

# Preface

The information systems have evolved in what today are called technological ecosystems for providing support to the management of information and knowledge in heterogeneous environments (García-Peñalvo et al., 2015a, 2015b). Recently, it has been detected a fundamental change in discussions about innovation in the current technological systems, both academic and political context, towards ecology and ecosystems (Adkins, Foth, Summerville, & Higgs, 2007; Adomavicius, Bockstedt, Gupta, & Kauffman, 2006; Aubusson, 2002; Birrer, 2006; Bollier, 2000; Crouzier, 2015; Smith, 2006; Tatnall & Davey, 2004; Watanabe & Fukuda, 2006; Zacharakis, Shepherd, & Coombs, 2003). The European Commission has begun to use the concepts of ecology and ecosystems as tools for regional innovation policy that are aimed at achieving the Lisbon Agreement goals (Dini et al., 2005; Nachira, 2002). The European Union considers digital ecosystems as a clear evolution of e-business tools and collaborative environments for organizational networks. Inside the project Digital Ecosystems promoted by the Directorate General Information Society and Media of the European Commission, a digital ecosystem has an architecture based on Open Source software components that work together to evolve and become gradually smarter through the ideas and components from the community (European Commission, 2006). In fact, the metaphor of the technology ecosystem comes from the biology area and it is transferred to the social area to better represent the evolving nature of relationships between people, their innovation activities and their environments (Papaioannou, Wield, & Chataway, 2009); to the services area as a more generic conceptualization of economic and social actors that create value in complex systems (Frow et al., 2014; Vargo & Lusch, 2011); and to the technological area, inspired by the business and biological ecosystem concepts of Moore (Moore, 1993) and Iansiti (Iansiti & Levien, 2004) in order to define the Software ECOsystems (SECO) (Yu & Deng, 2011). A software ecosystem refers to the set of businesses and their interrelationships in a common software product or service market (Jansen, Finkelstein, & Brinkkemper, 2009) or, from an architectural point of view, it is the structure or structures of the software ecosystem in terms of elements, the properties of these elements, and the relationships among these elements, where elements can be systems, system components, and actors (Manikas & Hansen, 2013).

Messerschmitt and Szyperski (2005) are the firsts to talk about software ecosystem to refer to a collection of software products that have some given degree of symbiotic relationships. According to Dhungana, Groher, Schludermann, and Biffi (2010) a software ecosystem can be compared with a biological ecosystem from the perspective of resource management and biodiversity and underline the importance of diversity, monitoring of health and supporting social interaction. This relationship between nature and technology appears in other authors, who use the definition of natural ecosystem to support its own definition of technological ecosystem (Chang & West, 2006; Chen & Chang, 2007; Laanpere, 2012; Pata, 2011). There are several definitions of natural or biological ecosystem but there are three elements that are present in all of them (Berthelemy, 2013): the organisms, the physical environment in which they carry out their basic functions, and the set of relationships among organisms and the environment. Thus, the technological ecosystem can be defined as a set of software components related to each other through information flows in a physical environment that provides support for such flows (García-Holgado & García-Peñalvo, 2013). Moreover, the users are part of any technological ecosystem, they are other key component such as the technological tools (Conde, García-Peñalvo, Rodríguez-Conde, Alier, & García-Holgado, 2014; García-Peñalvo & Conde, 2014).

The metaphor of ecosystem has been chosen to provide technological solutions to give suitable answers to knowledge management problems in heterogeneous contexts. There are several examples in the domain of Public Administration (García-Holgado & García-Peñalvo, 2014), in the informal learning management context (García-Peñalvo, Johnson, Alves, Minović, & Conde-González, 2014), in the domain of education (García-Holgado & García-Peñalvo, 2016; Llorens, Molina, Compañ, & Satorre, 2014), in the research context (for examples see chapter 6 by Dhananjay S. Deshpande et al. and chapter 10 by Özgün Imre in this book), in the domain of Libraries (Chad, 2013), etc.

## **DEVELOPMENT OF TECHNOLOGICAL ECOSYSTEMS**

The definition of technological ecosystems is a complex process with a wide range of requirements. Each technological ecosystem is unique. It is very difficult to find two different institutions or companies that share the exact same problems and goals regarding their own knowledge management (García-Holgado & García-Peñalvo, 2013).

Technological ecosystems should have the ability to recognize a complex network of independent interrelationships among the components that compose its architecture, while offering an analytical framework for understanding the specific evolution

patterns of its technology infrastructure, taking into account that its components must be able to adapt to changes suffered by the ecosystem and not collapse before them if they cannot accept the new conditions (Pickett & Cadenasso, 2002). Technological ecosystems should connect and relate the different tools and services that arise and serve for the knowledge management, building technological ecosystems, increasingly complex internally, from the semantic interoperability of its components to transparently provide more functionality and simplicity to its users. In particular, the use of service oriented architectures has increasing in the development of learning systems, as these are currently not a single system or monolithic platform (Pardo & Delgado Kloos, 2011), but more and more services and tools are used to create heterogeneous ecosystems (for a review of interoperability in learning ecosystems see Nikolas Galanis et al. chapter in this book).

Besides, to overcome the problems related to link different applications, from a technological point of view, a technological ecosystem should be developed using a technological framework that allow the evolution and adaptation of the different components of the ecosystem itself and also permit for the incorporation of new components that extend its functionality. In this book, there are several chapters focused on providing a framework to develop different types of technological ecosystems such as gamification ecosystems or learning ecosystems (see chapter 1, 4 and 5). When defining a framework for technology ecosystems we should take into account the integration, the interoperability and the evolution of its components, and a proper definition of the architecture that supports it (Bo, Qinghua, Jie, Haifei, & Mu, 2009; Bosch, 2010; García-Peñalvo, Conde, Alier, & Casany, 2011; Gustavsson & Fredriksson, 2003). The current status and technical and technological evolution of digital ecosystems has a very pronounced parallelism with all the technology that develops around the Internet and cloud services. More specifically, the evolution in making data collection, analysis procedures and decision-making are based on certain types of emerging technologies such as the Internet of Things (Domingo & Forner, 2010), processes that extract concepts of Business Intelligence (Ferguson, 2012; Long & Siemens, 2011), or data mining processes applied to knowledge management (Romero & Ventura, 2007, 2010; Yukselturk, Ozekes, & Türel, 2014).

## **THE CHALLENGES**

Namely, the ecosystems make possible provide new and improved services that the single tools cannot be able to provide separately to resolve knowledge and information management problems inside any kind of institution or company, but the development of these technological solutions should face several challenges such as:

- The challenge of supporting decision-making processes to improve technological ecosystems and the processes related to the knowledge management.
- The challenge of establishing interoperability protocols and standards between the different components that compose the ecosystem.
- The challenge of defining a framework to develop technological ecosystems that can evolve and adapt to the changing needs not only of users, but also of the technology itself.

The main goal of this book is exploring the evolution of the knowledge management systems based on Open Source software in any kind of context, from companies to institutions, and providing different approaches to resolve the challenges related to technological ecosystems.

## **ORGANIZATION OF THE BOOK**

The book is organized into ten chapters. A brief description of each of the chapters follows:

Chapter 1, “Enhancing Education for the Knowledge Society Era with Learning Ecosystems”, identifies the existing challenges in educational and knowledge management processes. In particular, the application of information technologies for the improvement of teaching and learning processes. The chapter proposes a new educational technology framework to support educational processes, the learning ecosystem.

Chapter 2, “Tools Interoperability for Learning Management Systems”, addresses the issue of the interoperability in learning ecosystems where the main component is a virtual learning environment (VLE) or a learning management system (LMS) that is integrating with external learning tools. This chapter focuses on the service-oriented approach to interoperability and present two approaches, the OKI and the IMS standards and the TSUGI framework.

Chapter 3, “Technological Ecosystem Maps for IT Governance: Application to a Higher Education Institution”, presents a model to evaluate the situation of the technological ecosystem of an organization in order to determine its features and the state of its technological ecosystem, and to identify possible improvement actions. The authors apply the model to a particular institution, the University of Alicante (Spain).

Chapter 4, “Gamification Ecosystems: Current State and Perspectives”, analyses the current situation of gamification ecosystems. The authors give an overview of the gamification topics, as well as definitions of the most important terms of that domain. A theoretical base to develop an integrated framework for gamification is then established.

Chapter 5, “Long-Term Analysis of the OpenACS Community Framework”, analyses the evolution of OpenACS, a high-level community framework designed for developing collaborative Internet sites. The authors review fourteen years of data from both the project’s source code repository and content repository.

Chapter 6, “Need of the Research Community: Knowledge Management and Open Source Solution”, studies the knowledge management processes in the research community and its problems, challenges and requirements. The authors propose an Open Source ecosystem to manage knowledge in academic research.

Chapter 7, “Software Engineering for Technological Ecosystems”, reviews the architecture issues and challenges that are within the software ecosystems. The author presents several limitations and different recommendations and solutions based on software engineering to improve the development of technological ecosystems.

Chapter 8, “Knowledge Structuring for Sustainable Development and the Hozo Tool”, establishes the need for a knowledge ecosystem to facilitate the decision-making process in Sustainability Science and Sustainable Development projects. The authors use an ontology exploration tool to create a practical approach of the ecosystem. They ground their arguments in four case studies that demonstrate how to apply ontology exploration for the collective thinking process.

Chapter 9, “Trying to Go Open: Knowledge Management in an Academic Journal”, describes a case study on knowledge management in a scientific journal. The authors examine the decision-making process to use Open Source technologies to support knowledge management.

*Francisco José García-Peñalvo*  
*University of Salamanca, Spain*

*Alicia García-Holgado*  
*University of Salamanca, Spain*

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