western Balkan universities, namely University of Belgrade (UB), University of Kragujevac (UNIKG), University of Niš (UNI) from Serbia, University of Banja Luka (UBL) and University of Tuzla (UNTZ) from Bosnia and Herzegovina and University Mediterranean (UNIM) from Montenegro. Each node has the technology to host the digital artefact, and the local academics develop and publish their OERs autonomously and independently from the other nodes (see Figure 4).

(2) *Scalability and modularity*. In addition to nodes, the infrastructure foresees a central repository, whose aim is to store, collect, and make available to any user the metadata of all the OERs stored in the network. Three important functions of the network of BAEKTEL are scalability, modularity, and registration.

In order to make scalable the infrastructure, by adding or removing nodes to the network, any University or Enterprise features its platform locally, with its OERs. The OERs are annotated with metadata before publishing, so to be retrievable and accessible by the other nodes, through a standard network's web portal (indexing web portal); by indexing data of OER in the web portal, any user can retrieve and access any OER presents the network.

The modular architecture of the Digital Technology BAEKTEL allows the operational autonomy of the nodes. Also, it allows the dismission and the effortless expansion or reduction of the network. More nodes at other institutions, academic or entrepreneurial equally, might join the BAEKTEL at any time. This function makes the technology responsive.

(3) *Openness*. The infrastructure can integrate digital artefacts (OERs) that are not created by nodes of the network, merely registering and describing the OER directly in the central metadata repository.

(4) *Indexing and Storing Metadata*. *Metadata function*. Metadata is 'data that describe other data' (Stanković *et al.*, 2014). It has the function of tagging any OER with the appropriate information, which allows an automated machine analysis. Metadata is the enabler of high performance of the coordination and combination of digital artefacts, thus of crucial learning activities, such as the search of learning contents within the digital artefacts, publishing, browsing contents, filtering, sorting, grouping, without going through each OER.

Metadata then help users find relevant learning resources and enable them to make informed decisions as to whether or not a particular resource is relevant to their purposes. Metadata is a machine-readable information content, inserted by the publishers of the OER into the code of OERs' web-page. Thus, the web metadata portal, once queried by the learner, acknowledges the knowledge content in the OER, and if the respondent to the query provides it as a consistent result.

The BAEKTEL development team performed a SWOT Analysis in order to select the best metadata standard for the case. BAEKTEL's approach to defining requirements of metadata was agreed as a combination of Dublin Core and LOM Standard (Stanković *et al.*, 2014). With this approach, the number of mandatory elements of the description of an OER was carefully selected, thus preventing metadata from becoming the bottleneck of the whole system (Stanković *et al.*, 2014).

(5) *OER recognisability - Metadata schema*. OER needs to be shared, accessible and discoverable by potential users across the learning environment, easy and fast. To this aim, OERs have been annotated in such a way that the users can recognize what specific learning objects are about, what is their learning content and prerequisites for their use, without even seeing them (Stanković *et al.*, 2014). It is crucial the quality of the description of OER and its tag. By these two activities, it depends on the efficacy and efficiency of the search, performed by the search engine. The description and tag of the OER have to comply with a standard under machine-readable forms. This ensures relevant results that both learners and teachers of DLP can compare.

(6) *OER discoverability - Indexing web portal*. In order to make the OER content more accessible as well as more discoverable, it is essential to provide users with advanced search features. All the OER content have been adequately described with metadata. For the indexing web portal, an assessment of the indexing and searching features, of the various digital asset management platforms, awarded ResourceSpace (http://www.resourcespace.org/) as best for managing metadata of BAEKTEL's OER. The functions provided by ResourceSpace were as follows: expandable to include advanced search capabilities (a search can be administered, other than by keywords, author, area, etc., by multilingual technical terms).

(7) *Hosting and Repository of OERs*. The local node, which corresponds to one networked University or Enterprise, functions as a repository. OER and the related metadata standards are often stored in the so-called Learning Object Repositories (LOR). Different LORs have different metadata schemas according to the different Artefacts' needs. A crucial requirement is achieving or improving interoperability among metadata records in order to enable federated searches and facilitate metadata management (Stanković *et al.*, 2014). A set of standards for describing DLOs can be considered for requirement definition, in order to standardize metadata and enable effective and efficient interoperability among LORs, and finally among knowledge, like Dublin Core (DCMI n.d.), LOM Standard (Association, 2002).

Digital platform

Digital Platform is a core as it deploys a set of functions able to provide the services to the users, combining digital artefacts. It hosts and provides a set of learning services, which mainly include OERs. The functions embedded in BAEKTEL can be reduced to learning, assessing, teaching, engaging, defined as follows.

(8) *Learning functions.* The learning functions offered by the platform are e-learning, webinars, web meetings, mobile access and learning, content authoring tools, tools for measuring real-time engagement in virtual classes and tracking individual student progress, templates for creation of landing pages, speaker information, registration pages, login pages and emails, customization tools (enabling the personalization of graphics with components, such as images, tables, charts, and carousels), engagement monitoring in real-time (with an engagement dashboard). A critical aspect of the learning experience is the easiness and the accuracy of the search of the OER. This way, users can find coherent OERs to respond to the specific need, or answer to, a specific question. This simple but strategic issue of DLP in BAEKTEL platforms is secured by an *indexing web portal* and a *learning platform.*

(9) *Assessing functions.* This function enables teachers in the academic environment to track the progress of students, as well as the company manager to track the learning advancement of employees. Both supervisors can monitor a set of data (such as hours spent, subjects, topics) and report how their students/employees are keeping pace with new knowledge (Obradović and Stanković, 2014).

(10) *Teaching functions.* Accessibility and use for DLO producers and users. An essential requirement is an easiness to use both by content creators and content users. edX backend control panel for producers-authors (edX Studio) makes it easy to combine different types of media and create a course structure that fulfils the didactic principle of systematization and gradualism. It also allows to create interactive tests, enable the user to self-evaluation, and track the progress of learning.

(11) *Engaging.* Suprafunctional elements are those functions of the DLP whose aim is leaving the learner a positive learning experience and engage (in terms of emotional, aspirational, cultural and social dimensions) (Williams *et al.*, 2008). According to a learner-centred approach, the BAEKTEL development team among the most interactive and user-friendly learning platforms designated edX platform, created by Massachusetts Institute of Technology, as the richest and most interactive user experience, compared to the other two most popular open-source learning platforms (OpenMOOC and Moodle).

(12) *Malleability.* Malleability is the ability the system platform has to adapt to changing market needs or requirements (Williams *et al.*, 2008). The edX distinctive features are the following ones: modular design, fast-growing community, use of third party plugins (software extensions that can be installed on top of the core framework to add new functionalities), regular learning tools addition (such as discussion board, equation editor, code execution simulators, etc.), simple and effective graphic design which result into a user-friendly interface (Radojičić *et al.*, 2014).

(13) *Learning Network.* Hence a network of edX nodes spread throughout partner countries, together with the Resource Space platform formed the core of the BAEKTEL framework.

(14) *Interactivity. Awareness in the learning process.* An essential requirement addressed by BAEKTEL has been active participation of users in the process of learning,

underlining their role as active subjects, as opposed to being passive bystanders. BAEKTEL enables the users to establish a specific interaction with the course creator, as well as the interaction between the user and the learning platform itself. This has been achieved by combining different types of questions, as well as animations and interactive applets which will demand direct user interaction.

(15) *Platform analytics (about OERs and functions).* A core function of BAEKTEL is the evaluation. The aim is to obtain user feedback on the quality of OER content, so to improve and further adapt to the end-user both contents and services. This is achieved by using standard questionnaires and by examining anonymous usage data generated by the learning platform.

The digital artefacts: OERs

The Digital Artefacts are the OERs. A set of functional requirements has been defined to provide valuable learning experiences of stakeholders (learners, teachers, of both types of Partners) of BAEKTEL.

(16) *Learning Flow. In* order to create and make available educational content in various teaching areas, and also in different industries, different users' background, different devices' technology, different forms of artefacts are needed. This implies the use of forms and formats of presentation contents: textbooks, scripts, PowerPoint presentations, various types of multimedia as video clips, audio recordings, animations and images.

(17) *Compliance–Adjusting the contents to the target learner.* One of the essential didactic criteria the OER must comply is compliance to a target learner. Since, the main subject is OER related to higher education institutions as well as partners from industry, the nature and the needs of the end-users are not unique. Hence, neither the level of education of the end-users nor their age or their motivation for using these means of education is easily predictable. That is why it is crucial to target courses and OERs to learners' profile. In such a way in each moment users are familiar with the aim, sum of knowledge and skills which can be obtained by a given course or digital content (Radojičić *et al.*, 2014) and can efficiently choose the learning service.

(18) *Description of OER (Describability).* The OER must allow to describe the course contents and all necessary prerequisites which a user must possess to follow the course's contents. The indexing web portal with metadata of the OER content should consider this too. The model of the metadata to enhance compliance is the Dublin Core standard as well as IEEE 1484.12.1-2002 Learning Object Metadata Standard (LOM). Then, it is more likely that users who decide to use a specific OER or take a specific course will meet the prerequisites and find the content useful, and thus be satisfied with the specific OER.

(19) *Heterogeneity of OERs' formats.* Combining different ways of digital learning objects, like plain and dynamic text, PowerPoint presentations, video clips and animations, and so on, allow to adjust the learning service, to the users' learning style (Felder and Silverman, 1988; Graf *et al.*, 2007; Radojičić *et al.*, 2014). The form of the digital content influences the quality of learning, that is the absorption of knowledge from the user can vary; can play an essential role in keeping the attention higher and the motivation to keep following the educational process.

(20) *Organizability.* The digital platform managing the OERs should satisfy the didactic principle of systematization and gradualism of the learning process. These principles

have been accomplished through the organization of the learning objects into a hierarchical structure, where significant learning contents (i.e. a course) are organized in smaller learning objects (like sections). BAEKTEL organizational levels were: courses, organized in sections, then into units, then into lessons (Radojičić *et al.*, 2014).

(21) *Self-consistency*. The OERs are the fundamental and elementary digital learning artefacts (objects), which have been designed in accordance to the principle of self-completeness, that is each object expresses its contents in a meaningful and consistent way, both if used as one single specific knowledge, that as part of course components.

(22) *Narration structure (Storytelling)*. The 'narrative' structure of the OER has been divided into three essential parts: introductory, main, resume/self-evaluation. In the introductory part it is introduced the content of the lesson with preliminary concepts, while awakening the interest of the user at the same time. Then the central part of the lesson consisting of the most significant part of the planned content, following the didactic principle of science. Finally, the third part of the lesson containing a short resume as well as some kind of self-evaluation consisting of questions and quizzes (Linzalone *et al.*, 2015; Radojičić *et al.*, 2014).

(23) *Scientific (reliability, verifiability)*. The elementary digital Learning contents of BAEKTEL embeds contemporary scientific development. Assumed that any learning subject cannot be fully explained and investigated in detail, in all aspects, and about the latest advancements of science, BAEKTEL implied one of the essential principles in the teaching process: to make learner familiar with the principal features and properties of a subject, as well as the connections and relations between subjects and phenomena. Hence, BAEKTEL comprehended digital learning materials according to the principle of science, and all the contents were reliable and verifiable.

(24) *Blending (of Academic and Entrepreneurial knowledge)*. One critical function, certainly the most iconic of BAEKTEL, is connecting the theory and the practice, which is blending and balancing academic knowledge and entrepreneurial knowledge OERs in the platform and the learning offer. This is achieved through the collection and connection of lessons produced by academics and entrepreneurs (or enterprises' experts). The digital platform is the connection which enables for the higher education institutions to enrich theoretical knowledge with examples of practical application offered by companies. On the other hand, partner enterprises use educational content offered by universities to enhance and renew the theoretical knowledge of entrepreneurs, experts and employees (Obradović and Stanković, 2014; Radojičić *et al.*, 2014; Stanković *et al.*, 2014).

Discussion and concluding remarks

Functions of a DLP connecting University and Enterprise

The paper presents a significative case of development of a DLP to support education-based knowledge exchange between University and Enterprise, within the theoretical frame of AE. The prototypal development of the platform BAEKTEL allowed to extract the functional characteristics of such DLP. Functional elements are strategic for successful DLP; however, the complexity and heterogeneity of users, suggest to analyse them in contextual situations, like this in AE.

In this perspective, the DLP BAEKTEL, although in a prototypal form, allowed to detect the mix of functions able to satisfy University and Enterprises.

The *function* level, more than the concept and the technical design levels, can shape the form and the performance of the DLP connecting Academia and Enterprises. Indeed,

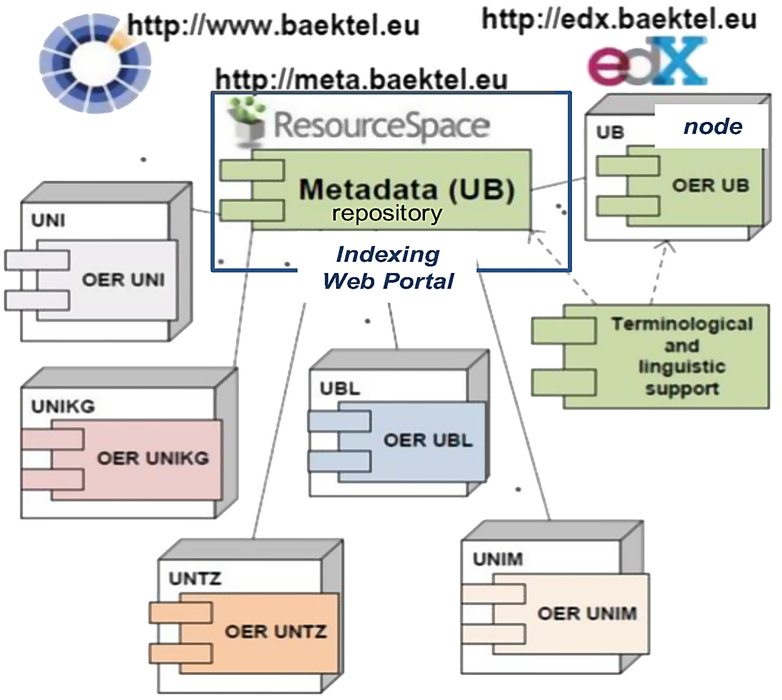

Figure 4.
The network structure of the Digital Infrastructure BAEKTEL

relations between Academia and Enterprises should be based on Partnerships, purposely designed both in terms of contents and technology infrastructure (Schiuma and Carlucci, 2018).

About the Technology Infrastructure, the case of BAEKTEL highlights 24 driving functional requirements for a DLP. They drive the design of three main BAEKTEL's design dimensions: Infrastructure (7), Platform (8), Artefact (9) (Figure 5).

The literature reports some other cases of DLP solutions such as APOLLO a MOOC system (Cirulli *et al.*, 2016) mainly based on the design of three critical assets: (1) an open-source technological platform; (2) a learning catalogue organized around the TER; (3) a purposeful software component developed to allow learners to access and use the digital contents effectively.

The platform used in APOLLO is an Open edX, which is currently the most visually engaging learning and teaching MOOC environment, supported by Stanford University, Google and many other international universities. The platform includes a learning management system (LMS) for content delivery and management of interaction with teachers and learners, and a content management system (CMS) to manage the creation and delivery of digital materials and courses. Other learning services include discussion groups, wikis, real-time assessment, and other interactive tools. By adopting an open approach to feed the knowledge base of the system, it is possible to involve companies, universities, experts and stakeholders in the design and implementation of online courses (Cirulli *et al.*, 2016).

It is particularly interesting compare the empirical results arising from the BAEKTEL case, with the theoretical 'i-Learning Model' proposed by (Elia, 2010). 'i-Learning Model' is an interdisciplinary framework that integrates managerial, organization, and technology dimensions, with strategic learning objectives in the current technology-enhanced

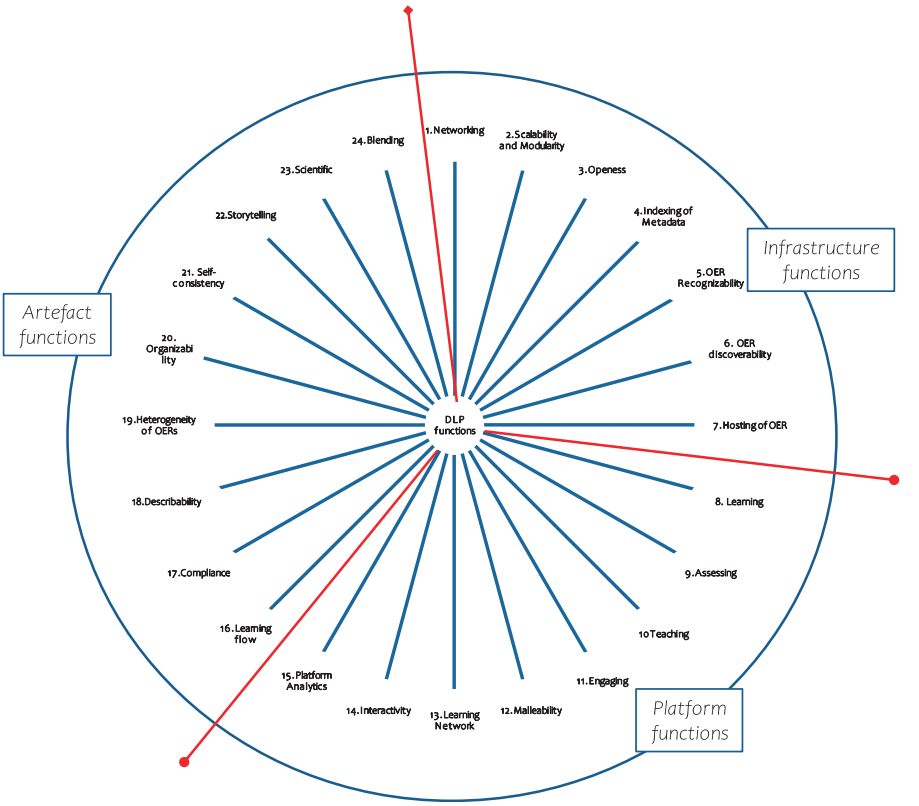

Figure 5.
Functional requirements of a DLP supporting education-based knowledge exchange between Universities and Enterprises

competitive scenario. The Model proposes six key dimensions/features that should characterize learning of adult learners (high education targets, and workers), in competitive organizations, to align organizational strategies with learning objectives. The six critical features are: *interactivity*, *immediacy*, *internetworking*, *individualization*, *interdisciplinarity*, *interoperability*. To a certain extent 5 out of 6 are confirmed by BAEKTEL. Namely *interactivity* is verifiable in BAEKTEL's functionalities ('14. Interactivity'), *immediacy* is attributable to the functions '5. OER Recognizability' and '6. OER Discoverability', *internetworking* can be associated to the interaction of '1. Networking', '3. Openess' and '13. Learning Network', *individualization* is reflected by the functions system included in '8. Learning', while *interdisciplinarity* is partially attributable to '4. Blending', and *Interoperability* appears not addressed.

Implications for theory and practice

The findings emerging form the presentation of the BAEKTEL case provide contributions to the ongoing scientific debate on the role of digital technologies to support AE. While knowledge exchange partnership between Academia and Enterprise were mainly based on tacit knowledge spillovers and personal interactions, recent developments in the context of digital technologies provide the ground for the exploration of new activities and the discovering of new ways of deploying knowledge and disclosing valuable relations in University–Enterprise.

The possible combinations of digitalization in the university ecosystem results in a diversity of phenomena with significantly different characteristics and socio-economic impacts (Giones and Brem, 2017), overhauling the 'traditional' mission of commercializing academic research (Siegel and Wright, 2015).

Pervasive Digital Technologies, like particularly DLPs, is opening new avenues for research and practice, like the emerging opportunity of crossing research and practice on Multisided platform Business models (Amit and Zott, 2012; Hagiu and Wright, 2015; Zott *et al.*, 2011) and E-Learning (Laksitowening *et al.*, 2016; Radojičić *et al.*, 2014; Senthil Kumaran and Sankar, 2013).

The functional design of the BAEKTEL platform represents a mechanism to connect and align stakeholders in the context of AE, despite their different backgrounds (Simeone *et al.*, 2017).

This article provides insights about the rationale of the adoption of digital technologies for AE, exploring a new form of digital AE enabled by DLPs that are designed to support the exchange education-based knowledge objectives. The proposed framework offers insights both for theory and for practice. From a conceptual point of view, it provides the dimensions to analyse and interpret how digital technologies can be deployed and exploit to support knowledge transfer about educational activities aimed at providing benefits both for academia and for enterprise. These dimensions help to open up a new debate about how AE should focus on University–Industry knowledge transfer based on the exchange of educational knowledge objects. From practical point of view the framework provides guidelines to design and assess digital platform aiming to support educational activities connecting Universities and Enterprises.

The research carried out, also suggest a strategy to respond to the need of Universities and Enterprise in regions aiming to foster local entrepreneurial development, to overcome socio-economic contextual limitations and connect with advanced knowledge networks (Bizri *et al.*, 2019). A model for entrepreneurial universities that operate in underdeveloped or developing countries, for instance, should carefully consider the potentiality of DLP to catalyse the formation and development of knowledge networks.

In the current and active debate on how to rethink and update the university system (Chen, 2019; Gibb *et al.*, 2013; Vesperi and Gagnidze, 2019), AE has to consider the potential of DLPs.

Furthermore, in response to the debate on the development of competitive professionals in the current socio-economic context, a recognition of the potentialities of DLP, is required. Elia *et al.* (2017), outlining a possible pathway towards the 'entrepreneurial university" model, highlight the need for integrating research, education and innovation, and promoting public-private partnership.

This paper contributes to addressing the Digital Entrepreneurship research in the context of Academia, by leveraging on the business offered by multisided platforms. (Zaheer *et al.*, 2019) argue that in the current third phase of development of research on Digital Entrepreneurship, the primary task is the business model transformation in an environment of ubiquitous connectivity. The authors outline the foundations for the fourth phase of research, aimed to embrace a broader range of contexts so that research can inform policy and practice at not just global but more granular levels. University indeed represents a context of deepening. It is urged that the scientific community to incorporate design science and action research methods, collaborate with practitioners in conceptualizing the research questions, and produce output that can inform policy and practice.

Conclusions

This paper, through the analysis of a case study, offers an analysis of the functional requirements of a DLP that can support AE focusing on University–Enterprises education-based knowledge exchange activities. The components of a DLP which should

be addressed with functional requirements according to BAEKTEL are Architecture and Network, Nodes, Learning services. Implications drawn from the empirical analysis are relevant for both University and enterprises.

However, it is necessary to recognize the limits of the use of a research approach based on case studies, widely discussed in the literature, and mainly related to the limited generalizability of the findings. Nonetheless, the explorative nature of the research has helped to define a framework that has value both for theory and practice. From a conceptual point of view, it provides the dimensions to analyse and interpret how digital technologies can be deployed and exploit to support knowledge transfer about educational activities aimed at providing benefits both for academia and for enterprise. While from practical point of view the framework provides guidelines to design and assess digital platform to support knowledge-based exchange between Universities and Enterprises. Further research about the use of digital technologies to support AE are necessary to better understand how Universities and Enterprises can deploy DLP to create mutual benefits.

Note

1. *Project website:* www.baektel.eu*; BAEKTEL DLP platform:* http://edx.baektel.eu/

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