Future Internet and Digital Ecosystems

Tiziana Russo Spena, Marco Tregua, and Francesco Bifulco

Abstract This chapter goes in-depth into the analysis of the new phenomena labelled under the umbrella of "future Internet" and "digital ecosystem". The Future Internet (FI) is defined as a collection of data communication network technologies in the future. In this chapter the FI is discussed in relation to the Digital Ecosystems i.e. the peer to peer structures of support for a networked architecture and collaborative environment. The debate over the digital ecosystem as a new emerging concept represents a step towards the achievement of a better understanding of how cultural heritage services are being transformed. Here, the attention is not only on the definition of a possible best structure for a networked environment but to the ways in which networked environments evolve along time and with reference to the dimensions, dynamics, and variables that affect their emergence. The chapter proposes a more detailed approach to digital ecosystems in business literature and how they are being shaped into practice, with particular reference to the cultural heritage context.

1 Introduction

Digital transformation is a term that is fuelling an increasing debate in business, public, and academic discourse (Kreiss and Brennen 2016; Matt et al. 2015). Over several decades, computing capabilities have grown exponentially in power, while their costs are relatively decreasing (Moore 1974). Today's broad spectrum of IT-based solution has transformed the activities and processes of organizations as well as their human users.

T. Russo Spena (✉) · M. Tregua
Department of Economics Management Institutions, University of Naples Federico II, Naples, Italy
e-mail: tiziana.russospena@unina.it; marco.tregua@unina.it

F. Bifulco
Department of Humanities, University of Naples Federico II, Naples, Italy
e-mail: fbifulco@unina.it

T. Russo Spena, F. Bifulco (eds.), *Digital Transformation in the Cultural Heritage Sector*, Contributions to Management Science,
https://doi.org/10.1007/978-3-030-63376-9_2

New technologies and their applications, such as smart devices, apps, sensors, and so on, provide companies with data on the products' uses, allowing for the development of new data-driven services. Also, smart technologies develop into connected platforms enabling the delivery of new and augmented services and offerings from a distance (Beverungen et al. 2017; Amitrano et al. 2018).

The Internet of Things uses a digital IT infrastructure to virtually network physical items such as "smart" objects to human users and other objects (Oriwoh et al. 2013). Evans (2012) called the resulting infrastructure an "Internet of Everything" (IoE) that links smart objects, humans, and data via connected digital processes to deliver value. In these systems, smart objects enable the monitoring, optimizing, or remote controlling of smart devices, or smart devices can autonomously adapt to their environment (Beverungen et al. 2017). In several cases, companies have successfully built new forms of business models, based on an ecosystem that connects customers to a range of services, other customers, and/or other providers and actors (Larivière et al. 2017; Vargo and Lusch 2017). Due to digital connectivity and network effects, formerly separate industries increasingly collaborate to offer new and better service provision. In some cases, they also conflate contributing to the emergence of systems with few players dominating a new digital hub economy (Iansiti and Lakhani 2017). The emergence of these new forms of relationships and business models has consequences for the entire market structure, the competitive forces within these "new markets" (including providers on different levels of the service network), and consumers and society (Ng and Wakenshaw 2017). More recently, Langley et al. (2020) showed, in more detail, the impacts of IoE on business models and highlighted the changes occurring at micro-, meso-, and macro-levels; moreover, they set a research agenda in the business domain to further understand how digital technologies change business models and societies.

Some industries have already experienced a far-reaching shift in their business models due to digitalization (i.e. the music business, the computer and software market, entertainment, and e-commerce (Li 2020; Matzner et al. 2018; Ng and Wakenshaw 2017). Yet, many other companies still must face notable challenges regarding digital transformation to grasp the profitable opportunities of smart and more effective service provision (Spohrer 2017).

This chapter aims to analyze, in-depth, the new phenomena labelled under the umbrella of the "Future Internet" and "digital ecosystem". More in detail, it is self-evident how technologies are shaping both contexts, but a more comprehensive framework is needed to better depict the role of the Future Internet and its tools in digital ecosystems. Additionally, the role of the digital ecosystem in business literature and service research should still be depicted, as the literature review highlighted. Some contributions are available, but scholars are simply proposing an understanding of the digital ecosystem through the lens of some business conceptualizations (Russo Spena et al. 2017). They emphasize the support offered to new opportunities for value creation (Kopalle et al. 2020) while stressing the need

to investigate the outcomes for firms in terms of the offering, value dynamics, competitiveness, and resource allocation.

The debate over the digital ecosystem as a new emerging concept represents a step towards the achievement of a better understanding of how cultural heritage services are being transformed (Li 2020; Russo Spena et al. 2017). The emerging technological trends in creative industries have been addressed by Li (2020), who describes them as the new conditions for their sustainability. However, the effect of increasing adoption of technology-driven businesses and new management challenges in creating new cultural service contexts require far more insights from both scholars and practitioners.

In this chapter, we propose a more detailed approach to what digital ecosystems are in the business literature and how they are being shaped into practice, with particular reference to the cultural heritage context, in line with the call by Li (2020). To achieve such an aim, we identify some empirical contexts to illustrate how the elements proposed in the literature can contribute to understanding a new way of carrying out cultural business activities in the new digital and ecosystem perspectives.

2 The Paradigm of the Future Internet

The Future Internet (FI) is defined as "a collection of data communication network technologies in the future" (Chang et al. 2011, p. 1). The Future Internet as global and common communication and distributed information system may be considered from various interrelated perspectives: the networks and shared infrastructure perspective, the services and application perspective as well as the media and content perspective.

FI has previously been proposed as the shift from a communication highway to a hybrid network controlling or operating virtually any device (Ulieru and Grobbelaar 2007) and even as "an enabling technology for a number of contemporary applications" (Naqvi et al. 2010, p. 90). Furthermore, FI is even considered an empowerment of the previously available tools to share data, as it should provide more resiliency to the hardware network and improve the quality of services (Tomkos et al. 2009). Resilience should also be applied to the FI architecture to avoid the negative consequences of failures affecting service continuity (Csikor et al. 2013, Papazoglou et al. 2010). Therefore, FI is aimed at favouring the creation of powerful infrastructures, supporting applications, and allowing for the achievement of new business models (Demestichas et al. 2013). These advances in service quality are performed thanks to the adaptability of the Future Internet to users' needs and to the contexts in which FI applications can be used (Karnouskos et al. 2012); the applications are, quite paradoxically, linked to both ease of use and complexity, as they appear to be easy to use by final users, while the complexity is related to two elements, namely (a) the technological infrastructure providing workability and services and (b) the interactions taking place in a wide and intertwined context made of services and systems.

Ben Hamida et al. (2012) proposed a focus on services and their provision when depicting the context of FI as consisting of a plethora of services, interacting one with another, and determining the scale of the FI itself. The linkages among services shaping FI are based on data, as users create data and content, and the open data approach chosen in lots of conditions is leading both public and private actors to share available data and contribute to the creation of new data (Davey et al. 2012). Additionally, data are sourced both consciously (as with crowdsourcing and social computing) and unconsciously (as in the case of tracing systems) (Antoniou et al. 2012). In sum, users are not thought of just as data consumers or service end-users, but as participants in the new Internet, namely, the FI (Oostveen et al. 2013). Thus, efforts are required to identify and understand the approaches favouring users' involvement in FI communities.

A focus on the linked systems is mirrored in the statement offered by Karnouskos et al. (2012), who expect that "FI will be a very complex system of systems" (p. xvi). These ties among systems are represented in different ways and with different conceptualizations, as in Wainwright and Papanikolaou (2012) when proposing data networks as both one of the main features of FI-based interactions (namely, a horizontal capability) and the output of these technologies. The concept of network is used by Matsubara et al. (2013) in considering the infrastructure connecting and orchestrating the FI of "people, devices, content, clouds, and things" (p. 28). One more approach proposed by FI scholars is related to ecosystem, as service ecosystems are thought of as scenarios in which FI can be suitable for use (Wajid et al. 2013); this last contribution is particularly useful for service scholars, as the previous linkages between FI and services were general, while Wajid et al. proposed a theoretical framework hosting the proposed tie. In the same vein, and leaning on Matsubara et al. (2013), Kumar and Krishna (2017) investigated FI as a lever for service universalization, as this would reduce the gap between areas in service provision; indeed, they observed the availability of new means of service provision with limited development of the communication infrastructure.

The Future Internet has been thought of as a relevant and effective set of instruments in relation to collective adaptive systems (Kos et al. 2012) and within service studies too, thanks to the cue previously proposed by Galis et al. (2009), framing FI as "a service- and self-aware network" (p. 112). The notion of awareness is carefully described by Świątek et al. (2012) when dealing with content awareness, context awareness, and user awareness. Content awareness is the choice of the right process to deliver data to the final users. Context awareness is the choice of the right channel to deliver data, while user awareness is a way to make explicit the two choices above in relation to a specific user; namely, it is the expression of customization. The feasibility of customization was stressed by Lu et al. (2018) as a result of the implementation of business platforms in supply chains, as innovation is designed, tested, implemented, and experienced through the efforts of multiple actors, including customers.

An increasing number of scholars in different fields of science is paying attention to changes and opportunities emerging because of the Future Internet, as several areas are being affected by it, such as digital media, enterprises, smart cities, healthcare, energy management, and transportation (Wainwright and Papanikolaou

2012). Thus, FI is affecting the ways firms conduct business and the chance to improve relationships among different actors in complex service-providing contexts (Bagur-Femenias et al. 2016).

3 The Technologies of the Future Internet

The Future Internet consists of several technologies and aspects, such as the Internet of Services (IoS), the Internet of Things (IoT), artificial intelligence (AI), cloud computing (CC), Network of the Future, and so on (Baker et al. 2009; Tselentis et al. 2009; Tregua et al. 2016). The above-cited elements can be considered together because they have some commonalities; indeed, cloud computing is a network of computers running the same application(s) at the same time, and three paradigms emerge to better describe it, viz. infrastructure-as-a-service, platform-as-a-service, and software-as-a-service (Alias et al. 2014). All of them are clearly focused on how solutions can be provided through the usage of new technologies. The distribution of data and instruments in a wide network is key even when one is defining the Internet of Services, as the same services can be accessed from different locations due to Internet connections (Vaz et al. 2012). The same logic is applied to data depending on objects and to the software favouring such a process; this is how the notion of IoT emerged (Tan and Wang 2010). Similarly, the Network of the Future is embedding all of the previous novel elements in defining how connectivity can lead to a wider network, with ubiquitous accessibility and a wide number of actors linked to one another (Alias et al. 2014). The usage of technologies is deeply changing the way firms behave, and the recent paradigm of the Future Internet is representing these changes. In any event, the definitions of such a paradigm are still emerging and sometimes conflict with one another (Hernández-Muñoz et al. 2011). One of the most commonly accepted definitions of the Future Internet is proposed by Boniface and Surridge (2013), who consider it as "a sociotechnical system comprising Internet-accessible information and services, coupled to the physical environment and human behaviour, and supporting smart applications of societal importance." Nowadays, many industries are implementing new instruments to improve the efficiency of their processes, as is happening in cultural heritage (Amato et al. 2013; Li 2020), tourism (Corigliano and Baggio 2013), the agri-food business (El Yasmine et al. 2014), and city management and safety systems (Vargas-Hernández and Pallagst 2020).

3.1 Internet of Things and Internet of Everything

The Internet of Things (IoT) is one of the technologies embedded in the paradigm of the Future Internet; some authors consider IoT to be the most relevant concept deriving from the notion of the Future Internet (Haller et al. 2009; Chang et al.

2011; Tregua et al. 2016). IoT is shaped by sensors and other tools connecting objects and making them communicate (Petrov et al. 2012, Wang et al. 2019); this communication is performed thanks to the software embedded in the objects and the software also facilitates the processing of an increasing number of data exchanged and collected (Haller et al. 2009).

One of the most commonly considered definitions considers IoT as a variety of things or objects—such as Radio-Frequency Identification (RFID) tags, sensors, actuators, mobile phones, etc.—which, through unique addressing schemes, are able to interact with each other and cooperate with their neighbours to reach common goals (Atzori et al. 2010). Additionally, the Internet of Everything (IoE) emerged as an evolution; this concept proposed a wider set of connections than IoT, as people are connecting among themselves and with objects (Barakat 2016). These definitions recall the comprehensive approach contained in the European Research Projects on the Internet of Things (2009), as IoT is thought of as addressing convergence, content, collections, computing, communication, and connectivity between people and things. Additionally, one of the areas of research for the Future Internet is the Internet of Services, a vision of the Internet in which everything (e.g. information, software, platforms, and infrastructure) is available as a "service," i.e. as the application of "digital competencies [. . .] for the benefit of another entity or the entity itself" (Matzner et al. 2018; p. 6).

Even service scholars have recently started paying attention to the linkages between IoT/IoE and the main service features; one of the most recent contributions is proposed by Andersson and Mattsson (2015), with a focus on service innovation, due to the great novelties brought by IoT. The authors proposed four elements of service innovation as potentially depending on IoT; objectification of actors, overlapping, intermediating, and business modelling were affected by IoT and led to service innovation, thanks to the interplay among them. Moreover, IoT acts as a set of mechanisms favouring the needed linkage between cloud services and end-user Internet service (Wang et al. 2013). Due to this focus on users, it is becoming more common to observe the shift from IoT to IoE, as people are integrated with things, services, and the context (Rahman and Rahmani 2018). This approach mirrors and empowers the statement by Winter and Ono (2015), who described the Internet of Everything (IoE) as the alignment and ties between the physical and virtual worlds. Moreover, Leminen et al. (2012) referred to IoT ecosystems and business models; in these new business models, firms use service applications to favour resource integration. However, they did not refer to IoE, while Langley et al. (2020) did and described the level of smartness for *things* with implications for business models and effects on the economy, due to the leverage on the capabilities and connectivity of smart things.

Furthermore, IoT is seen as the element favouring interactions (Gretzel et al. 2015) and the development of relationships oriented to value co-creation by providing the tools necessary to allow the integration of firms' and customers' instruments. IoT—as well as IoE—is providing the chance to better connect objects, services, and actors, so that actors' involvement in creating experiences is greater than before (Wang et al. 2013; Russo Spena et al. 2016; Tregua et al. 2016). The interactions

depicted above can be observed even in the assemblage of things and objects as described by Ng and Wakenshaw (2017); this assemblage should not be thought of as something static such as a mere accumulation of resources, but as a continuous adjustment towards the optimized combination to increase value potentialities.

Some practical consequences have been highlighted by Ehret and Wirtz (2017) when proposing the industrial IoT, namely, the implementation of IoT in an industrial context aimed at the achievement of a more responsive design of solutions to users and, thus, to a higher value to be created. Another recent advance has been proposed by Antonova (2018) when depicting IoT as a way to favour partners' integration in a complex and dynamic network; due to this new chance to interact, actors can share their competitive advantages and shape new business models to achieve more complete value creation for both the partners and the end-users.

3.2 Cloud Computing and Artificial Intelligence

Cloud computing (CC) is sometimes considered to be a set of various services provided as computing services, leading to a sharing infrastructure or a platform to deliver applications and services. Dempsey and Kelliher (2018) tried to clarify the jungle of definitions and the differences depending on a series of different perspectives: They depicted CC as the democratization and utilization of computing power favouring the overcoming of technical and financial shortages. They leverage the previous theoretical proposal by Benlian and Hess (2011) when stressing the opportunity to provide on-demand services and software to access resources, data, and applications for several users. As a consequence, CC is offering a new way to provide and distribute software applications, thus leading to changes in the way firms can achieve revenue due to new forms of service provision and subscription. In summary, CC has been defined (Dempsey and Kelliher 2018) as the fifth utility and its effects on human activities are hugely relevant; they can have even more of an impact when considering the connections to be created with artificial intelligence and machine learning.

Artificial intelligence (AI) is one of the changes taking place in the widest scenario of the human-machine interactions; the development of AI is still progressing, even if its deployment is still a bit far (Corea 2017). In any event, AI is just behind the corner in several industries, and the way business is thought about is changing due to the great and still unexplored potentialities that can emerge by using AI in companies and business models. Before one looks at the changes that can take place in some industries, it is necessary to clarify what AI is, due to the novelty of this topic. AI is considered a system leading computer to learn autonomously, namely, to improve the already available algorithms, without explicitly programming the computer for such a task (Corea 2017). The adjective "artificial" stands for the strict relationship with data instead of focusing on physical law as human beings are. Data are crucial in depicting the main features of AI, as data—and especially big data—are the basic input to start the processes of AI; among these processes, the

most common one is analyzing data to improve both the way an output can be achieved and the content of the output itself. Corea (2017) described two different types of AI depending on the application of data; if AI leads to knowledge to be applied to several environments because of the possible integration among different skills, it is called Artificial General Intelligence (AGI); if the knowledge created is led by creativity and is featured by social and emotional skills and impacts, it is Superintelligent AI or ASI. One of the environments benefiting from AI is health care, with special reference to start-ups, as it is possible to prevent, diagnose, and cure diseases thanks to the opportunities that AI offers (Garbuio and Lin 2019).

AI provides opportunities to increase the effectiveness and efficiency of service provision and customer interaction (Larivière et al. 2017; Marinova et al. 2017; Rust and Huang 2012), such as in the case of medical diagnoses or intelligent chatbots to support customer interactions. AI threatens human service jobs in a wide range of industries, from bus drivers and call centre agents to financial analysts and even lawyers and doctors (Huang and Rust 2018).

All the expected contributions emerging from AI and its different evolutions can be observed in a business context when paying attention to business models; AI is based on a continuous evolution, with the advantage of a reduced experimentation phase, due to the extremely reduced time of data processing and process improvements. Moreover, the business models of firms focused on AI favour a great spreading of these new tools, as they are provided for free to stimulate all the advantages of open source and open innovation. Due to this approach, it will be easier to decrease the time-to-market of AI, the problems in testing, and the validation of mechanisms.

4 Business Ecosystems at the Digital Forefront

Business scholars are paying attention to the way actors are being interrelated by technology in contexts known as digital ecosystems. Boundaries among industries are being blurred due to the widespread incorporation of technologies. The digital ecosystem represents an industry phenomenon based on the adoption of Internet-based technologies for business accelerating the progress of industry convergence and favouring engagement and its management (Morgan-Thomas et al. 2020); the authors claimed that the management of engagement depends on innovation in devices, new devices, and shifts in connectivity.

More definitions—including well-established ones—of "digital ecosystem" rely on Moore's conceptualizations of business ecosystems, i.e. "an economic community supported by a foundation of interacting organizations and individuals—the organisms of the business world." This economic community produces goods and services of value to customers, who are themselves members of the ecosystem. An ecosystem includes customers, producers, competitors, and other stakeholders, whereas it is not possible to divide economic activities under specific industries. The features of a business ecosystem include fragmentation, interconnectedness,

cooperation, and competition (Iansiti and Levien 2002). A wealthy ecosystem sees a balance between cooperation and competition in a dynamic free market. All actors complement one another, leading to a more dynamic division of labour, organized along one-dimensional value chains and two-dimensional value networks.

However, a unique and commonly accepted definition of "digital ecosystem" does not exist. As highlighted by Marinos et al. (2011), the extant contributions by scholars are leading to different meanings in a general way and even because of different interpretations by different actors. Similarly, Jardim-Goncalves et al. (2013) stressed how "current economic theories have difficulty in explaining digital ecosystems" (p. 24). The term "digital ecosystem" is still used to describe a variety of concepts, ranging from the existing networking infrastructure of the Internet to digital ecosystem services which enable customers to use existing e-business solutions. The term is also increasingly linked to the future development of Information and Communications Technology (ICT) adoption for e-business, to support business ecosystems (Chatzoglou and Chatzoudes 2016). However, Iansiti and Lakhani (2020) observed the phenomenon from a different angle, stating the unstoppable growth of some global firms (e.g. Google, Facebook, and Alibaba), as the services they provide are offered through algorithms and the services are mostly automated.

A seminal definition of "digital ecosystem" has been proposed by Chang and West (2006) as an analogy to previous definitions of ecosystems; more in detail, the authors stated that a digital ecosystem is "an open, loosely coupled, domain clustered, demand-driven, self-organising agents' environment, where each *specie* is proactive and responsive for its own benefit or profit" (p. 6). Openness is the feature best representing digital ecosystems as similar to natural ecosystems, while the reference to the loosely coupled agents mirrors the chance to continuously involve new actors from the digital community. Self-organization makes the digital ecosystem different from other perspectives, where there are key actors leading relationships and activities; as a consequence, roles are not fixed, control is decentralized, and collaborations represent the key to a successful collaboration of all the agents (or actors). Scholars from information technology offer some more insights into how to depict a digital ecosystem, by contributing to the debate in business literature, as their definitions take into account economic aspects such as businesses, SMEs, markets, and so on. Ghormley (2012) proposed a digital ecosystem as a community cloud with amalgamations of distributed control.

By focusing on the role of technology, Matopoulos et al. (2012) proposed a different perspective on the digital ecosystem with a more detailed focus on businesses. As a consequence, they proposed a new theorization switching the focus from a digital ecosystem to a "digital business ecosystem" (DBE) when applying its main features to business contexts; consequently, a DBE offers opportunities to firms to operate and collaborate through digital technologies when performing actions depending on their products and services (Maracine and Scarlat 2009). Additionally, a DBE is considered the milieu supporting the creation of contexts in which firms can extend their markets. More in detail, *e-attributes* are individuated to depict SMEs and clusters favouring the emerging of a DBE. The main advantages of operating in digital ecosystems can be categorized as mainly internal and mainly

external. The internal advantages are related to the achievement of higher levels of efficiency, the ease in accessing information, and the chance to always be up to date. The external advantages are the ease in finding partners to match resources, knowledge, and experiences, the extension of the potential market, and the combination of services with those of partners.

Some authors (Selander et al. 2013) split a digital ecosystem into a central part and a periphery; they highlighted how the survival of both the ecosystem and the peripheral actors is not mutually influenced. Recently, a similar distinction between the key actor and the other actors was proposed by Nambisan (2017) when highlighting the relevance of the firm leading the platform in a digital ecosystem; the key role of this firm depends on its chance to address both value creation and appropriation. With their digital business models and vast market coverage, companies function as game changers, both in established markets and beyond traditional market boundaries. In several cases, they have successfully built new forms of competitive power, creating a hub economy with one or a few dominant players. Iansiti and Lakhani (2020) refer to this development as the "digital domino effect" to describe a process in which more and more markets and actors that traditionally competed in separate industries are reduced to just a few hub firms that capture growing shares of the overall economic value created (Iansiti and Lakhani 2020). Some more elements depicting a digital ecosystem are learning and interactions. These two topics are influencing actions towards the achievement of specific goals and are taking place in complex contexts, as ecosystems are; this complexity is expressed by ecosystems' main features, namely decentralization, autonomy, diversity, and reception of conflicts. When the role of knowledge is particularly stressed in an ecosystem or in a digital ecosystem, it is common to propose a new conceptualization known as "knowledge ecosystem," where creation, sharing, deploying, and the risk of forgetting can take place (Maracine and Scarlat 2009). Among the four knowledge-based activities, creation is more crucial than the others, and it is thought to start when tacit knowledge becomes explicit.

A digital ecosystem is a context where digital elements—viz., software, components, applications, and services—are acting together to favour the achievement of a specific aim, like the creation of content, a business process, and so on (Kannan et al. 2010). More recently, Conti et al. (2019) defined a digital ecosystem as "a digital environment populated by interacting and competing digital species" (p. 2); digital features permeate services and data too, and these two elements are strictly connected in some specific contexts, as highlighted with reference to smart cities by Zuccalà and Verga (2017), stating that a digital ecosystem favours data sharing useful to synergic applications to different public services, enabling innovative solutions.

The interactions depicted above are also at the forefront of service scholars' studies in which digitalization can be observed mainly in the assemblage of things and objects and services as described by Ng and Wakenshaw (2017). This assemblage should not be thought of as something static, such as a mere accumulation of resources, but as a continuous adjustment towards the optimized combination to increase value potentialities. Digital ecosystems rely on interactions and the

development of relationships oriented to value co-creation; in such a view, technologies provide the context to allow for the integration of companies' and customers' propositions (Lusch and Nambisan 2015; Gretzel et al. 2015). Smith et al. (2017) framed the digital ecosystem as interactions offering entrepreneurs access to resources for the achievement of desirable outcomes. The characterization of the effectiveness of digital ecosystems can be made through the concept of bridging and bonding. Bridging refers to connections of actors within the network, ideally reaching as many diverse connections as possible to access new knowledge. Bonding is referred to as the behaviour of actors within the network. Providing others with emotional support, sharing solidarity, and enriching relationships with commitment characterize high levels of bonding.

In sum, digital ecosystems rely on a community or network of actors with common or interdependent purposes which lead to their value-creating activities rather than mere technologies. Therefore, new digital technologies must be thought of from the perspective of the networked collaborations and integration they provide; they do not define what a network is or what communities are but, rather, what they can do together and how they can transform their way of doing to increase the value.

5 The Digital Ecosystem in Cultural-Based Services

Several studies consider the role of technologies in cultural-based services and, more in general, in relation to cultural heritage (Donghui et al. 2017; Kalay et al. 2007; Li 2020; Tengberg et al. 2012). Some of the reasons why scholars are paying a significant amount of attention to how technology is reshaping cultural heritage are the new means of service provision (Strielkowski et al. 2012), the challenges for marketers (Hausmann 2007), the cooperation taking places among actors (McKercher and Du Cros 2002), and the approach to an ecosystem perspective (Lazzeretti and Sartori 2016). In this part, attention will be devoted to the digital ecosystem emerging in—and for—cultural heritage. Eklund et al. (2009) are some of the first scholars to depict a digital ecosystem through cultural heritage and, namely, through a museum. More in detail, they described a digital museum in Australia as a representation of the real-world museum; the digital transformation deployed for this museum inspired the digital exploration of an already existing museum, proposing a digital ecosystem as the transforming of a business ecosystem. Additionally, this ecosystem is thought of as linked to other ecosystems consisting of stakeholders, other museums, and other actors; the ties among ecosystems frame new ecosystems.

Some key features have been discussed as common in the context of cultural heritage. The first aspect involves the need for cultural digital ecosystems to embrace digital solutions for cultural heritage promotion and preservation (Lawson et al. 2010). Companies must take up the opportunities brought in by digitalization and digitization as a means to valorize and preserve their cultural heritage. New technologies bring cultural heritage sites back to life. Virtual museums offer visitors the ability to see artwork residing in different places in context and to experience objects

or sites inaccessible to the public. The example of Linked Heritage regarding intangible cultural heritage is a positive step in this direction that could be replicated elsewhere.

Exhibit 1 Linked Heritage

Linked Heritage is an already-completed project contributing to Europeana, as is Athena Europe.

This project was aimed at looking for new content related to cultural heritage across Europe, improving the quality of cultural content, and enlarging the amount of data available to Europeana. In a more general vein, Linked Heritage had, as its main goal, the coordination of standards and technologies to be provided to Europeana, and thus to all EU countries and external partners.

The Internet of Things is deployed in Linked Heritage, as geospatial standards, geographic information, and *e*-infrastructures are the main elements supporting cultural institutions in Europe towards the creation of further knowledge and the achievement of higher efficiency in cultural services.

In Linked Heritage, cooperation was key to building the digital ecosystem itself, as an explicit call for participation was launched at the beginning of the project. Through this call, the partners operating at the launch of the project were joined by participants who stated that they could contribute as content providers and as members of working groups, roundtables, and other seminars to enhance cultural-heritage-based initiatives, or as disseminators of the information collected in the project and already available in Europeana. Public regional and local authorities engaged with relevant stakeholders. These actors included both public and cultural institutions (galleries, libraries, museums, archives, and film heritage institutions) as content providers; cultural industry as re-users of cultural heritage content in applications and added-value services, e.g. in the education, edutainment, design, gaming, and tourism sectors; technology firms as providers of digitization/preservation technologies; and Internet actors such as social networks, online reference works, and philanthropic organizations.

Knowledge sharing is both a result favored by participation and a reward for actors joining Linked Heritage; the joining of new actors favored the creation of a wider community, as nine new partners and four sister projects partnered with the already acting team composed of 37 partners, eight main contributors, and a coordinator taking care of the relationships, both internal to the project and with the external institutions. Finally, complexity is mirrored in the activities and their relationships, as in the Athena Europe project, but in the content of data to be collected and shared; indeed, digital objects are considered aggregators of digital data, so the content providers joining the project had to gather material from the contexts spread all over Europe, standardize

(continued)

them, apply the Europeana guidelines and procedures, and support the administrative tasks. Digital technology is featuring the project because it provides a new way to use data and an unambiguous reference to the content and its provider.

Additional aspects include the need to foster collaboration and create partnerships between regional authorities, museums, and academia to increase the attractiveness of the museums and visitors' experience (Pierroux 2018). There is a need to build the knowledge base and enhance the capacity of public and private actors and institutions to develop and implement digitization strategies for cultural heritage artefacts based on common standards and approaches. Overcoming differences and integrating knowledge and competences from different domains must be addressed as well. Cooperation can contribute to this process by providing a platform for mutual learning and knowledge exchange between actors. The examples of DATABENC and ATHENA demonstrate how to respond to the demand for innovation. The applications of digital technologies for cultural heritage can be inspirational in another context in terms of strengthening knowledge and competences for the rise of innovation and improvement of the cultural heritage context.

Exhibit 2 DATABENC

Databenc is a project established by two universities in Southern Italy that gathers together another university, several SMEs, four research centres, and more than 50 other partners.

This ecosystem is aimed at stressing open innovation as an approach to favouring the activities of a high-technology scientific district dealing with cultural heritage. Integrating knowledge, favouring the conservation of cultural heritage assets, proposing new services through ICT, and making usage sustainable are the main aims of this project. The aims are to gather and communicate the content of the scientific knowledge of an artistic, archaeological, literary, historical, and philosophical nature in the territory of Region Campania. The emphasis is on historic centres, activating, and experiencing new strategies for their representation, organization, dissemination, and promotion based on paradigms of technological intelligence.

The set of actors launched technologies supporting physical visiting paths, virtual re-enactment, and learning-oriented contexts to favour the spread of knowledge about the local area's cultural heritage. The partners of Databenc aim to propose the safeguarding, conservation, and fruition of cultural heritage through cloud computing; more in detail, the development of a web platform allows for an integrated approach towards data management and the standardization of service processes. The technological equipment provides intelligence tools that support transparency and economic growth as well as they

(continued)

allow to coordinate the different business and economic models and the real and participatory actions of local governance and of other actors.

The community consists not just of the wide set of project partners but also of local actors such as schools, museums, and other private associations. These actors constantly took part in the activities, shared content online, and contributed to the dissemination of the results achieved through the project. The complexity of the project not only depends on the wide range of actors but is mirrored by the ties among different fields of science needed to improve the solutions to be proposed in relation to the cultural heritage assets. The uniqueness of the cultural and natural heritage is particularly stressed to identify the interventions to be carried out and the need to preserve local areas. The partners of the project particularly stressed the relevance of cloud-based, web-based, and Internet of Things-oriented services as the three main pillars of the platform identified as crucial in furthering the cultural services. Innovation, sustainability, and service provision are the three outputs to be achieved through the technology-based platform, built through the support of all actors cooperating with each other, plus the interventions of the local community.

Exhibit 3 Athena Europe

Athena Europe is a project carried out by several partners all over Europe under the coordination of the European Commission.

This project aims to favour the participation of museums and other institutions in Europeana, the digital library collecting all digital products from institutions in the countries of the European Union. Moreover, Athena Europe aims to coordinate the activities of museums all over Europe, looking for digital content in these museums, favouring the integration of the several sectors of cultural heritage, and developing tools to support access to digital content. All of these aims can be achieved by mapping and coordinating stakeholders and content all over Europe and by enforcing the relationship with Europeana.

In Athena Europe, cooperation is a key process, as there are partners with specific roles—namely, 23 content providers, six technology providers, six actors dealing with dissemination, one evaluation body, and one coordinator taking care of the relationships with the European agencies. The cooperation among these actors takes place to favour knowledge collection, transformation into a digital version if needed, and dissemination through digital tools all over Europe and even outside the European area, thanks to the involvement of other partners. The focus on data collection and dissemination is useful to show the setting up of a community that enables the workability of this ecosystem based on digital tools; more in detail, additional partners were appointed to favour

(continued)

collection and dissemination in each of the countries joining the project. Following the choice of these partners, local communities emerged, and a coordinator of communities was appointed at Europeana. Finally, complexity is not only self-evident in the context described in the previous lines but can also be observed when looking at the activities to be performed, as they are greatly intertwined with one another. The main activities described in Athena Europe are monitoring and evaluation, awareness and dissemination, identifying of standards and recommendations, integration of data, coordination of content, analysis of issues, and development of plug-ins to be integrated into Europeana. These activities are all linked to one another and are not just a sequence of tasks to be done. The redundancies, interconnections, and mutual influence among them take place through technologies, as the set of tools favouring the performing of these activities and the integration and dissemination of data.

In many cases, cultural heritage is thought of differently when one is dealing with a digital ecosystem; namely, it is considered part of a wider digital ecosystem including city or tourism business. Amato et al. (2013) considered cultural heritage to be an element of a city undergoing a digital transformation enabling the integration of a heterogeneous range of cultural, architectural, technological, social, and natural artefacts to provide new experiences for leisure and business. Additionally, Li (2020) paid attention to the multiple business models adopted by firms in different markets and also in the so-called multi-sided markets. Therefore, an ecosystem represents the upstream, downstream, and horizontal complexity of multiple stakeholder contexts. In such contexts, digital platforms enable the management of multi-sided relations.

The example of the CHRISTA PROJECT is a positive step in citizens' engagement and attracting the interest of different actors (tourists, youth, citizens, etc.) in the city's history and the culture of the county.

Exhibit 4 Christa Project

The *Christa project* is an interregional project of cooperation acting at both the national and European levels to favour the sustainable development of culture-based initiatives through innovation and aimed at developing tourism.

In Christa, heritage is thought of as natural and cultural, so cultural tourism, heritage tourism, and ecotourism are the main contexts to which the results are aimed and expected. Ten partners from 10 countries are collaborating in this project, but each of the partners has its main responsibilities in an area close to where it operates. Sharing initiatives, disseminating knowledge, and cross-supporting are the key approaches of this project.

In the Christa project, the partners carry out their main efforts in relation to the local area where they operate, but they cooperate to identify and define

(continued)

policies for sustainable and responsible actions in relation to cultural and natural tourism development. The partners of this project act together to deploy all-embedding actions—namely, interventions aimed at preserving, conserving, offering, and restoring cultural heritage assets. The goals of the project are defined in line with the framework proposed by the European Union and the Horizon 2020 targets. The community is built around these goals, as the partners identified public authorities and stakeholders as both contributors and beneficiaries of the project, since the summarizing aim is to provide environmental and resource-oriented efficiency. Additionally, the community is further developing, as during the dissemination of events, new ideas were launched, and new partnerships were created to favour similar interventions. Finally, the complexity of this project is based on the need to operate on two different layers, as each member must act on a local base and a national base, due to the nature of the project. Hence, the definition of local interventions, standards, and policies requires a process of negotiation and adaptation to achieve a result that can be applied all over Europe in the areas featuring the project. Moreover, the complexity is represented by the intricacy of the aims related to protecting cultural heritage assets and making them available to users. Digital tools are supporting this project, as they are favouring the analysis of good practices, mutual learning among partners, capacity building through the involvement of local communities, and scenario evaluation to test the adaptability of policies in different areas.

6 Discussion

The rise of the concept of the digital ecosystem has been proposed in the literature as related to cultural heritage.

As mentioned above, digital technology provided cultural businesses with a necessary infrastructure to build a new digital business integrating different technologies (IoT and IoE, cloud computing AI technologies) that made it possible for users and different businesses and actors to come together and build a digital ecosystem of interactions (Antonova 2018). Interactions within the digital surroundings and the material context of digital technology change the means of doing in the cultural heritage context and become a key focus in the cultural ecosystem (Li 2020). Indeed, the cooperation among firms to set a digital ecosystem (Maracine and Scarlat 2009), the community shaped by this ecosystem (Ghormley 2012) and the complexity depending on knowledge are the key factors shaping new digital cultural activities. In the same vein, Li (2020) addressed a call for research on the effects of technology in digital ecosystems based on cultural heritage by describing the contribution of platforms for mutual learning and knowledge exchange between multiple actors ecosystems.

Mutual adjustments within the digital ecosystem regarding products, services, and locations include consideration of all the social and technological components fostering interactions within digital ecosystems. Instead of exchanging property as in the traditional market-based economy, made up of sellers and buyers, the parties in this new network-based economy share access to services and experiences. For example new technology-enabled services are increasing the complexity of the cultural experience and connecting previously distinct digital, physical, and social realms (Bolton et al. 2014); they are increasingly nested within complex self-adjusting service ecosystems (Subramony et al. 2018), and the ongoing changes in the service ecosystem context trigger innovation which, in turn, may lead to further complexity (Edvardsson et al. 2018).

Thus, the digital cultural ecosystem (Matopoulos et al. 2012) is more consistent with a view of the networking of different actors and businesses and the adjustment of the players to the new realities of the digital economy. Multiple actors can be seen as providers and clients in a cultural ecosystem; therefore, it is not just a matter of how complex an ecosystem's structure is, as companies have a series of portfolios and the ties among ecosystems shape new ones. Formally, a digital cultural ecosystem can be huge, covering joint content management systems of one country or region, but it can also be small, such as a virtual museum or private collection of artefacts. In the digital ecosystem, local and global actors concurrently operate to determine solutions to satisfy different problems. Digital ecosystems are platforms for the network-based economy of business ecosystems, providing mechanisms for the creation of new business and value; these results emerge as a consequence of how digital ecosystems are shaped; indeed, they consist of both internal and external advantages, such as increasing efficiency, the availability of more information, and the chance to benefit from the activities of multiple partners. These features mirror, and are mirrored in, the notion of the ecosystem itself, namely, a context continuously reshaped by actors. The cooperation of actors is one factor depicting the essence of ecosystems, including when they are framed as digital ecosystems (Maracine and Scarlat 2009). Digital cultural ecosystems have a kind of self-generative nature working on a service-oriented logic in which users can act as providers at the same time; these interchanging roles were described in ecosystems in general, but the characteristics of cultural heritage provide much more evidence on how actors participate in these joint processes with synergic efforts. These efforts are not driven or steered by one single actor, but the trigger point may vary because of the changing roles of actors. Also, the new technologies created an open space to provide and access information, knowledge, data, and new resources. The digitization and online accessibility of cultural resources become input for added-value products and services which can fuel innovation in areas such as tourism, education, advertising, and gaming. In detail, the new view proposed by Iansiti and Lakhani (2020) considering firms as drivers of new technologies is spreading, as some of these firms have grown too much and IT-based solutions may help in dealing with such relevant numbers.

References

Alias C, Qzgiir C, Jawale M, Noche B (2014) Evaluating the potential of Future-Internet-based transportation control tower solutions using the example of a logistics service provider. In: Proceedings of the 2014 Biennial CSME International Congress. Toronto (ON), CAN

Amato F, Chianese A, Mazzeo A, Moscato V, Picariello A, Piccialli F (2013) The talking museum projects. Procedia Computer Science 21:114–121

Amitrano C, Tregua M, Russo Spena T, Bifulco F (2018) On Technology in Innovation Systems and Innovation-Ecosystem Perspectives: A Cross-Linking Analysis. Sustainability 10 (10):37–44

Andersson P, Mattsson LG (2015) Service innovations enabled by the "internet of things". IMP J 9 (1):85–106

Antoniou A, Theodoridis E, Chatzigiannakis I, Mylonas G (2012) Using future internet infrastructure and smartphones for mobility trace acquisition and social interactions monitoring. In: Álvarez F et al (eds) The Future Internet Assembly. Berlin, Springer, pp 117–129

Antonova A (2018) Smart services as scenarios for digital transformation. Industry 40 3 (6):301–304

Atzori L, Iera A, Morabito G (2010) The internet of things: A survey. Comput Netw 54 (15):2787–2805

Bagur-Femenias L, Perramon J, Barquero JD (2016) Does intensive social network management lead to positive effects in quality practices? Total Qual Manag Bus Excell 27 (11–12):1246–1260

Baker N, Zafar M, Moltchanov B, Knappmeyer M (2009) Context-Aware Systems and Implications for Future Internet. In: Tselentis G et al (eds) Towards the Future Internet. IOS Press, Berlin, pp 335–345

Barakat SM (2016) Internet of things: Ecosystem and applications. J Curr Res Sci 4(1):32

Ben Hamida A, Kon F, Oliva GA, Dos Santos CEM, Lorré JP, Autili M et al (2012) An integrated development and runtime environment for the future internet. In: Álvarez F et al (eds) The Future Internet Assembly. Berlin, Heidelberg, Springer, pp 81–92

Benlian A, Hess T (2011) Opportunities and risks of software-as-a-service: Findings from a survey of IT executives. Decis Support Syst 52(1):232–246

Beverungen, D., Matzner, M., & Janiesch, C. (2017). Information systems for smart services, 15, 781–787

Bolton RN, Gustafsson A, McColl-Kennedy J, Sirianni NJ, Tse DK (2014) Small details that make big differences: A radical approach to consumption experience as a firm's differentiating strategy. J Serv Manag 25(2):253–274

Boniface M, Surridge CU (2013) Research Challenges for the Core Platform for the Future Internet.. Retrieved from http://ec.europa.eu/information_society/activities/foi/library/docs/fippp-research-challenges-for-coreplatform-issue-1-1.pdf

Chang RS, Kim TH, Peng SL (2011) Security-Enriched Urban Computing and Smart Grid: Second International Conference, SUComS 2011, Hualien, Taiwan, September 21–23, 2011. Proceedings (Vol. 223). Springer Science & Business Media

Chang E, West M (2006) Digital ecosystems and comparison to existing collaboration environment. WSEAS Trans Environ Dev 2(11):1396–1404

Chatzoglou P, Chatzoudes D (2016) Factors affecting e-business adoption in SMEs: an empirical research. J Enterp Inf Manag 29(3):327–358

Conti V, Ruffo SS, Vitabile S, Barolli L (2019) BIAM: a new bio-inspired analysis methodology for digital ecosystems based on a scale-free architecture. Soft Comput 23(4):1133–1150

Corea F (2017) Artificial intelligence and exponential technologies: business models evolution and new investment opportunities. Springer, London

Corigliano MA, Baggio R (2013) Creatività, innovazione, tecnologie e competitività nel turismo. Rivista di Scienze del Turismo-Ambiente Cultura Diritto Economia 4(1–2):53–82

Csikor L, Rétvári G, Tapolcai J (2013) High availability in the future internet. In: Galis A, Gavras A (eds) The Future Internet Assembly. Springer, Berlin, Heidelberg, pp 64–76
Davey J, Mansmann F, Kohlhammer J, Keim D (2012) Visual analytics: Towards intelligent interactive internet and security solutions. In: Álvarez F et al (eds) The Future Internet Assembly. Berlin, Heidelberg, Springer, pp 93–104
Ehret M, Wirtz J (2017) Unlocking value from machines: business models and the industrial internet of things. J Mark Manag 33(1-2):111–130
Demestichas P, Georgakopoulos A, Karvounas D, Tsagkaris K, Stavroulaki V, Lu J et al (2013) 5G on the horizon: Key challenges for the radio-access network. IEEE Veh Technol Mag 8 (3):47–53
Dempsey D, Kelliher F (2018) Industry Trends in Cloud Computing. Pallgrave McMillian, New York
Donghui C, Guanfa L, Wensheng Z, Qiyuan L, Shuping B, Xiaokang L (2017) Virtual reality technology applied in digitalization of cultural heritage. Cluster Computing, 1–12
Edvardsson B, Frow P, Jaakkola E, Keiningham TL, Koskela-Huotari K, Mele C, Tombs A (2018) Examining how context change foster service innovation. J Serv Manag 29(5):932–955
Eklund P, Goodall P, Wray T, Bunt B, Lawson A, Christidis L, Van Olffen M (2009) Designing the digital ecosystem of the virtual museum of the pacific. In 2009 3rd IEEE International Conference on Digital Ecosystems and Technologies (pp. 377–383). IEEE
El Yasmine ASL, Ghani BA, Trentesaux D, Bouziane B (2014) Supply chain management using multi-agent systems in the agri-food industry. In: Chaib-draa B, Müller J (eds) Service Orientation in Holonic and Multi-Agent Manufacturing and Robotics. Switzerland, Springer, Cham, pp 145–155
European Research Projects on the Internet of Things (CERP-IoT) (2009) Strategic Research Agenda (SRA). Internet of Things—Strategic Research Roadmap
Evans D (2012) The internet of everything: How more relevant and valuable connections will change the world. Cisco IBSG:1–9
Galis A, Denazis SG, Bassi A, Giacomin P, Berl A, Fischer A et al (2009) Management Architecture and Systems for Future Internet Networks. In: Tselentis G et al (eds) Future Internet Assembly. IOS press, Amsterdam, pp 112–122
Garbuio M, Lin N (2019) Artificial intelligence as a growth engine for health care startups: Emerging business models. Calif Manag Rev 61(2):59–83
Ghormley Y (2012) Twos company, threes a cloud: Challenges to implementing service models. J Serv Sci 5(1):19–28
Gretzel U, Sigala M, Xiang Z, Koo C (2015) Smart tourism: foundations and developments. Electron Mark 25(3):179–188
Haller S, Karnouskos S, Schroth C (2009) The internet of things in an enterprise context. In: Domingue J, Fensel D, Traverso P (eds) Future Internet Symposium. Berlin, Heidelberg, Springer, pp 14–28
Hausmann A (2007) Cultural tourism: Marketing challenges and opportunities for German cultural heritage. Int J Herit Stud 13(2):170–184
Hernández-Muñoz JM, Vercher JB, Muñoz L, Galache JA, Presser M, Gómez LAH, Pettersson J (2011) Smart cities at the forefront of the future internet. In: Domingue J et al (eds) Future internet assembly. Springer, Berlin, Heidelberg, pp 447–462
Huang MH, Rust RT (2018) Artificial intelligence in service. J Serv Res 21(2):155–172
Iansiti M, Lakhani KR (2017) Managing our hub economy. Harv Bus Rev 95(5):84–92
Iansiti M, Lakhani KR (2020) Competing in the Age of AI. Harvard Business Review, Jan-Feb.
Iansiti M, Levien R (2002) The new operational dynamics of business ecosystems: Implications for policy, operations and technology strategy. Division of Research, Harvard Business School, Boston, MA
Jardim-Goncalves R, Grilo A, Agostinho C, Lampathaki F, Charalabidis Y (2013) Systematisation of Interoperability Body of Knowledge: the foundation for Enterprise Interoperability as a science. Enterprise Information Systems 7(1):7–32

Kalay Y, Kvan T, Affleck J (2007) New heritage: New media and cultural heritage. Routledge, London

Kannan R, Balasundaram SR, Andres F (2010, October) The role of mulsemedia in digital content ecosystem design. In Proceedings of the international conference on management of emergent digital ecosystems (pp. 264-266)

Karnouskos S, Colombo AW, Bangemann T, Manninen K, Camp R, Tilly M, Eliasson J (2012, October) A SOA-based architecture for empowering future collaborative cloud-based industrial automation. In IECON 2012-38th Annual Conference on IEEE Industrial Electronics Society (pp. 5766–5772). IEEE

Kopalle PK, Kumar V, Subramaniam M (2020) How legacy firms can embrace the digital ecosystem via digital customer orientation. J Acad Mark Sci 48(1):114–131

Kos A, Pristov D, Sedlar U, Sterle J, Volk M, Vidonja T et al (2012) Open and scalable IoT platform and its applications for real time access line monitoring and alarm correlation. In: Andreev S, Balandin S, Koucheryavy Y (eds) Internet of Things, Smart Spaces, and Next Generation Networking. Springer, Berlin, Heidelberg, pp 27–38

Kreiss D, Brennen JS (2016) Normative theories of digital journalism. *Sage handbook of digital journalism studies*. New York, Sage

Kumar MR, Krishna YS (2017) Future Networks an SOA perspectives Design Goals. Int J Adv Res Comput Sci 8(9):649–654

Langley DJ, van Doorn J, Ng IC, Stieglitz S, Lazovik A, Boonstra A (2020) The Internet of Everything: Smart things and their impact on business models. J Bus Res, online first

Larivière B, Bowen D, Andreassen TW, Kunz W, Sirianni NJ, Voss C et al (2017) "Service Encounter 2.0": An investigation into the roles of technology, employees and customers. J Bus Res 79:238–246

Lawson A, Eklund PW, Goodall P, Wray T, Daniel V, Van Olffen M (2010) Designing a digital ecosystem for the new museum environment: the Virtual Museum of the Pacific. In: Yeatman H (ed) The SInet 2010 eBook. SInet UOW, Wollongong, pp 227–239

Lazzeretti L, Sartori A (2016) Digitisation of Cultural Heritage and Business Model Innovation: The Case of the Uffizi Gallery in Florence. Studies on the Value of Cultural Heritage 14:945–970

Leminen S, Westerlund M, Rajahonka M, Siuruainen R (2012) Towards IOT ecosystems and business models. In: Andreev S, Balandin S, Koucheryavy Y (eds) Internet of things, smart spaces, and next generation networking. Berlin, Heidelberg, Springer, pp 15–26

Li F (2020) The digital transformation of business models in the creative industries: A holistic framework and emerging trends. Technovation 92:102012

Lu Y, Papagiannidis S, Alamanos E (2018) Internet of Things: A systematic review of the business literature from the user and organisational perspectives. Technol Forecast Soc Chang 136:285–297

Lusch RF, Nambisan S (2015) Service innovation: A service-dominant logic perspective. MIS Q 39 (1):155–176

Maracine V, Scarlat E (2009) Dynamic Knowledge and Healthcare Knowledge Ecosystems. Electron J Knowl Manag 7(1):99–110

Marinos A, Moschoyiannis S, Krause P (2011) Towards a restful infrastructure for digital ecosystems. Int J Electron Bus 9(5–6):484–498

Marinova D, de Ruyter K, Huang MH, Meuter ML, Challagalla G (2017) Getting smart: Learning from technology-empowered frontline interactions. J Serv Res 20(1):29–42

Matopoulos A, Herdon M, Várallyai L, Péntek Á (2012) Digital business ecosystem prototyping for SMEs. J Syst Inf Technol 14(4):286–301

Matsubara D, Egawa T, Nishinaga N, Kafle VP, Shin MK, Galis A (2013) Toward future networks: A viewpoint from ITU-T. IEEE Commun Mag 51(3):112–118

Matt C, Hess T, Benlian A (2015) Digital transformation strategies. Bus Inf Syst Eng 57 (5):339–343

Matzner M, Büttgen M, Demirkan H, Spohrer J, Alter S, Fritzsche A, Ng IC et al (2018) Digital Transformation in Service Management. J Ser Manag Res 2(2):3–21
McKercher B, Du Cros H (2002) Cultural tourism: The partnership between tourism and cultural heritage management. Routledge, London
Moore JM (1974) Computer aided facilities design: an international survey. Int J Prod Res 12 (1):21–44
Morgan-Thomas A, Dessart L, Veloutsou C (2020) Digital ecosystem and consumer engagement: A socio-technical perspective. J Bus Res, online first
Nambisan S (2017) Digital entrepreneurship: Toward a digital technology perspective of entrepreneurship. Entrep Theory Pract 41(6):1029–1055
Naqvi S, Dallons G, Ponsard C (2010, May) Applying digital forensics in the future internet enterprise systems-European SME's perspective. In Systematic Approaches to Digital Forensic Engineering (SADFE), 2010 Fifth IEEE International Workshop on (pp. 89–93). IEEE
Ng IC, Wakenshaw SY (2017) The Internet-of-Things: Review and research directions. Int J Res Mark 34(1):3–21
Oostveen AM, Meyer ET, Pickering B (2013) User involvement in future internet projects. In: Domingue J et al (eds) The Future Internet Assembly. Berlin, Heidelberg, Springer, pp 310–322
Oriwoh E, Jazani D, Epiphaniou G, Sant P (2013) Internet of things forensics: challenges and approaches. In 9th IEEE International Conference on Collaborative computing: networking, Applications and Worksharing (pp. 608–615). IEEE
Papazoglou M, Pohl K, Parkin M, Metzger A (2010) Service research challenges and solutions for the future internet: S-cube-towards engineering, managing and adapting service-based systems. Springer, London
Pierroux P (2018) Learning and engagement in museum mediascapes. In: Drotner K, Dziekan V, Parry R (eds) The Routledge Handbook of Museums, Media and Communication. London, Routledge, pp 128–142
Petrov V, Andreev S, Koucheryavy Y (2012) An applicability assessment of IEEE 802.11 technology for machine-type communications. In 2012 The 11th Annual Mediterranean Ad Hoc Networking Workshop (Med-Hoc-Net) (pp. 24–31). IEEE
Rahman H, Rahmani R (2018) Enabling distributed intelligence assisted future internet of things controller. Applied computing and informatics 14(1):73–87
Russo Spena T, Amitrano CC, Tregua M, Bifulco F (2016) Cultural service experiences and smart technologies. In: Bifulco F, Russo Spena T (eds) Managing Cultural Heritage. Mc Graw Hill, Milan, pp 63–80
Russo Spena T, Tregua M, Bifulco F (2017) Searching Through the Jungle of Innovation Conceptualizations: System, Network and Ecosystem domains. J Serv Theory Pract 27(5):977–1005
Rust RT, Huang MH (2012) Optimizing service productivity. J Mark 76(2):47–66
Selander L, Henfridsson O, Svahn F (2013) Capability search and redeem across digital ecosystems. J Inf Technol 28(3):183–197
Smith C, Smith JB, Shaw E (2017) Embracing digital networks: entrepreneurs' social capital online. J Bus Ventur 32(1):18–34
Spohrer J (2017) IBM's service journey: A summary sketch. Ind Mark Manag 60:167–172
Strielkowski W, Riganti P, Jing W (2012) Tourism, cultural heritage and e-services: Using focus groups to assess consumer preferences. Tourismos: an International Multidisciplinary Journal of Tourism 7(1):41–60
Subramony M, Solnet D, Groth M, Yagil D, Hartley N, Kim PB, Golubovskaya M (2018) Service work in 2050: toward a work ecosystems perspective. J Serv Manag 29(5):956–947
Świątek P, Juszczyszyn K, Brzostowski K, Drapała J, Grzech A (2012) Supporting content, context and user awareness in Future Internet applications. In: Álvarez F et al (eds) The Future Internet Assembly. Springer, Berlin, Heidelberg, pp 154–165
Tan L, Wang N (2010) Future internet: The Internet of Things, Proceeding of 3rd International Conference on Advanced Computer Theory and Engineering (ICACTE), 5: 376–380

Tengberg A, Fredholm S, Eliasson I, Knez I, Saltzman K, Wetterberg O (2012) Cultural ecosystem services provided by landscapes: assessment of heritage values and identity. Ecosyst Serv 2:14–26

Tomkos I, Pointurier Y, Azodolmolky S, Eiselt M, Zami T, Piesiewicz R et al (2009) DICONET: future generation transparent networking with dynamic impairment awareness. In: Tselentis G et al (eds) Toward the future Internet. IOS press, Dublin, pp 173–182

Tselentis G, Domingue J, Galis A, Gavras A, Hausheer D, Krco S, Lotz V, Zahariadis T (2009) Towards the future internet. A European research perspective. IOS Press, Washington, DC:: The Netherlands

Tregua M, Russo Spena T, Bifulco F (2016) The Context of Future of Internet and Cultural Heritage. In: Bifulco F, Russo Spena T (eds) Managing Cultural Heritage. McGraw Hill, Milan, pp 23–45

Ulieru M, Grobbelaar S (2007) Engineering industrial ecosystems in a networked world. In Industrial Informatics, 2007 5th IEEE International Conference, 1: 1–7

Vargas-Hernández JG, Pallagst K (2020) Green Innovation and Sustainable Urban Ecosystems. In: Vargas-Hernández JG, Pallagst K (eds) Building an Entrepreneurial and Sustainable Society. New York, IGI Global, pp 54–74

Vargo SL, Lusch RF (2017) Service-dominant logic 2025. Int J Res Mark 34(1):46–67

Vaz AM, Magalhaes Martins B, Carneiro Brandao R, Alberti AM (2012) Internet of lnformation and Services: A Conceptual Architecture for Integrating Services and Contents on the Future Internet. IEEE Latin America Transactions, I 6:2292–2300

Wainwright N, Papanikolaou N (2012) Introduction: the FIA research roadmap, priorities for future Internet research. In: Álvarez F et al (eds) The Future Internet Assembly. Springer, Berlin, Heidelberg, pp 1–5

Wajid U, Marín CA, Mehandjiev N (2013) Optimizing service ecosystems in the cloud. In: Galis A, Gavras A (eds) The future internet assembly. Springer, Heidelberg, pp 115–126

Wang T, Luo H, Jia W, Liu A, Xie M (2019) MTES: An intelligent trust evaluation scheme in sensor-cloud-enabled industrial Internet of Things. IEEE Transactions on Industrial Informatics 16(3):2054–2062

Wang W, De S, Cassar G, Moessner K (2013) Knowledge representation in the internet of things: semantic modelling and its applications. Automatika 54(4):388–400

Winter J, Ono R (2015) The Future Internet: Alternatives Visions. Switzerland, Springer, Cham

Zuccalà M, Verga ES (2017) Enabling energy smart cities through urban sharing ecosystems. Energy Procedia 111:826–835