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## UNDERSTANDING OPEN DATA BUSINESS MODELS FROM INNOVATION AND KNOWLEDGE MANAGEMENT PERSPECTIVES

### Abstract

**Purpose** – This paper analyses the open data business models (ODBMs) as a source of knowledge and innovation to generate economic value. A framework for understanding open data business models (ODBMs) is presented. Firstly, the knowledge structure of the ODBMs literature is identified. Secondly, a conceptual model for analysing the ODBMs is proposed. And, finally, the future trends in ODBMs research are discussed.

**Design/methodology/approach** – A co-word analysis is performed to identify the topics related with ODBMs.

**Findings** –The ODBMs structure of knowledge is articulated in five themes: business model, smart city, business ecosystem, decision making and innovation. Based on these results, a five-step model for analysing ODBMs is proposed. Finally, a discussion of the future trends of ODBMs focused on a knowledge management perspective, open data ecosystems, and business intelligence is presented.

**Originality** –The paper proposes to apply the principles and models of knowledge management and business intelligence to ODBMs in order to transfer and transform open data into valuable knowledge that can be used for developing apps. In that context, the importance of encouraging collaboration between different agents in the so-called open data ecosystem is presented.

**Keywords:** Open data business models (ODBMs), Co-word analysis, Innovation, Knowledge management, Open data ecosystem, Business intelligence

**Paper type:** Research paper.

## 1. Introduction

Business models have been studied for a long time. Exploitation of business opportunities for creating value can be achieved through the development of business models (Yu, 2016). Business models allow creating value for society and/or revenue for companies. In recent years, their impact has been broadened considering the business model innovation theory (e.g., Foss and Saebi, 2017). This has led researchers to ask new questions such as: Which are the drivers, enablers and barriers to business model innovation? Where can business model innovation be originated? In that context, there are several interesting fields of application such as open innovation and dynamic capabilities (Foss and Saebi, 2017).

Business models can be studied from an open innovation perspective. Indeed, open business models facilitate the integration and commercialisation of external resources and present a new form of value capture. Firms that are increasingly dependent on external resources and capabilities need to adopt an open system perspective (Foss and Saebi, 2017). In this context, open data and social business models are “a phenomenon based on a collaborative-based system of governance characterized by an interplay between public and private elements” (Janssen and Zuiderwijk, 2014, p. 707). Although public data are the more frequent, considering the private data in hybrid models can contribute to increase the value creation (Janssen and Zuiderwijk, 2014).

Nevertheless, Kitsios *et al.* (2017) found that there is a limited knowledge about the open data ecosystem from the business perspective. Magalhaes *et al.* (2014) highlight that there is a gap in the literature concerning how data create value for firms, and there are few academic papers in the context of open government data (OGD) that analyse the phenomenon of business models. Corrales-Garay *et al.* (2020b, p. 12) state that “new studies on the generation of new open data business models via the collaborative development of specific applications and services in open innovation processes are necessary”. In the same way, Zeleti (2014) affirms that there is a need for further research on business models in the context of open data.

This paper is focused on the study of the open data business models (ODBMs). The first objective of this paper is to analyse the ODBMs structure of knowledge. For this purpose, the following research questions were posed: (1) What are the main topics on ODBMs research? (2) Is there any conceptual model for analysing ODBMs? The second objective is to offer some recommendations for understanding ODBMs and to identify future trends. The following research question is proposed: (3) What are the future trends in the ODBMs research?

After this introduction, the theoretical framework presenting the context of ODBMs from business model innovation theory is explained. In the following section, a co-word analysis is performed to identify different topics. The results and discussion section deals firstly with the identification and analysis of the main topics, that is, business model, smart city, business ecosystem, decision making and innovation, and secondly presents a discussion of each topic based on a five-step model: context, inputs, process, outputs and impact. In section five, future trends in the study of ODBMs are identified: knowledge management, open data ecosystems, and business intelligence. Finally, conclusions, limitations, and future research directions are presented.

After accomplishing these two objectives, the contributions of that paper are to (a) identify the main topics and the relationship in that research stream; (b) present a model for analysing ODBMs; and (c) guide the new research in that topic.

## **2. Theoretical background**

### **2.1. Business model innovation**

The “business logic” is represented by a business model (Casadesus-Masanell and Ricart, 2010). In that sense, “A business model articulates the logic, the data, and other evidence that support a value proposition for the customer, and a viable structure of revenues and costs for the enterprise delivering that value” (Teece, 2010, p. 179). Other authors have defined business models as “the process of capturing, creating and delivering value” (Johnson *et al.*, 2008; Massa and Tucci, 2013; Bashir and Farooq, 2019).

Foss and Saebi (2017) define business model innovation (BMI) as “designed, novel and non-trivial changes to the key elements of a firm's business model and/or the architecture linking these elements”. This is a more holistic view of business models that has positively influenced the performance of entrepreneurial and innovative firms. The literature recognises that business model innovation can be undertaken due to different reasons, such as cost reduction, new product introduction, process optimisation, access to new markets and performance improvement (Foss and Saebi, 2017). In addition, Foss and Saebi (2017) found that there are several interesting fields of application of business model innovation such as sustainability, servitisation, open innovation and dynamic capabilities.

Moreover, there are still significant gaps in understanding the drivers of business model innovation (Foss and Saebi, 2017). Some theoretical frameworks are useful for developing new insights such as innovation theory (Henderson and Clark, 1990), dynamic capabilities theory (Teece *et al.*, 1997) and open innovation theory (Chesbrough, 2010; Chesbrough and Crowther, 2006).

Thus, the ability to innovate the business models in response to major changes in the external environment may be a key dynamic capability (Zott *et al.*, 2011). In addition, the literature on open innovation shows that specific types of open innovation require specific business models (Saebi and Foss, 2015). In that context, open business models facilitate the integration and commercialisation of external resources (Chesbrough and Crowther, 2006; Laursen and Salter, 2006) and present a new way to create value. Some authors highlight that it is important to understand how firms can align open business models with value creation (Randhawa *et al.*, 2016). Firms that increasingly rely on external resources and capabilities need to adopt an open system perspective (Berglund and Sandström, 2013).

Although there are many literature reviews about business model innovation, we have only found one study, Zeleti (2014), which analyses the business models from an open data perspective. This is the reason why we’ve focused on the open data perspective. A summary of the most relevant and recent literature reviews on business model innovation and open data business models is shown in Table I.

INSERT TABLE I ABOUT HERE

### **2.2. Open data business models**

From an open system perspective of ODBMs, there is an interesting phenomenon that is the Open Data Government. The economic, political, and social importance of open data has increased exponentially in recent years (Corrales-Garay *et al.*, 2019a). The use of open data allows for the creation of new digital services, particularly applications (Abella *et al.*, 2015; 2017), sometimes in an open innovation process that fosters stakeholder

collaboration (Corrales-Garay *et al.*, 2019b; 2020a). Therefore, open data serves as a viable base from which entrepreneurs may generate new business models. Corrales-Garay *et al.* (2020b, p. 1) found that “open data sources, innovation, and business models are studied as critical factors for analysing entrepreneurship through open data”.

Open data increases transparency, the accountability, the involvement and self-empowerment of citizens to economic growth and can stimulate the competitiveness and innovation of firms. Open data is beneficial for researchers, governments, businesses and society (Kitsios *et al.*, 2017). There are three domains of interdependencies of open data: 1) government policies and practices, 2) innovators for combination of technology, business and government and 3) business, users and civil society (Harrison *et al.*, 2012; Zuiderwijk *et al.*, 2014).

Open data serves as a viable base from which entrepreneurs may generate new business models through the generation of new digital services by reusing open data (Kitsios *et al.*, 2017; Lindman, 2014; Lindman *et al.*, 2014; 2016; Zimmermann and Pucihar, 2015). But despite the existence of studies that identify types of business models that can be created from open data, some authors point out the lack of business models and value network as main challenges in open data reuse (Kitsios and Kamariotou, 2019). Reinforcing this idea, Zeleti *et al.* (2014) establish that more rigorous academic studies of the different ODBMs are necessary.

Otherwise, in the academic literature, there are different perspectives to analyse the ODBMs. One of the most used approaches is the application of the Business Model Canvas, which includes the following elements: key partnerships, key activities, key resources, value proposition, relationship with customers, customer groups, channels, revenue stream, and cost structure (Immonen *et al.*, 2014; Kitsios *et al.*, 2017; Zimmermann and Pucihar, 2015). Janssen and Zuiderwijk (2014) present six types of infomediary business models. Other previous studies have highlighted the importance of assessing the role of the actors in the open data ecosystem (Immonen *et al.*, 2014; Kitsios *et al.*, 2017) or present the archetypes or models such as Duval and Brasse (2014), Feller *et al.* (2011), Ferro and Osella (2013), Hammell *et al.* (2012), Janssen and Zuiderwijk (2014), Kitsios *et al.* (2017), Magalhaes *et al.* (2014), Zeleti *et al.* (2014), Yu (2016) and Zimmermann and Pucihar (2015). Other studies should thoroughly analyse the generation of value and new business models that emerge from the collaborative development of different products or services as applications in the open data ecosystem (Yu, 2016). Zeleti and Ojo (2017) present a model for synthesizing the value elements in ODBMs.

### **3. Methodology**

#### ***3.1. Sample selection process***

ODBMs literature was studied following a systematic method. The article follows a three-stage approach -planning stage, conducting stage and reporting stage- as applied by Marikyan *et al.* (2019) and previously suggested by Tranfield *et al.* (2003). The entire process can be observed in Figure 1.

INSERT FIGURE 1 ABOUT HERE

The final number of documents to review (56) is classified by year in Figure 2. 2016, with 11 documents, can be highlighted, followed by 2014 and 2017 with 10 studies respectively.

INSERT FIGURE 2 ABOUT HERE

### 3.2. Co-word analysis

The bibliometric technique of co-word analysis was used to identify different themes/topics in the literature related with ODBMs. Science mapping uses co-occurrences among keywords to obtain thematic clusters (Cobo *et al.*, 2011). Co-word analysis identifies relationships between ideas using models of co-occurrence of term pairs from a set of documents. Therefore, the relationships between the topics represented by the terms can be established (He, 1999). Then, to determine the knowledge structure of this field, we performed an analysis of the keywords.

SciMAT software has been used for a co-word analysis and to identify the main topics (Cobo *et al.*, 2012). Co-occurrence matrix and equivalence index calculations were carried out (Callon *et al.*, 1991). Thematic networks with a maximum network size of 12 and a minimum size of 3 were then created. Following Callon *et al.* (1991), based on their measures of centrality and density, a strategic diagram was created to classify each thematic network into different groups: well-developed and isolated topics; emerging or disappearing topics; basic and cross-sectional topics; and central topics.

## 4. Results and discussion

### 4.1. Results

Based on the strategic diagram presented (Figure 3), “Smart Cities” and “Business Ecosystem” are the central themes, characterized by a high degree of internal development and strong ties with other concepts of the field of research. The well-developed and isolated theme is “Decision Making”, that has a high degree of internal development. “Business Model” is the basic and cross-sectional theme. It shows strong ties with other issues and is very relevant to the area of knowledge considered. And the emerging or disappearing theme is “Innovation”. For each theme, a subnetwork (Figures 4-6), that contains keywords that are related with it is presented. Each subnetwork forms a theme/topic.

INSERT FIGURE 3 ABOUT HERE

-“Business Model”: This basic and cross-sectional theme contains the highest number of documents (37) and shows the highest h-index (8). The analysis of the term subnetwork (Figure 4) indicated that, in addition to the main term, the keyword “Open Data” was highly relevant considering the number of documents and the significance of the relationship between both terms.

INSERT FIGURE 4 ABOUT HERE

-“Smart City”: This theme is central, with three documents and an h-index of 3. An examination of the term subnetwork (Figure 5) reveals a strong relationship between the main term “Mobile Telecommunication Systems” and “Economics”.

-“Business Ecosystem”: This is a central theme, with two documents and an h-index of 2. The evaluation of the term subnetwork (Figure 5) shows a strong relationship between the main term, “Ecosystem” and “Collaborative Environments”.

INSERT FIGURE 5 ABOUT HERE

-“Innovation”: This is an emerging theme with three documents and an h-index of 2. The analysis of the term subnetwork (Figure 6) points out a relation of certain intensity between the main term, “Entrepreneurship” and “European Union”.

-“Decision Making”: This theme is well-developed and isolated with three documents and h-index of 1. An examination of the term subnetwork (Figure 6) shows considerable relations between the main term “Design” and “Government Data Processing”.

INSERT FIGURE 6 ABOUT HERE

## 4.2. Discussion

### 4.2.1. The knowledge structure of open data business models

Figure 7 shows the logic of the knowledge structure on ODBMs to answer the first research question: What are the main topics of study on ODBMs research? We observe that the previous studies have analysed ODBMs from the perspective of the business ecosystem and their application in smart cities. Additionally, the main utility observed in the studies is its application for decision-making. However, innovation is the emerging topic on which attention is currently being focused. Therefore, we can see how ODBMs are starting to be studied from the perspective of innovative business models as defined by Foss and Saebi (2017).

INSERT FIGURE 7 ABOUT HERE

#### Topic 1. Open data business models

The main topic is ODBMs. The increase of the access and use of data in an “Open Data” format fosters the generation of new “Business Models” (e.g., Eskelinen *et al.*, 2017). There were significant connections between subnetwork terms and with the main term and “Open Data” (Figure 4). Data and information exchange may involve an “Open Innovation” process that generates value for many agents, including companies, public organizations, and consumers. In that sense, “Open Data” are usually released by the public sector (“Open Government Data”) (e.g., Zimmermann and Pucihar, 2015) as part of the trend toward openness and “Open Government” (Janssen and Zuiderwijk, 2014), generating new “Open Data Business Models” (e.g., Zeleti *et al.*, 2016; Zeleti and Ojo, 2017), such as the creation of new ODBMs associated with OGD platforms. Therefore, barriers related to the data and “Metadata” format should be overcome (Duval and Brasse, 2014). Likewise, open data generate new “Business Opportunities” for agents that use and produce data through the business ecosystem like the development of new products and services (e.g., Immonen *et al.*, 2014; Kitsios *et al.*, 2017), especially mobile applications (“Mobile App”) based on new business models (e.g., Guesmi, 2014; Walravens, 2015). In that regard, concepts as open data “Value Network” and business models are key elements in order to develop innovative applications (e.g., Kitsios and Kamariotou, 2019) that can have plausible commercial opportunities (“Electronic Commerce”) (e.g., Walravens, 2015; Walravens *et al.*, 2016).

We find some interesting studies regarding to ODBMs. Ferro and Osella (2012; 2013), considering private sector enterprises, present eight archetypal business models for the public data reuse: premium, freemium, open source like, infrastructural razor and blades, demand-oriented platform, supply-oriented platform, free as branded advertising, and white label development. Zeleti *et al.* (2014) present a classification into five categories: premium, freemium, razor-blade, indirect benefit and cost saving. In that line, Duval and Brasse (2014), in the context of OGD platform, consider three business models: free, freemium and premium. In that sense, it can be observed that discussions on ODBMs are predominantly in the practitioners’ community (Zeleti *et al.*, 2014), for example, the analyses by McKinsey, in the US (Manyika *et al.*, 2013) and Deloitte, in UK (Hammell

*et al.*, 2011). Deloitte's research identifies five business model archetypes in the open data "marketplace": suppliers, aggregators, developers, enrichers, and enablers. And, Gurin (2014) classifies OGD business into two groups: business models that use open data to improve service -from sectors such as healthcare, energy, education, and finance-called better business through open data; and business models that would not exist without open data, that is, open data pure plays.

### *Topic 2. Open data business models in a business ecosystem*

ODBMs can be developed in a business ecosystem. In that context, open data can foster business opportunities for agents that produce or use data through "Business Ecosystem". This benefits all the agents in the open data "Ecosystem" through the generation of a "Collaborative Environment" (e.g., Immonen *et al.*, 2014; Kitsios *et al.*, 2017) (Figure 5).

Kampars *et al.* (2020) consider the capability-driven development approach, which allows modelling of open data processing ecosystems, facilitates knowledge exchange about open data usage among members of the ecosystem, and supports configuring information systems for open data processing. In that line, Zuiderwijk *et al.* (2014) consider the view of ecosystem of open data and explain that open data ecosystem could be seen as the combination of different types of ecosystems: 1) government ecosystems - open data are mainly published by the government-; 2) business ecosystems -open data can also be provided by the private sector-; 3) innovation ecosystems -for the collaborative arrangements between agents-; 4) information ecosystem -interconnection of people, work, value supported by technology-; 5) software ecosystems -a networked community of organizations based on software technology-; and 6) digital ecosystem -interconnected, interrelated and interdependent digital species enabling the service co-innovation and co-creation among members utilizing and sharing common assets and knowledge-.

In that context, actors in the open data ecosystem -data providers, service providers, application developers, application users, and infrastructure and tool providers- and models based on the Business Model Canvas are considered in previous literature (e.g., Immonen *et al.*, 2014; Kitsios *et al.*, 2017; Zimmermann and Pucihar, 2015). Magalhaes *et al.* (2014) identify three archetypes for ODBMs: enablers, facilitators and integrators. But Hammell *et al.* (2012) identify five archetypes: suppliers, aggregators, developers, enrichers and enablers. In addition, Janssen and Zuiderwijk (2014) present infomediary business models considering four value-based aspects (value proposition, value architecture, value network, public value/value finance) and identify six types of business models: single-purpose apps; interactive apps; information aggregators; comparison models; open data repositories; and service platforms.

### *Topic 3. Open data business models and smart cities*

Modern cities are increasingly responding to the concept of "Smart City," which is characterized by data interconnection and information exchange. In this context, open data play a key role, generating economic activity ("Economics") through new business models based on the digital economy, such as mobile applications ("Mobile App"). The smart city ecosystem has been developed using information and communication technologies through new platforms and telecommunication systems ("Mobile Telecommunication System") (e.g., Mrazovic *et al.*, 2016; Walravens, 2015). In addition, there is a strong relationship between "Smart City" and "Brussels" because of the existence of academic works focused in the study of the smart city ecosystem of Brussels Capital Region (e.g., Walravens, 2015; Zotano and Bersini, 2017) (Figure 5).



#### *Topic 4. Open data business models for decision making*

One of the applications of ODBMs is “Decision Making”. Whereas the public sector seeks to create public value, the private sector pursues business benefit, generating new business models. Therefore, it is necessary to implement specific mechanisms to coordinate these objectives, improving the processing of the released information (“Government Data Processing”) (e.g., Overbeek and Janssen, 2015). Private organizations are not very active opening up their datasets. There is a lack of guidelines on the “Decision Making” process of private organizations in order to open and share their datasets. In that sense, there are certain works that generate a decision support framework that involves this process using a “Design” science approach in the study (e.g., Buda *et al.* 2016) (Figure 6).

In that line, Zimmermann and Pucihar (2015, p. 1) highlight that ODBMs “support entrepreneurs in reusing and combining available open data sources to provide value-added services”. Saxena (2014) explains the re-use of open data can be used to solve problems.

#### *Topic 5. Open data business models for innovation*

Finally, the emerging topic is innovation. In that sense, OGD promote “Entrepreneurship” and business “Innovation”, especially within the area of information technology, creating new business models (Figure 6). In that regard, the studies carried out in the context of countries within the “European Union” are noteworthy (e.g., Lakomaa and Kallberg, 2013; Wiczorkowski, 2019). The study of innovation in ODBMs is a subject of study that is beginning to develop. In that sense, in the work of Kitsios *et al.* (2017), the innovation in business models in the open data ecosystem is proposed. However, it would be interesting to analyse the different types of innovation existing to create new ODBMs within this ecosystem, since the existing literature is not focused on that.

#### *4.2.2. A five-step model for analysing open data business models*

This literature review stresses the importance of studying ODBMs, but this subject needs to be investigated thoroughly. Then, to answer the second research question -Is there any conceptual model for analysing ODBMs?-, we have proposed a five-step conceptual model to identify the main elements in order to study ODBMs. In addition, some emerging themes are presented.

Based on the results obtained, a classification of the topics identified in the subnetworks has been made. The elements considered in the conceptual model for analysing entrepreneurship through open data by Corrales-Garay *et al.* (2020b) have been taken as a reference: context, inputs, process, outputs and impact (Table II).

INSERT TABLE II ABOUT HERE

The model proposed in Table II shows the different aspects to be considered for analysing ODBMs, grouped by key elements. The first element, context, is determined by the theories, principles and systems applying to ODBMs -open government and information management, mobile telecom systems, and electronic commerce- and by the business ecosystems and their applications to the smart cities.

Additionally, we have to consider the necessary inputs for the business model process, which in this case are OGD, open data, and metadata. Various processes are then applied to these data to carry out business models. Entities must manage the information to turn it into knowledge that can be reused (government data processing), that is, innovation processes into open and collaborative environments. In that sense, a value network can

be created. Then, some outputs can be obtained, such as apps that allow companies to define their business models and entrepreneurship activities. Finally, the phenomenon of ODBMs has an impact in the development of business opportunities and in the economic sphere.

## **5. What comes next in open data business models research?**

Finally, to answer the third research question -What are the future trends in the ODBMs research?-, we have conducted a qualitative analysis of the previous literature and we have identified several factors that affect ODBMs and can be considered new or future themes (Figure 8).

INSERT FIGURE 8 ABOUT HERE

### ***5.1. Open data business model from a knowledge management perspective***

We have observed that no ODBMs from a knowledge management perspective have been developed. Then, a future theme is the study of ODBMs from a knowledge management perspective. One of the elements of the context in Table II is information management. In that sense, as we observed that ODBMs use data as input and need to transform data into knowledge to be reused, the knowledge management perspective can be considered.

New business environments, characterized by dynamically discontinuous change, claim for the sense-making model of knowledge management (Malhotra, 2000). Palacios *et al.* (2009, p. 292) state that “knowledge management has gained popularity as a consequence of the emergent need to incorporate the dynamics of change to the information architecture and the business model, as well as to develop and encourage the growth of systems that are useful in adapting to a turbulent environment inherent to a knowledge-based economy”. In that sense, Malhotra (2005) studies the combination of knowledge management technologies with company business processes in order to improve business performance.

Knowledge management is a framework to learn, share and codify the knowledge to create value and provides a coordinating mechanism for transforming data and knowledge into products and services (Bashir and Farooq, 2019). To develop a good business model, knowledge management capabilities can be used considering the knowledge acquisition, conversion, dissemination, application and knowledge reuse. Bashir and Farooq (2019, p. 362) found that “the integration of knowledge management and business model innovation (value proposition, assets and capabilities, revenue and cost architecture and actors in business networks) leads to a sustainable competitive advantage”.

Nielsen (2018, p. 48) highlights that there is an interesting relationship between the fields of business models and knowledge management: “Sometimes the improvement of knowledge management practices creates improvements in business models, and at other times this relationship may be swapped around”. In this sense, knowledge management practices affect the transformation of business models (Li *et al.*, 2021). Nielsen (2018) found that for all business models, intellectual capital and knowledge are important but, there are some business model configurations where knowledge management is the key value driver. In that context, some authors (Hussinki *et al.*, 2017; Marr *et al.*, 2003; Seleim and Khalil, 2011; Wiig, 1997) highlight the relationship between knowledge management and intellectual capital. Marr and Schiuma (2001) explain that for obtaining, growing and sustaining intellectual capital is fundamental the knowledge management. Other authors as Alvino *et al.* (2020, p. 76) deepened this relation stating “that knowledge management

(KM) and the implementation of intellectual capital (IC) can contribute to improving competitiveness and trust of stakeholders, favouring innovation and sustainable growth”, which is connected with the creation of sustainable business models.

Knowledge management is multidisciplinary, with contributions originating from the Computer Science, Information Science, Organization Science and Cognitive Science disciplines (Wiig, 2002; Dalkir, 2011). The American vision of Knowledge Management, has contributions from Information Sciences and Computer Sciences and is based on the coding of elements of knowledge using technologies (Waltz, 2003). From this perspective, the use of knowledge management instruments such as corporate portals, content management systems, knowledge-based systems and decision support systems is analysed. From this perspective, knowledge management involves a process that, as a value chain, starts from the raw material (data) to the products (knowledge). The process involves the acquisition of data, classification, filtering, indexing and organization (information), reasoning (analysis and synthesis) for the creation and dissemination of knowledge (Rautenberg *et al.*, 2017). Klaila (2000, p. 138) explains “how a knowledge-driven business model identifies the critical behaviours, competencies, market conditions, finances and other resources needed to make change happen”. This perspective can be applied to the ODBMs case, helping to understand how the outputs can be reached from the inputs, in this case, the development of knowledge that can be used to create apps.

Following Mohamed *et al.* (2020, p. 498) “the transformation from data to knowledge takes place through the addition of faithful context and semantics to data through tactics, techniques and procedures of acquisition, nurturing, and sharing”. Mohamed *et al.* (2020) define a conceptual framework called “knowledge iterative value network” for the synthesis of knowledge from OGD that identifies five phases applied to data to extract knowledge and then create data from that knowledge: acquisition, dissemination, analysis, synthesis and implementation. In particular, in the last phase it is possible to see the effect of this process on companies and their business models. Mohamed *et al.* (2020, 505) state that “the implementation of OGD involves activities that transform data into services and products or knowledge that can be leveraged for decision-making and problem solving” and leads to a value network, that is, “any set of roles and interactions in which people engage in both tangible and intangible exchanges to achieve economic or social good” (Allee, 2008, p. 6). This model can be considered in the definition of ODBMs since it helps to understand the process and the outputs that can be generated with open data.

Knowledge management has a connection with the concept of intellectual capital that can be considered. Following Stewart (1997, p. 10): “Intellectual capital is intellectual material – knowledge, information, intellectual property, experience – that can be put to use to create wealth”. From this perspective, knowledge constitutes the core of intellectual capital, so it can be considered a key activity for creating, enhancing and sustaining intellectual capital inside organizations (Marr and Schiuma, 2001). Hussinki *et al.* (2017) demonstrate that companies with high use of knowledge management practices and high levels of intellectual capital are generally related with an improvement in market and innovation performance in contrast with those firms with low levels. In that sense, innovation performance can be improved through openness strategies inside open innovation paradigm, while integrating intellectual capital (Lo *et al.*, 2020). So, intellectual capital can be considered a source of open innovation. Likewise, open innovation processes can generate open data and open data can create open innovation (Corrales-Garay *et al.*, 2019b). Following that, future contributions may broaden the

knowledge management perspective, taking into account the influence of intellectual capital in the ODBMs.

In that regard, open innovation processes that foster collaboration between different agents can constitute an interesting opportunity for service development. Thus, Bican *et al.* (2017) establish in their study how companies can manage knowledge through intellectual property rights in this kind of processes. In this sense, knowledge management practices can support collaborative innovation (An *et al.*, 2014). Immonen *et al.* (2018, p. 1257) state that “the utilization of open data in digital services requires new innovation practices, service development models, and a collaboration environment”.

## **5.2. Open data business models in an open data ecosystem**

The perspective of the open data ecosystem for analysing ODBMs is an interesting future theme. Open data ecosystems can stimulate innovation and citizen participation. To form an ecosystem, various applications, tools and portals are available to be used by open data providers and users (Zuiderwijk *et al.*, 2014). Zuiderwijk *et al.* (2014) present the main elements of open data ecosystems: 1) to release and publish open data, 2) to search, find, evaluate and view data and their licenses, 3) to clean, analyse, enrich, combine, link and visualize data; 4) to interpret and discuss data and to provide feedback to the data agents; 5) to show directions for using and reusing open; 6) to apply a quality management system; and 7) to provide different types of metadata to connect the elements. Immonen *et al.* (2014) analysed the open data ecosystem from a business perspective and stressed that more studies on the open data ecosystem are necessary. Although studies like that of Kitsios *et al.* (2017) have taken that approach, showing the collaboration and generation of value among various agents in the open data ecosystem, more studies should be conducted along this research stream.

Business models from an ecosystem perspective can be considered, following Timmers (1998), as “the architecture of products, services, and information flows, including the descriptions of various business actors and their roles, the potential benefits for various actors, and the sources of revenues”. Future studies should develop essential concepts not addressed in the literature, including the identification of the primary agents responsible for developing each type of business model and the effect of different agents and types of ODBMs on the main elements of the business model process. Specifically, the literature should answer questions like “in what kind of format(s) is/are data released by data publishers?”. This topic is important for developing different types of business models, especially for information aggregators and comparison models; these data, collected from different sources, must be in an open linked format that favours their reuse. Another question that should be answered is “what are the main barriers to the reuse of data by different agents?”. These barriers can be effectively addressed by classifying and studying them. Moreover, considering the above questions, the literature should address “how do the format of data and the barriers to their reuse affect factors, such as the value network and value architecture?”

In addition, it is essential to increase the public value or value finance factor of open data repositories and service platforms, which are frequently connected to open data repositories, by classifying the open data most commonly used by agents reusing data on these platforms, as this information is useful for entrepreneurs who try to develop business models based on new applications. In addition, answering questions, such as “what types of users or reusing agents -social reusers or professional reusers and users,

academic users, or citizens (Abella *et al.*, 2019) access the data on these platforms?” is critical for evaluating new business models based on open data.

Research should develop a classification system based on the type of platform, considering characteristics such as the degree of availability of datasets and the differences in the value finance factor. This is especially critical for service platforms. There are platforms that already offer their services to users for free; these are mainly focused on providing public value, whereas other platforms work with different payment systems in order to obtain economic benefit.

### **5.3. Open data business models and business intelligence**

Finally, the third future theme is the study of ODBMs considering the tools of business intelligence. Other element of the model proposed in Table II are inputs. We observed that ODBMs can use business intelligence to search, storage and manage data.

In that sense, Negash (2004, p. 178) state that “business intelligence systems combine data gathering, data storage, and knowledge management with analytical tools to present complex internal and competitive information to planners and decision makers”. “Business intelligence assists in strategic and operational decision making” (Negash, 2004, p. 179). Mazón *et al.* (2012) explain that “Open Business Intelligence” facilitates non-expert users to analyse and visualize linked open data, thus generating actionable information by means of reporting, OLAP analysis, dashboards or data mining; and to share the new acquired information as linked open data to be reused by anyone. This is an excellent mechanism to allow citizens to understand and analyse linked open data in a user-friendly manner (Mazón *et al.*, 2012). Following the philosophy of business intelligence (Trieu, 2017), to learn what we know, how well we know, and what we need to know about the processes of organizations obtaining business value from ODBMs are an important issue. In that sense, ODBMs should analyse their economic impact (Table II). Magalhaes and Roseira (2020) state that “the release of government data in an open format is broadly expected to generate innovation and economic value. However, despite the emerging public notoriety of this issue, literature is still scarce regarding the commercial application of OGD”. Then, it is necessary to understand how firms use ODBMs to create value.

Zeleti and Ojo (2017) develop the six-value business models to facilitate the explanation and detailed analysis of existing ODBMs in practice: 1) value proposition -offer, value and channel-; 2) value adding process -knowledge management, strategic and operational-; 3) value network -actors and support infrastructure-; 4) value capture -profit model and market size-; 5) value in return -value of sale, future opportunity and income-, and 6) value management -structure, administration, discipline and governance-. Feller *et al.* (2011), in turn, consider the value proposition (product), the customer interface (target customer, distribution channel, relationship), the infrastructure management (value configuration, core competency, partner network) and the financial aspects (cost structure, revenue model).

## **6. Conclusions**

This paper studies the ODBMs as a source of knowledge and innovation to generate economic value. Relevant topics (first research question) are identified, a five-step model for analysing ODBMs is proposed (second research question) and a discussion of some future trends (third research question) is made.

We have observed that the consideration of business model innovation theory is a more recent phenomenon that has highlighted the interest in developing business models in

open contexts, aligned with open innovation and OGD. However, there is little work that has analysed ODBMs. In that sense, there are three academic contributions of the paper. Firstly, the analysis carried out in this paper has allowed us to provide a picture of the main topics that have been studied in ODBMs: business model, smart city, business ecosystem, decision making and innovation. Secondly, a five-step model for analysing ODBMs has been proposed. Our suggestion is that in order to develop ODBMs, a strategic decision-making process can be followed considering the following aspects: context, inputs, process, outputs and impact.

Finally, the third theoretical contribution of this work is the identification of the future trends in the study of ODBMs. Particularly, it is noted that knowledge management is a complementary theoretical framework to underpin studies on ODBMs. Furthermore, the application of business intelligence and the understanding of the open data business ecosystem are fundamentals for creating value.

Regarding the practical implications for those intending to develop new business models based on applications, we emphasize the importance of encouraging collaboration between different agents in the so-called open data ecosystem (Kassen, 2018).

This research has some limitations derived from the use of a bibliometric analysis. Further studies can also apply complementary methodologies, such as content analysis or case studies.

Future research can consider some questions that still need to be addressed, such as: 1) What are the main sources of open data used in business models? 2) How do open innovation processes affect the development of business models for open data-driven organizations? 3) What are the determining agents and factors that are presented in business models based on open data? Future studies could also address some case studies in order to the five-step model for analysing ODBMs, and propose some key performance indicators (KPIs) to measure the economic impact of ODBMs.

## References

- Abella, A., Ortiz-de-Urbina-Criado, M. and De-Pablos-Heredero, C. (2015), "Information reuse in smart cities' ecosystems", *El Profesional de la Información*, Vol. 24 No. 6, pp. 838-844. DOI: 10.3145/epi.2015.nov.16
- Abella, A., Ortiz-de-Urbina-Criado, M. and De-Pablos-Heredero, C. (2017), "A model for the analysis of data-driven innovation and value generation in smart cities' ecosystems", *Cities*, Vol. 64, pp. 47-53. DOI: 10.1016/j.cities.2017.01.011
- Abella, A., Ortiz-de-Urbina-Criado, M. and De-Pablos-Heredero, C. (2019), "The process of open data publication and reuse", *Journal of the Association for Information Science and Technology*, Vol. 70 No. 3, pp. 296-300. DOI: 10.1002/asi.24116
- Allee, V. (2008), "Value network analysis and value conversion of tangible and intangible assets", *Journal of Intellectual Capital*, Vol. 9 No. 1, pp. 5-24. DOI: 10.1108/14691930810845777
- Alvino, F., Di Vaio, A., Hassan, R. and Palladino, R. (2020), "Intellectual capital and sustainable development: a systematic literature review", *Journal of Intellectual Capital*, Vol. 22 No. 1, pp. 76-94. DOI: 10.1108/JIC-11-2019-0259

- An, X., Deng, H., Chao, L. and Bai, W. (2014), "Knowledge management in supporting collaborative innovation community capacity building", *Journal of Knowledge Management*, Vol. 18 No. 3, pp. 574-590. DOI: 10.1108/JKM-10-2013-0413
- Andreini, D., Bettinelli, C., Foss, N.J. and Mismetti, M. 2021, "Business model innovation: a review of the process-based literature", *Journal of Management and Governance*. DOI: 10.1007/s10997-021-09590-w
- Andrianto, T., Koseoglu, M.A. and King, B. (2021), "A business model innovation process for tourism: findings from a literature review", *Tourism Recreation Research*. DOI: 10.1080/02508281.2021.1878654
- Bashir, M. and Farooq, R. (2019), "The synergetic effect of knowledge management and business model innovation on firm competence: a systematic review", *International Journal of Innovation Science*, Vol. 11 No. 3, pp. 362-387. DOI: 10.1108/IJIS-10-2018-0103
- Bashir, M., Naqshbandi, M.M. and Farooq, R. (2020), "Business model innovation: a systematic review and future research directions", *International Journal of Innovation Science*, Vol. 12 No. 4, pp. 457-476. DOI: 10.1108/IJIS-06-2020-0081
- Berglund, H. and Sandström, C. (2013), "Business model innovation from an open systems perspective: structural challenges and managerial solutions", *International Journal of Product Development*, Vol. 18, No. 3-4, pp. 274-285. DOI: 10.1504/IJPD.2013.055011
- Bican, P.M., Guderian, C.C. and Ringbeck, A. (2017), "Managing knowledge in open innovation processes: an intellectual property perspective", *Journal of Knowledge Management*, Vol. 21 No. 6, pp. 1384-1405. DOI: 10.1108/JKM-11-2016-0509
- Bocken, N., Strupeit, L., Whalen, K. and Nußholz, J. (2019), "A review and evaluation of circular business model innovation tools", *Sustainability*, Vol. 11 No. 8, p. 2210. DOI: 10.3390/su11082210
- Brasseur, T-M., Mladenow, A. and Strauss, C. (2017), "Open business model innovation: literature review and agenda for future research", *Business Informatics*, Vol. 42 No. 4, pp. 7-16. DOI: 10.17323/1998-0663.2017.4.7.16
- Buda, A., Ubacht, J., Janssen, M. and Sips, R. (2016), "Decision support framework for opening business data", in Decman, M., & Jukic, T. (Ed.s), *16th European Conference on e-Government (ECEG)*, Academic Conferences Limited, Reading, pp. 29-37.
- Callon, M., Courtial, J. and Laville, F. (1991), "Co-word analysis as a tool for describing the network of interactions between basic and technological research: the case of polymer chemistry", *Scientometrics*, Vol. 22 No. 1, pp. 155-205. DOI: 10.1007/BF02019280
- Casadesus-Masanell, R. and Ricart, J.E. (2010), "From strategy to business models and onto tactics", *Long Range Planning*, Vol. 43 No. 2-3, pp. 195-215. DOI: 10.1016/j.lrp.2010.01.004
- Chesbrough, H. (2010), "Business model innovation: opportunities and barriers", *Long Range Planning*, Vol. 43 No. 2-3, pp. 354-363. DOI: 10.1016/j.lrp.2009.07.010
- Chesbrough, H. and Crowther, A.K. (2006), "Beyond high tech: early adopters of open innovation in other industries", *R&D Management*, Vol. 36 No. 3, pp. 229-236. DOI: 10.1111/j.1467-9310.2006.00428.x

- Cobo, M.J., López-Herrera, A.G., Herrera-Viedma, E. and Herrera, F. (2011), “Science mapping software tools: review, analysis, and cooperative study among tools”. *Journal of the American Society for Information Science and Technology*, Vol. 62 No. 7, pp. 1382-1402. DOI: 10.1002/asi.21525
- Cobo, M.J., López-Herrera, A.G., Herrera-Viedma, E. and Herrera, F. (2012), “SciMAT: a new science mapping analysis software tool”, *Journal of the American Society for Information Science and Technology*, Vol. 63 No. 8, pp. 1609-1630. DOI: 10.1002/asi.22688
- Corrales-Garay, D., Mora-Valentín, E.-M. and Ortiz-de-Urbina-Criado, M. (2019b), “Open data for open innovation: an analysis of literature characteristics”, *Future Internet*, Vol. 11 No. 3. DOI: 10.3390/fi11030077
- Corrales-Garay, D., Ortiz-de-Urbina-Criado, M. and Mora-Valentín, E.-M. (2019a), “Knowledge areas, themes and future research on open data: a co-word analysis”, *Government Information Quarterly*, Vol. 36 No. 1, pp. 77-87. 10.1016/j.giq.2018.10.008
- Corrales-Garay, D., Mora-Valentín, E.-M. and Ortiz-de-Urbina-Criado, M. (2020b), “Entrepreneurship through open data: an opportunity for sustainable development”, *Sustainability*, Vol. 12 No. 12, p. 5148. DOI: 10.3390/su12125148
- Corrales-Garay, D., Ortiz-de-Urbina-Criado, M. and Mora-Valentín, E.-M. (2020a), “A research agenda on open data impact process for open innovation”, *IEEE Access*, Vol. 8, pp. 34696-34705. DOI: 10.1109/ACCESS.2020.2974378
- Dalkir, K. (2011), *Knowledge Management in Theory and Practice*, The MIT Press, Cambridge. DOI: 10.4324/9780080547367
- Daspit, J.J., (2017), “D. Andreini and C. Bettinelli: business model innovation: from systematic literature review to future research directions”, *Journal of Management and Governance*, Vol. 21 No. 3, pp. 785-792. DOI: 10.1007/s10997-017-9388-2
- Duval, A. and Brasse, V. (2014), “How to ensure the economic viability of an open data platform”, in Jeffery, K., Clements, A., De Castro, P., & Luzi, D. (Ed.s.), *Procedia Computer Science*, 33, Elsevier, Amsterdam, pp. 179-182. DOI: 10.1016/j.procs.2014.06.030
- Eskelinen, T., Räsänen, T., Santti, U., Happonen, A. and Kajanus, M. (2017), “Designing a business model for environmental monitoring services using fast MCDS innovation support tools”, *Technology Innovation Management Review*, Vol. 7 No. 11, pp. 36-46. DOI: 10.22215/timreview/1119
- Feller, J., Finnegan, P. and Nilsson, O. (2011), “Open innovation and public administration: transformational typologies and business model impacts”, *European Journal of Information Systems*, Vol. 20 No. 3, pp. 358-374. DOI: 10.1057/ejis.2010.65
- Ferro, E. and Osella, M. (2012), “Business models for PSI re-use: a multidimensional framework. Using open data: policy modeling, citizen empowerment”, paper presented at the Using Open Data: Policy Modeling, Citizen Empowerment, Data Journalism, 19-20 June, Brussels, available at [https://www.w3.org/2012/06/pmod/pmod2012\\_submission\\_16.pdf](https://www.w3.org/2012/06/pmod/pmod2012_submission_16.pdf) (accessed July 11, 2020).



- Ferro, E. and Osella, M. (2013), "Eight business model archetypes for PSI re-use", paper presented at the Open Data on the Web Workshop, 23-24 April, London, available at [https://www.w3.org/2013/04/odw/odw13\\_submission\\_27.pdf](https://www.w3.org/2013/04/odw/odw13_submission_27.pdf) (accessed August 10, 2019).
- Filser, M., Kraus, S., Breier, M., Nenova, I. and Puumalainen, K. (2021), "Business model innovation: Identifying foundations and trajectories", *Business Strategy and the Environment*, Vol. 30 No. 2, pp. 891-907. DOI: 10.1002/bse.2660
- Foss, N.J. and Saebi, T. (2017), "Fifteen years of research on business model innovation: how far have we come, and where should we go?", *Journal of Management*, Vol. 43 No. 1, pp. 200–227. DOI: 10.1177/0149206316675927
- Guesmi, S. (2014), "Open data, big data and crowdsourcing: emergent mobile apps business models", *Digiworld Economic Journal*, No. 96, pp. 53-72.
- Gurin, J. (2014), *Open Data Now: The Secret to Hot Startups, Smart Investing, Savvy Marketing, and Fast Innovation*, McGraw-Hill, New York, NY.
- Hammell, R., Perricos, C., Branch, D. and Lewis, H. (2011), *Unlocking Growth: How Open Data Creates New Opportunities for the UK*, Deloitte, London.
- Hammell, R., Perricos, C., Lewis, H. and Branch, D. (2012), *Open Growth: Stimulating Demand for Open Data in the UK*, Deloitte, London.
- Harrison, T.M., Pardo, T.A. and Cook, M. (2012), "Creating open government ecosystems: a research and development agenda", *Future Internet*, Vol. 4 No. 4, pp. 900-928. DOI: 10.3390/fi4040900
- He, Q. (1999), "Knowledge discovery through co-word analysis", *Library Trends*, Vol. 48 No. 1, pp. 133-159.
- Henderson, R.M. and Clark, K.B. (1990), "Architectural innovation: the reconfiguration of existing product technologies and the failure of established firms", *Administrative Science Quarterly*, Vol. 35 No. pp. 9-30. DOI: 10.2307/2393549
- Hossain, M. (2017), "Business model innovation: past research, current debates, and future directions", *Journal of Strategy and Management*, Vol. 10 No. 3, pp. 342-359. DOI: 10.1108/JSMA-01-2016-0002
- Husin, S.S., Rahman, A.A.A., Mukhtar, D. and Nawi, N.C. (2020), "A systematic literature review on business model innovation: industrial, methodology and positioning gaps", *International Journal of Innovation, Creativity and Change*, Vol. 10 No. 10, pp. 201-220.
- Hussinki, H., Ritala, p., Vanhala, M. and Kianto, A. (2017), "Intellectual capital, knowledge management practices and firm performance", *Journal of Intellectual Capital*, Vol. 18 No. 4, pp. 904-922. DOI: 10.1108/JIC-11-2016-0116
- Immonen, A., Palviainen, M. and Ovaska, E. (2014), "Requirements of an open data based business ecosystem", *IEEE Access*, Vol. 2, pp. 88-103. DOI: 10.1109/ACCESS.2014.2302872
- Immonen, A., Ovaska, E. and Paaso, T. (2018), "Towards certified open data in digital service ecosystems", *Software Quality Journal*, Vol. 26 No. 4, pp. 1257-1297. DOI: 10.1007/s11219-017-9378-2

- Janssen, M. and Zuiderwijk, A. (2014), "Infomediary business models for connecting open data providers and users", *Social Science Computer Review*, Vol. 32 No. 5, pp. 694-711. DOI: 10.1177/0894439314525902
- Johnson, M.W., Christensen, C.M. and Kagermann, H. (2008), "Reinventing your business model", *Harvard Business Review*, Vol. 86 No. 12, pp. 53-63.
- Kampars, J., Zdravkovic, J., Stirna, J. and Grabis, J. (2020), "Extending organizational capabilities with open data to support sustainable and dynamic business ecosystems", *Software and Systems Modeling*, Vol. 19 No. 2, pp. 371-398. DOI: 10.1007/s10270-019-00756-7
- Kassen, M. (2018), "Adopting and managing open data: stakeholder perspectives, challenges and policy recommendations", *Aslib Journal of Information Management*, Vol. 70, No. 5, pp. 518-537. DOI: 10.1108/AJIM-11-2017-0250
- Kitsios, F. and Kamariotou, M. (2019), "Open data value network and business models: opportunities and challenges", in Becker, J., & Novikov, D. (Ed.s.), *Proceedings - 21st IEEE Conference on Business Informatics (CBI 2019)*, 1, IEEE, New York, NY, pp. 296-302. DOI: 10.1109/CBI.2019.00040
- Kitsios, F., Papachristos, N. and Kamariotou, M. (2017), "Business models for open data ecosystem: challenges and motivations for entrepreneurship and innovation", in Loucopoulos, P., Manolopoulos, Y., Pastor, O., Theodoulidis, B., & Zdravkovic, J. (Ed.s) *IEEE 19th Conference on Business Informatics (CBI)*, IEEE, New York, NY, pp. 398-407. DOI: 10.1109/CBI.2017.51
- Klaila, D. (2000), "Knowledge as a transformation agent", *Journal of Knowledge Management*, Vol. 4 No. 2, pp. 138-144. DOI: 10.1108/13673270010372260
- Kraus, S., Filser, M., Puumalainen, K., Kailer, N. and Thurner, S. 2020, "Business model innovation: a systematic literature review", *International Journal of Innovation and Technology Management*, Vol. 17 No. 6. DOI: 10.1142/S0219877020500431
- Lakomaa, E. and Kallberg, J. (2013), "Open data as a foundation for innovation: the enabling effect of free public sector information for entrepreneurs", *IEEE Access*, Vol. 1, pp. 558-563. DOI: 10.1109/ACCESS.2013.2279164
- Laursen, K. and Salter, A. (2006), "Open for innovation: The role of openness in explaining innovation performance among UK manufacturing firms", *Strategic Management Journal*, Vol. 27 No. 2, pp. 131-150. DOI: 10.1002/smj.507
- Li, H., Hu, Q., Zhao, G. and Li, B. (2021), "Viewpoint: The co-evolution of knowledge management and business model transformation in the post-COVID-19 era: insights based on Chinese e-commerce companies", *Journal of Knowledge Management*. DOI: 10.1108/JKM-03-2021-0177
- Lindman, J. (2014), "Similarities of open data and open source: impacts on business", *Journal of Theoretical and Applied Electronic Commerce Research*, Vol. 9 No. 3, pp. 59-70. DOI: 10.4067/S0718-18762014000300006
- Lindman, J., Kinnari, T. and Rossi, M. (2014), "Industrial open data: case studies of early open data entrepreneurs", in Sprague, R.H. (Ed.), *47th Hawaii International Conference on System Sciences, (HICSS)*, IEEE, New York, NY, pp. 739-748. DOI: 10.1109/HICSS.2014.99
- Lindman, J., Kinnari, T. and Rossi, M. (2016), "Business roles in the emerging open-data ecosystem", *IEEE Software*, Vol. 33 No. 5, pp. 54-59. DOI: 10.1109/MS.2015.25

- Lo, C., Wang, C. & Chen, Y.-C. 2020, "The mediating role of intellectual capital in open innovation in the service industries", *Sustainability*, Vol. 12 No. 12, p. 5220. DOI: 10.3390/su12125220
- Loon, M. and Quan, X.I. (2021), "Theorising business model innovation: an integrated literature review", *Australian Journal of Management*, Vol. 46 No. 3, pp. 548-577. DOI: 10.1177/0312896220976751
- Magalhaes, G. and Roseira, C. (2020), "Open government data and the private sector: an empirical view on business models and value creation", *Government Information Quarterly*, Vol. 37 No. 3, p. 101248. DOI: 10.1016/j.giq.2017.08.004
- Magalhaes, G., Roseira, C. and Manley, L (2014), "Business models for open government data", in Barbosa L.S., Estevez E., & Janssen M. (Ed.s), *ACM International Conference Proceeding Series*, Association for Computing Machinery, New York, NY, pp. 365-370. DOI: 10.1145/2691195.2691273
- Malhotra, Y. (2000), "Knowledge management and new organization forms: a framework for business model innovation", *Information Resources Management Journal*, Vol. 13 No. 1, pp. 5-14. DOI: 10.4018/irmj.2000010101
- Malhotra, Y. (2005), "Integrating knowledge management technologies in organizational business processes: getting real time enterprises to deliver real business performance", *Journal of Knowledge Management*, Vol. 9 No. 1, pp. 7-28. DOI: 10.1108/13673270510582938
- Manyika, J., Chui, M., Groves, P., Farrell, D., Kuiken, S.V. and Doshi, E.A. (2013), *Open data: Unlocking Innovation and Performance with Liquid Information*, McKinsey Global Institute, San Francisco, CA.
- Marikyan, D., Papagiannidis, S. and Alamanos, E. (2019), "A systematic review of the smart home literature: a user perspective", *Technological Forecasting and Social Change*, Vol. 138, pp. 139-154. DOI: 10.1016/j.techfore.2018.08.015
- Marr, B., Gupta, O., Pike, S. and Roos, G. (2003), "Intellectual capital and knowledge management effectiveness", *Management Decision*, Vol. 41 No. 8, pp. 771-781. DOI: 10.1108/00251740310496288
- Marr, B. and Schiuma, G. (2001), "Measuring and managing intellectual capital and knowledge assets in new economy organisations", in Bourne, M. (Ed.), *Handbook of Performance Measurement*, Gee, London.
- Massa, L. and Tucci, C.L. (2013), "Business model innovation", Dogson, M., Gann, D., & Phillips, N. (Ed.s), *The Oxford Handbook of Innovation Management*, Oxford University Press, Oxford, pp. 420-441.
- Mazón, J.N., Zubcoff, J.J., Garrigós, I., Espinosa, R. and Rodríguez, R. (2012), "Open business intelligence: on the importance of data quality awareness in user-friendly data mining", in *Proceedings of the 2012 Joint EDBT/ICDT Workshops (EDBT-ICDT '12)*. Association for Computing Machinery, New York, NY, USA, pp. 144-147. DOI: 10.1145/2320765.2320812
- Mohamed, N., Pillutla, S. and Tomasi, S. (2020), "Extraction of knowledge from open government data. The knowledge iterative value network framework", *VINE Journal of Information and Knowledge Management Systems*, Vol. 50 No. 3, pp. 495-511. DOI: 10.1108/VJIKMS-05-2019-0065

- Mrazovic, P., De La Rubia, I., Urmeneta, J., Balufo, C., Tapias, R., Matskin, M. and Larriba-Pey, J.L. (2016), “CIGO! Mobility management platform for growing efficient and balanced smart city ecosystem”, in *IEEE 2nd International Smart Cities Conference: Improving the Citizens Quality of Life, (ISC2)*, IEEE, New York, NY, pp. 106-109. DOI: 10.1109/ISC2.2016.07580750
- Negash, S. (2004), “Business intelligence”, *Communications of the Association for Information Systems*, Vol. 13. DOI: 10.17705/1CAIS.01315
- Nielsen, C. (2018), “Relating successful business models to intellectual capital and knowledge management practices”, *Electronic Journal of Knowledge Management*, Vol. 16 No. 1, pp. 48-55.
- Overbeek, S. and Janssen, M. (2015), “Using a domain-specific modeling language for analyzing harmonizing and interfering public and private sector goals: a scenario in the context of open data for weather forecasting”, in Hammoudi, S., Pires, LF., Desfray, P., & Filipe, J. (Ed.s), *3rd International Conference on Model-Driven Engineering and Software Development (MODELSWARD)*, IEEE, New York, NY, pp. 531-538. DOI: 10.5220/0005237505310538
- Palacios, D., Gil, I. and Garrigos, F. (2009), “The impact of knowledge management on innovation and entrepreneurship in the biotechnology and telecommunications industries”, *Small Business Economics*, Vol. 32 No. 3, pp. 291-301. DOI: 10.1007/s11187-008-9146-6
- Rautenberg, S., Motyl Kaue, S., Cassiana Burda, A., Anderson, S. and Marom de Moura, F. (2017), “Dados abertos conectados e gestão do conhecimento: estudos de caso cientométricos em uma universidade brasileira”, *Perspectivas em Ciência da Informação*, Vol. 22 No. 3, pp. 116-142. DOI: 10.1590/1981-5344/2885
- Randhawa, K., Wilden, R. and Hohberger, J. (2016), “A bibliometric review of open innovation: setting a research agenda”, *Journal of Product Innovation Management Advance*, Vol. 33 No. 6, pp. 750-772. DOI: 10.1111/jpim.12312
- Saebi, T. and Foss, N.J. (2015), “Business models for open innovation: matching heterogeneous open innovation strategies with business model dimensions”, *European Management Journal*, Vol. 33 No. 3, pp. 201-213. DOI: 10.1016/j.emj.2014.11.002
- Saur-Amaral, I., Soares, R.R. and Proença, J.F. (2018), “Business model innovation: towards a conceptual framework”, *Tourism and Management Studies*, Vol. 14 No. 1, pp. 80-93. DOI: 10.18089/tms.2018.14107
- Saxena, A. (2014), “5 ways government data can inspire startup innovation”, *Entrepreneur*, available at: <http://www.entrepreneur.com/article/240187> (accessed August 1, 2019).
- Seleim, A.A.S. and Khalil, O.E.M. (2011), “Understanding the knowledge management-intellectual capital relationship: a two-way analysis”, *Journal of Intellectual Capital*, Vol. 12 No. 4, pp. 586-614. DOI: 10.1108/14691931111181742
- Sinkovics, N., Gunaratne, D., Sinkovics, R.R. and Molina-Castillo, F. (2021), “Sustainable business model innovation: an umbrella review”, *Sustainability*, Vol. 13 No. 13, p. 7266. DOI: 10.3390/su13137266
- Stewart, T. (1997), *Intellectual Capital: The New Wealth of Organizations*, Doubleday Business, New York, NY.

- Teece, D.J. (2010), "Business models, business strategy and innovation", *Long Range Planning*, Vol. 43 No. 2-3, pp. 172-194. DOI: 10.1016/j.lrp.2009.07.003
- Teece, D.J., Pisano, G. and Shuen, A. (1997), "Dynamic capabilities and strategic management", *Strategic Management Journal*, Vol. 18 No. 7, pp. 509-533. DOI: 10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z
- Timmers, P. (1998), "Business models for electronic markets", *Electronic Markets*, Vol. 8 No. 2, pp. 3-8. DOI: 10.1080/10196789800000016
- Tranfield, D., Denyer, D. and Smart, P. (2003), "Towards a methodology for developing evidence-informed management knowledge by means of systematic review", *British Journal of Management*, Vol. 14 No. 3, pp. 207-222. DOI: 10.1111/1467-8551.00375
- Trieu, V.-H. (2017), "Getting value from business intelligence systems: a review and research agenda", *Decision Support Systems*, Vol. 93, pp. 111-124. DOI: 10.1016/j.dss.2016.09.019
- Vils, L., Mazzieri, M.R., Rodrigues, G.V. and Da Silva, A.R. (2017), "Business model innovation: a bibliometric review", *International Journal of Innovation*, Vol. 5 No. 3, pp. 311-324. DOI: 10.5585/iji.v5i3.243
- Walravens, N. (2015), "Mobile city applications for Brussels citizens: smart city trends, challenges and a reality check", *Telematics and Informatics*, Vol. 32 No. 2, pp. 282-299. DOI: 10.1016/j.tele.2014.09.004
- Walravens, N., Van Compernelle, M., Colpaert, P., Ballon, P., Mechant, P. and Mannens, E. (2016), "'Open government data" - based business models: a market consultation on the relationship with government in the case of mobility and route-planning applications", in Callegari, C., VanSinderen, M., Sarigiannidis, P., Samarati, P., Cabello, E., Lorenz, P., & Obaidat, M.S. (Ed.s), *Proceedings of the 13th International Joint Conference on e-Business and Telecommunications (ICETE)*, 2, SciTePress, Setúbal, pp. 64-71. DOI: 10.5220/0005948300640071
- Waltz, E. (2003), *Knowledge Management in the Intelligence Enterprise*, Artech House, Boston, MA.
- Wieczorkowski, J. (2019), "Open data as a source of product and organizational innovations", in Callegari C., van Sinderen M., Cabello E., Samarati P., Lorenz P., Obaidat M.S., & Sarigiannidis P. (Ed.s). *Proceedings of the 13th International Joint Conference on e-Business and Telecommunications (ICETE)*, 2, Academic Conferences and Publishing International Limited, Sonning Common, pp. 1119-1128. DOI: 10.34190/ECIE.19.190
- Wiig, K.M. (1997), "Integration intellectual capital and knowledge management", *Long Range Planning*, Vol. 30 No. 3, pp. 399-405. DOI: 10.1016/S0024-6301(97)90256-9
- Wiig, K.M. (2002), "Knowledge management in public administration", *Journal of Knowledge Management*, Vol. 6 No. 3, pp. 224-239. DOI: 10.1108/13673270210434331
- Yu, C.C. (2016), "A value-centric business model framework for managing open data applications", *Journal of Organizational Computing and Electronic Commerce*, Vol. 26 No. 1-2, pp. 80-115. DOI: 10.1080/10919392.2015.1125175

- Zeleti, F.A. (2014), “Business models for open data businesses”, in *8th International Conference on Theory and Practice of Electronic Governance (ICEGOV 2014)*, *ACM International Conference Proceeding Series*, Association for Computing Machinery, New York, NY, pp. 543-546. DOI: 10.1145/2691195.2691299
- Zeleti, F.A. and Ojo, A. (2017), “The 6-values open data business model framework”, Ojo, A., & Millard, J. (Ed.s), *Government 3.0 – Next Generation Government Technology Infrastructure and Services*, Springer, Cham, pp. 219-239. DOI: 10.1007/978-3-319-63743-3\_9
- Zeleti, F.A., Ojo, A. and Curry, E. (2014), “Emerging business models for the open data industry: characterization and analysis”, in *ACM International Conference Proceeding Series*, Association for Computing Machinery, New York, NY, pp. 215-226. DOI: 10.1145/2612733.2612745
- Zeleti, F.A., Ojo, A. and Curry, E. (2016), “Exploring the economic value of open government data”, *Government Information Quarterly*, Vol. 33 No. 3, pp. 535-551. DOI: 10.1016/j.giq.2016.01.008
- Zhang, H., Xiao, H., Wang, Y., Shareef, M.A., Akram, M.S. and Goraya, M.A.S. (2021), “An integration of antecedents and outcomes of business model innovation: a meta-analytic review”, *Journal of Business Research*, Vol. 131, pp. 803-814. DOI: 10.1016/j.jbusres.2020.10.045
- Zimmermann, H. and Pucihar, A. (2015), “Open innovation, open data and new business models”, in Petr, D., Gerhard, C., & Vaclav, O. (Ed.s), *Schriftenreihe Informatik*, 44, Universitätsverlag Rudolf Trauner, Linz, pp. 449-458. DOI: 10.2139/ssrn.2660692
- Zotano, M.A.G. and Bersini, H. (2017), “A data-driven approach to assess the potential of smart cities: the case of open data for Brussels capital region”, *Energy Procedia*, Vol. 111, pp. 750-758. DOI: 10.1016/j.egypro.2017.03.237
- Zott, C., Amit, R. and Massa, L. (2011), “The business model: recent developments and future research”, *Journal of Management*, Vol. 37 No. 4, pp. 1019-1042. DOI: 10.1177/0149206311406265
- Zuiderwijk, A., Janssen, M. and Davis, C. (2014), “Innovation with open data: essential elements of open data ecosystems”, *Information Polity*, Vol. 19 No. 1-2, pp. 17-33. DOI: 10.3233/IP-140329