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Business Model Analytics: Technically Review Business Model Research Domain

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MANUSCRIPT DETAILS: Business Model Analytics: Technically Review Business Model Research Domain

: the business model field of study has been in the focal attention of both researchers and practitioners within the last two decades, it yet suffers from a great concern about its identity crisis. Accordingly, this study aims to clarify the intellectual structure of business model through identifying the research clusters and their sub-clusters, the prominent relations, and the dominate research trends.paper uses some common text mining methods including co-word analysis, burst analysis, timeline analysis, and topic modeling to analyze and mine the title, abstract, and keywords of 14081 research documents related to the domain of business model.results revealed that the business model field of study consists of three main research areas including electronic business model, business model innovation, and sustainable business model, each of which has some sub-areas and has been more evident in some particular industries. Additionally, from the time perspective, research issues in the domain of sustainable development are considered as the hot and emerging topics in this field. In addition, the results confirmed that information technology has been one of the most important drivers, influencing the appearance of different study topics in the various period of time._RESEARCH_LIMITATIONS/IMPLICATIONS_(LIMIT_100_WORDS) :No data available._PRACTICAL_IMPLICATIONS_(LIMIT_100_WORDS) :No data available.contribution of this study is to quantitatively uncover the dominant knowledge structure and prominent research trends in the business model field of study, considering a broad range of scholarly publications and using some promising and reliable text mining techniques.

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Abstract

Purpose: Although the business model field of study has been in the focal attention of both researchers and practitioners within the last two decades, it yet suffers from a great concern about its identity crisis. Accordingly, this study aims to clarify the intellectual structure of business model through identifying the research clusters and their sub-clusters, the prominent relations, and the dominate research trends.

Design/Methodology: This paper uses some common text mining methods including co-word analysis, burst analysis, timeline analysis, and topic modeling to analyze and mine the title, abstract, and keywords of 14081 research documents related to the domain of business model.

Findings: The results revealed that the business model field of study consists of three main research areas including electronic business model, business model innovation, and sustainable business model, each of which has some sub-areas and has been more evident in some particular industries. Additionally, from the time perspective, research issues in the domain of sustainable development are considered as the hot and emerging topics in this field. In addition, the results confirmed that information technology has been one of the most important drivers, influencing the appearance of different study topics in the various period of time.

Originality/Value: The contribution of this study is to quantitatively uncover the dominant knowledge structure and prominent research trends in the business model field of study, considering a broad range of scholarly publications and using some promising and reliable text mining techniques.

Keywords: Business model; Knowledge structure; Research trends; Text mining

1. Introduction

Since the mid-1990s, with the advent of Internet technology and the growth of electronic businesses such as Amazon and E-bay, business logic has changed dramatically. The development of new information and communication technologies alongside with the establishment of open global trading structures meant that customers were in a position to choose from many available product manufacturers and service providers; therefore, businesses were forced to make fundamental and radical changes in their proposed value to their clients (Teece, 2010). Many scholars consider this period as the beginning time of due attention of both scientists and practitioners' communities to the subject of business model (Demil & Lecocq, 2010; Hong & Jinho, 2017; Massa, Tucci, & Afuah, 2017). During this period, businesses and their operation structures became complex and diverse, products' life-cycle started to shorten, and also competition among the businesses became more intense (Osterwalder, 2004). Therefore, achieving success in business was no more solely dependent on innovation in the design of product, service, or brand; rather innovation in the business model was also considered as a key factor in business success (X. Li, Qiao, & Wang, 2017). The business model concept based on a widely accepted definition is described as the dominant logic of business in creating value, the way of delivering that value to customers, and the structure of costs associated with the value (Teece, 2010).

As a result of business context change from the late 1990s, we have witnessed a sudden increase in the number of academic papers and practical documents on the subject of business model (Massa et al., 2017), and a highly welcome by professional researchers to the specialized panels and scientific conferences related to this subject (X. Li et al., 2017). To date, the subject of business model has remained a hot topic among the researchers, and each year, the number of papers on this topic is increasing (Hong & Jinho, 2017). Usually, when researchers face a popular and prolific field of study, which is the main theme (or at least a sub-theme) in many research documents, they ask themselves some questions about the intellectual structure of the field. Accordingly, the business model field with such attributes has not been an exception in the recent years. In fact, many scholars have mentioned their concerns about the identity crisis of business model field and subsequently, called for clarifying the field's scope, e.g., knowledge structure and research trends as comprehensive, transparent, and reliable as possible (X. Li et al., 2017; Massa et al., 2017; Wirtz, Pistoia, Ullrich, & Göttel, 2016). In sum, although the business model term has become a buzzword and fashion in the business world, there is a lack of holistic understanding about the exact boundaries of business model research sphere within the scientific communities.

Meanwhile, the identification of hot topics and uncovering their intellectual structures have always been fascinating for scholars. Researchers with different reasons and motives are putting effort on emerging and hot topics to create high impact on and to contribute toward the development of knowledge. However, at the onset of their research, they may confront with questions such as "What should I work on?", "Are my ideas any good, are they novel, or have they already been taken?", or "What can I learn from others and how can I improve on their work?" Questions of this type are also formed in the mind of entrepreneurs. Those who can provide better answers for such questions are rewarded. It means that researchers achieve scientific success and academic fame and the entrepreneurs benefit from the competitive advantages stemmed in novel business logics and new value sources (Boyack, 2004). Answers to these questions can also be interesting for other individuals and organizations, e.g., scientific

conferences for announcing call for papers, research funding agencies for allocating funds to more valuable subjects, universities for prioritizing their research and subsequently, maintaining their reputation and credibility, and even other people interested in getting acquainted with the edge of knowledge topics.

However, it would be impossible (or at least very difficult) to answer such questions and predict the future science trends without knowing the past and present knowledge structure that is made of the underlying concepts of the articles related to the study domain. A comprehensive review of the articles can provide valuable information about the intellectual structure of the domain, the hidden trends, the information flows, and the future orientations of research studies (Hong & Jinho, 2017; Morris & Yen, 2004). These are exactly the less considered scholarly concerns, which are needed to be addressed in the business model field according to the above-mentioned discussion. Researchers usually investigate these sorts of scientometrical issues using various qualitative or quantitative methods (X. Wang, Wang, & Xu, 2013).

Although qualitative methods, such as meta-analysis, content analysis, and systematic literature review have always been introduced as promising and high-quality research methods (Dresch, Lacerda, & Antunes, 2015), they suffer from some disadvantages. A number of researchers have argued that qualitative methods have an inherent bias in the selection of articles' inclusion/exclusion criteria. The bias that is shaped by the researcher's perception of articles' quality can lead to a contradiction in the selection of two or more studies with the same topic and similar results (Rosenthal & DiMatteo, 2001; Walker, Hernandez, & Kattan, 2008). Moreover, the role of researcher in judgmentally deciding about different analysis criteria can lead to a contradiction among the findings of some qualitative analyses of similar articles with the same hypotheses (Stegenga, 2011). In addition, the growing number of documents published each year in developing research fields has made the qualitative analysis process more complicated and time-consuming. Consequently, the results of these analyses are not updated at the time of publication (Bastian, Glasziou, & Chalmers, 2010). Therefore, qualitative analyses can hardly notice the latest changes and advances in growing study fields.

However, quantitative methods can be used as a substitute for or a complement to qualitative methods. Quantitative analyses can provide an organized picture and integrated summary of a large amount of textual data without the interference of human perception or judgment and by presenting a top-down analysis of the all published documents (Pendlebury, 2008). One instance of such quantitative analyses is text mining, which has been a pretty well-known and well-used approach in recent business/management studies. Text mining algorithms can extract valuable information from non-structured (or semi-structured) textual contents and reveal new patterns, relationships, and current trends among the huge amounts of documents (Gonzalez, Tahsin, Goodale, Greene, & Greene, 2015). In addition to text mining algorithms, other quantitative analysis methods, such as scientometrics or bibliometric analyses are also widely used by researchers (Tang, Liao, & Su, 2018). For example, co-occurrence analysis and co-citation analysis are the two most widely used scientometrics and bibliometric analyses that can be greatly helpful in recognizing the hidden themes and latent patterns within a set of scientific documents, depicting the relations between them using statistical analyses and visualization techniques (Leung, Sun, & Bai, 2017).

In the literature analysis of business model, so far, a number of researchers have used qualitative analyses, such as systematic literature review method, but a few numbers of papers

have done this investigation with quantitative analyses, such as scientometrics methods (X. Li et al., 2017). However, even the articles that have used quantitative methods had their own limitations, such as lacks in the mining of various textual attributes (e.g., title, abstract, and keywords) of published works with different types (e.g., journal article, proceedings paper, and book chapter), instead commonly and repeatedly analyzing the bibliographic features (e.g., citations). Accordingly, the main mission of this paper is to quantitatively clarify the intellectual structure of business model literature applying some promising text mining and visualization techniques to achieve in the following aims: 1) Identifying dominant research clusters and their respective sub-clusters, their prominent relations, and their evolution over time, 2) Finding hot and emerging research trends, 3) Recognizing the evolution of core concepts over time, and 4) Detecting salient research topics and their categories. It is possible to sum up these purposes in the form of two main Research Questions (RQs):

RQ_1: What is the dominant knowledge structure in the business model field of study?

RQ_2: What are the prominent research trends in the business model field of study?

The main contribution of the current study is to apply some trendy text mining methods on all types of scholarly documents associated with the topic of business model to provide a complete, transparent, and reliable picture of this research domain. The importance of this contribution is addressing the identity crisis of business model field stemmed in its multidisciplinary nature and relatively achieving a theoretical consensus on the intellectual boundaries of this research sphere. This is attained by applying promising quantitative methods on a wide range and a huge number of scholarly publications.

This paper is structured as follows: Following the introduction (section 1), the second section is devoted to the literature review in which relevant quantitative and qualitative review articles and their constraints have been investigated. In the third section, the research methods, respective tools, and the reason of applying these methods are described. In section 4, the results of the study and the discussions related to each result are provided in rich detail. In the final section, an integrated summary of the results, research limitations, and suggestions for further research are presented.

2. Literature Review

Some notable and noticeable factors have led the researchers to review the literature of business model field of study over time. First, there is deviation in the type of perception and understanding of business model concept between both people with business-oriented and technology-oriented perspectives due to the two-fold nature of business model notion, i.e., business and technology (Osterwalder, Pigneur, & Tucci, 2005). Also, an increasing number of papers in the field of business model (George & Bock, 2011) between academicians and practitioners (Zott, Amit, & Massa, 2011), popularity and at the same time criticisms against the concept of business model (Klang, Wallnöfer, & Hacklin, 2014), and the interdisciplinary nature of this field (Wirtz et al., 2016) make business model research field increasingly controversial.

Similar to the progress of review studies in the most of other scientific fields, the business model-related review studies have also a timeline. This means that although researchers have followed a systematic and organized approach to collect data, the review studies, at first, were

mainly conducted subjectively and judgmentally based on authors' credibility and intuition. For instance, the explicit statement of inclusion/exclusion criteria of under-review documents and considering the academic or practical orientation of studies can be referred to. Nevertheless, the presentation of findings was mainly subjective and based on the judgment of authors (George & Bock, 2011; Osterwalder et al., 2005; Zott et al., 2011). In this way, with the aim of clarifying the understanding of business model concept and its usages in Information Systems (IS) field, Osterwalder et al. (2005) subjectively reviewed the roots, understandings (or better to say misunderstandings), usages, position in the firm, terminologies, ontologies, roles, potentials, and evolution of the concept over time. They prospected the future of the concept in the IS field. George and Bock (2011) queried the "business model" term on December 1, 2008, in the EBSCO Business Source Premiere and Web of Science (WoS) databases and subjectively identified six themes within the literature. Due to their aim of reframing the concept with an entrepreneurial lens, they suggested four future research streams on entrepreneurship. Zott et al. (2011) reviewed the business model-related articles from 1975 to 2009 with a systematic approach (e.g., detailed inclusion/exclusion criteria and using a document set from the EBSCO Business Source Complete database and a set of leading journals, which are distinguished by their practical or academic orientation). They identified three themes within the literature and suggested four research streams and the need for the clarification of what exactly a scholar means by the phrase "business model", which addresses the concern of "literature divergence" mentioned by almost all the professional scholars in the field, to the best of authors' knowledge.

Then using stricter document coding methods and more explicit inclusion/exclusion criteria for the selection of documents, both the systematicity and objectivity aspects of review studies were strengthened. Therefore, gradually these studies changed to the ones that were not purely based on subjective judgments. Apart from the above-mentioned cases, other worthwhile comprehensive review studies have also been conducted on the business model research area either through combining quantitative and qualitative analyses (Wirtz et al., 2016) or through the expansion of previous studies' timespan and prior researches' databases (Massa et al., 2017). In this way, Wirtz et al. (2016) employed 1) quantitative analysis, 2) qualitative analysis, and 3) an expert survey respectively to 1) integrate the definitions, perspectives, and components of business model phenomenon into a framework, 2) identifying four research areas within the field, and 3) suggest future research directions. They used the EBSCO database and searched in abstracts and titles between 1965 and 2013. By extending Zott et al. (2011) literature review timespan, Massa et al. (2017) searched for the articles consisting "business model" term in the title, abstract, or keywords between 2010 and 2015 in the Scopus database and after applying a restriction on journals they added their query to Zott et al. (2011) dataset. They identified three interpretations within the literature and suggested to scholars to state explicitly which one they agree and use in their studies and what is their rationale behind it. They also concluded the business model as an extension of strategy.

Along with the evolution of the movement from subjective and judgmental review studies into objective and hands-off approaches, as well as stricter, systematic, and transparent reviews, relatively objective analyses with combined themes were initially carried out in the business model field (Bergiante, Santos, & Santo, 2015; Coombes & Nicholson, 2013; Maucuer & Renaud, 2019). As examples, Coombes and Nicholson (2013) employed citation analysis to identify the marketing field overlap with the business model concept in the literature. Bergiante

et al. (2015) conducted a bibliometric analysis on the relationship between the business model concept and the airline industry. Maucuer and Renaud (2019) performed co-citation analysis and bibliographic coupling analysis to decipher the development of business model literature across the strategy, innovation, and entrepreneurship disciplines. This group of studies reviewed only some sub-areas of the business model field; therefore, they have not provided an inclusive view of this big field.

Then, scientometrics and bibliometric analyses like co-citation analysis or Social Network Analysis (SNA) were conducted specifically on the domain of business model (Hong & Jinho, 2017; X. Li et al., 2017). Accordingly, to extract hot topics in the business model field, X. Li et al. (2017) used co-citation analysis on the business model-related articles published from 1995 to 2015 in the WoS database. Their main study limitation is investigating only article citations and inferring results on this basis. Hong and Jinho (2017) employed SNA on the keywords of business model-related articles indexed in the Scopus database between 1979 and 2015 to identify the knowledge structure of business model area. The notable constraint of their study is exploring only the keywords of article and concluding the research in this way. The introduced scientometrical review studies in the area of business model have been subject to the limitations mentioned by the authors. These limitations are mainly in respect to the inadequacy of using only the limited type of bibliographic fields, such as citations or keywords, and insufficiency of using only the limited kind of scientific documents, such as articles, in representing the intellectual structure of a research field.

From the described background of this study, these noticeable conclusions can be drawn: Over time, the review studies have gradually become more systematic and objective in contrast to the previous judgmental and subjective studies. Although subjective judgments are still an integral part of such studies (Øyna & Alon, 2018), but compared to the previous review studies, which were completely based on the author's judgment, quantitative analyses (such as text mining approach and bibliometric analysis) are less judgmental and biased (Nerur, Rasheed, & Natarajan, 2008; Raghuram, Tuertscher, & Garud, 2010). The more systematic the analysis of data is, the lower the author's bias will be (Tranfield, Denyer, & Smart, 2003). In addition, the high volume of texts in a research domain (e.g., the domain of business model) implicitly indicates the justification for using systematic and relatively hands-off approaches for review, organizing, and summarization (Yan, Lee, & Lee, 2015), especially when the field under-discussion is interdisciplinary or multidisciplinary (Nerur et al., 2008). Therefore, firstly, this study aimed at employing various and promising text mining techniques in an unprecedented manner within the business model field of study to overcome the limitations of conventional qualitative methods and simultaneously gain the advantages of novel quantitative analyses. Secondly, the authors decided to address the research questions on the basis of different textual attributes (e.g., title, abstract, and keywords) of different kind of scholarly documents (e.g., journal article, proceedings paper, and book chapter) to avoid the limitations of previous scientometrical researches. Moreover, this study extended the timespan of the latest reviews, which is considerable due to the increasing number of publications within this prolific field of study.

3. Research Method

Considering the research aims, various methods have been used in this study. Generally, these methods include some common text mining techniques that have been applied to process the main textual attributes of business model-related research documents. In this section, in addition to describing the implementation process of the study, specific descriptions are presented about each of the applied methods. The descriptions mainly include the introduction of the method and its main rationale for analyzing the data, a brief reference to the history of the method, the reasons for the employment of the method, and the tools used to implement it. **Table 1** illustrates an overview of these descriptions in a summary representing the techniques, approach, aims, results, and the related applied tools.

Table 1. An overview of the research approach and techniques

No.	Technique	Approach	Aims	Results	Tool
1	Co-word analysis	Text mining	Identifying dominant research clusters and their respective sub-clusters, their prominent relations, and their evolution over time	Figure 1, Figure 2, Table 4	VOSviewer
2	Burst analysis	Text mining	Finding hot and emerging research trends	Table 5, Table 6	CiteSpace
3	Timeline analysis	Text mining	Recognizing the evolution of core concepts over time	Figure 3, Figure 4	CiteSpace
4	Topic modeling	Text mining	Detecting salient research topics and their categories	Figure 5	BigML

3.1. Data Collection

In the first step, the required data were collected from the WoS database. To this aim, in the WoS Core Collection database, those documents that contained the term “business model” or “business models” in their title, abstract, or keywords were searched. In this process, no specific search filter was considered for timespan, the type of document, and subject category to include all relevant information from available published documents related to the BM topic. In fact, since this research seeks to seize the body of science in a field of study, no specific limitation was considered for querying in the database, and 14081 scientific documents were obtained as output dataset. These documents have several types, including the journal article, proceedings paper, book chapter, etc. In addition, these documents belong to the different subject categories of WoS, including the business, management, computer science, and IS. After completing the search process, a report of the records was retrieved in the intended format, with full record content and cited references. In summary, the obtained dataset for this study includes all scientific documents containing the term “business model” or “business models” in their title, abstract, or keywords and have been indexed in the WoS Core Collection database throughout the all years until the search date, June 26, 2018.

3.2. Data Preparation

The raw dataset collected in the previous stage has different textual attributes. In this research, only specific cases of them have been used in each method. These attributes, separated based on each method, represented in **Table 2**. In fact, in each of the text mining techniques used in this research, the title, abstract, author keywords, Keywords Plus, or a subset of these attributes have been used as the input corpus of algorithms. The meaning of each attribute is quite

evident; however, in the case of Keywords Plus, it should be explained that they are terms determined by an automatic algorithm through the detection of iterative phrases among the titles of cited references in the document (Garfield & Sher, 1993). In their research study, Zhang et al. (2016) compared the use of author keywords with Keywords Plus in the WoS. As a general conclusion, they proposed the Keywords Plus to be also considered in bibliographic analyses, because the great number of these terms and the wide range of their meanings can lead to some advantages. Therefore, we also decided to use the Keywords Plus attribute besides the author keywords. As **Table 2** shows, from among the various text mining methods, only one of them analyzes keywords, the other one analyzes the abstract, and the two others analyze the title, abstract, and keywords. The diversity of these attributes in the input corpus has provided the capability for the obtained results based on various attributes for presenting multi-dimensional analyses about the gathered documents. It is also expected that these analyses, generally, have more depth and accuracy compared with the case when just one attribute is used.

Table 2. Textual attributes used in each of the employed methods

	Title	Abstract	Author keywords	Keywords Plus
Co-word analysis			✓	✓
Burst analysis	✓	✓	✓	✓
Timeline analysis	✓	✓	✓	✓
Topic modeling		✓		

After selecting the textual attributes based on the intended research aims, we pre-processed the built corpus to make the text ready for applying the main analyses, and to increse the quality of the reluts. The pre-processing step involves the tokenization of the text, the deletion of uninformative words, compounding similar terms, and considering n-grams. Thus, in each of the text mining methods, after passing this stage, a ready and clean text forms the basis of analysis.

3.3. Data Processing

3.3.1. Co-word Analysis

Co-word analysis as one of the text mining methods was first proposed by Callon, Courtial, Turner, and Bauin (1983) (Yan et al., 2015). This technique is based on the main idea that co-occurrence of important words describes the relation between the contents of a specific set of documents (Callon, Courtial, & Laville, 1991). The co-word analysis is based on two main assumptions: 1) Words used in an article are good representatives reflecting the article's content, and 2) Co-occurrence of two words in various articles is an indication of their relationship with each other such that the more the co-occurrence is, the closer their relation will be (Feng, Zhang, & Zhang, 2017). In recent years, researchers have used this method to achieve various aims such as the evaluation of research and development impacts, the assessment of technological development trends, the analysis of research trends and hotspots, and the summarization of research subjects' evolution (Z. Wang, Zhao, & Wang, 2015).

In this research, the use of co-word analysis made it possible to achieve two main groups of macro- and micro-goals. The detection of important keywords and depiction of their relations

are among the micro-goals, while the detection of important topics in the domain of business model through clustering these keywords and the introduction of hidden themes in each cluster are considered as macro-goals. In addition, considering the dimension of time in the co-occurrence network of keywords, the possibility of achieving each of the mentioned goals, with temporal considerations, has been provided. In this study, the VOSviewer software has been used to visualize the results of co-word analysis and to draw the co-occurrence network of keywords. To draw this network, from among all keywords, including author keywords and Keywords Plus, the most iterative keywords were detected using the frequency g-index method (Yan et al., 2015). According to the discussion provided by Van Eck and Waltman (2014), visualization in the VOSviewer software is done based on the distance-based approach. This means that nodes in a bibliographic network are located beside each other such that the distance between two nodes almost reveals their relatedness. In the co-word network, the size of nodes is determined based on the occurrences of keywords, showing the degree of their importance in the network. It is to be mentioned that VOSviewer categorizes those nodes that have closer relation with each other in one cluster through solving an optimization problem. For the complete understanding of visualization and clustering way in the VOSviewer software, the descriptions proposed by Waltman and Van Eck (2013), Waltman, Van Eck, and Noyons (2010), Van Eck and Waltman (2014), and Van Eck, Waltman, Dekker, and van den Berg (2010) can be used.

3.3.2. Burst Analysis

Burst detection in the field of text mining was first proposed by Kleinberg (2003) (Sawant, Li, & Wang, 2011). The Kleinberg's goal of developing Burst Detection Algorithm (BDA) was to identify the topics that have suddenly become in the focus of attention of documents over a period of time. This algorithm identifies a sudden increase in the prevalence of a document stream on a specific subject, called the burst of activity (Kleinberg, 2003).

In this algorithm, the recognition of co-topic documents is done based on the co-occurrence of terms in the documents. In burst analysis, attention to the start and end times of burst of each term can be useful in finding hot and emerging topics (Najmi, Rashidi, Abbasi, & Waller, 2017). Moreover, one of the most important advantages of BDA, in comparison with citation-based methods, is that it can identify the emerging issues in scholarly papers regardless of the number of citations received by the papers. Therefore, this algorithm can recognize an emerging scientific field even before it obtains significant citation numbers (C. Chen, 2006).

In this paper, we deployed the burst analysis technique to achieve two major goals: 1) Identifying emerging research trends between 1991 and 2018, and 2) Detecting the events that stimulated these hot topics. We used the CiteSpace software to perform the burst analysis, which benefits from a built-in Kleinberg algorithm as its BDA.

3.3.3. Timeline Analysis

Visualization through the timeline view method was first proposed by Morris, Yen, Wu, and Asnake (2003). They conducted this kind of visualization on scholarly papers with the aim of identifying the emergence and disappearance of research fronts over time, finding the seminal

articles of each research front, recognizing the structural hierarchy of research fronts, and detecting the information flows in each research front.

The most important feature of this type of visualization is its logic of node placement. In fact, the nodes in this visualization are located horizontally based on the publication year and vertically based on the different research fronts. This kind of visualization, as a special type of visualizing words' co-occurrence network, is also used with the aim of identifying the origin and hierarchy of terms' formation in a scientific subject. In this study, timeline visualization has been implemented for terms using the CiteSpace software. To do this, first, the most frequent terms were identified from the title, abstract, author's keywords, and Keywords Plus applying the g-index method, previously mentioned in the co-word analysis section. The clustering in this software is done using the technique suggested by Popescul, Flake, Lawrence, Ungar, and Giles (2000). Clustering is the base of vertical positioning of nodes in this visualization and the horizontal positioning of nodes is based on year. Here, the "year" means the first year that the frequency of term has reached a level to be considered as a frequent term due to the g-index method. In this study, the size of nodes indicates the number of iterations and the importance of related terms. The thickness of colored squares around each node also shows the iteration rate of respective term over different time periods. The time intervals associated with each color are depicted in a color bar above the figure, and the branches demonstrate the co-occurrence of terms among the documents.

3.3.4. Topic Modeling

Topic modeling is a statistical probabilistic modeling that attempts to discover hidden topics in a set of documents (i.e., corpus). As the most prevalent topic modeling technique, Latent Dirichlet Allocation (LDA) is an unsupervised machine-learning algorithm that models the hidden topics of a corpus with the Bayesian probabilistic network. This algorithm is based on two main assumptions: 1) Each document is a probabilistic distribution of predetermined topics and 2) Each topic is a probabilistic distribution of a fixed set of words (D. Blei, Carin, & Dunson, 2010; D. M. Blei, Ng, & Jordan, 2003; Griffiths & Steyvers, 2004; Kinsman, Rotter, James, Snow, & Willis, 2010). The LDA was used very soon for the modeling of scientific documents as a promising technique (D. M. Blei & Lafferty, 2007; Griffiths & Steyvers, 2004).

Using text mining algorithms, it is possible to extract significant research topics and important research trends from scientific documents more efficiently (Fang, Yang, Gao, & Li, 2018). Accordingly, Mohebi, Sedighi, and Zargaran (2017) argued the widespread use of LDA method at the field of scientometrics and bibliometric research. In the present study, the topic modeling approach and specifically the LDA algorithm has been applied on the abstract of retrieved documents following the great number of previous research studies (J. Chen, Wei, Guo, Tang, & Sun, 2017; Choi, Lee, & Sohn, 2017; Fang et al., 2018; Griffiths & Steyvers, 2004; Jiang, Qiang, & Lin, 2016; Kim & Yoon, 2015; Kulkarni, Apte, & Evangelopoulos, 2014; Zheng, McLean, & Lu, 2006).

Since in the topic modeling, the machine cannot process the semantic load of words and phrases but the researcher has an adequate understanding of the subject, the judgment of researcher may lead to a better decision making about the selection of LDA parameters and reaching better results (Chang, Gerrish, Wang, Boyd-Graber, & Blei, 2009; Grimmer & Stewart, 2013; Jiang et al., 2016; Levy & Franklin, 2014). Performing frequent experiments and using domain

experts' judgment is also widely used and mentioned in scientific articles as a usual way to select the proper LDA parameters (J. Chen et al., 2017). Hence, determining parameters in this type of research is largely due to the justification of authors (Fang et al., 2018). However, the use of statistical measures for selecting parameters and fitting model are good points to start the experiments (D. M. Blei et al., 2003; Griffiths & Steyvers, 2004; W. Li & McCallum, 2006; Newton & Raftery, 1994; Teh, Jordan, Beal, & Blei, 2006; Wallach, 2006), to benefit from both machine objectivity and human subjectivity.

In order to conduct the topic modeling, we utilized the BigML software (https://bigml.com/) in this research, because it automatically provides the authors with such a starting point. Beginning with the software offers, 12 experiments were conducted, and each time, the results were judged by the researchers to ensure the better selection of topics. Further, to result in a more accurate topic model, the uninformative words were identified and removed in the first three experiments. Finally, the experiment No. 12 is approved as the best-desired model. The manipulated parameters during the research are summarized in **Table 3**. Some other important parameters in this research are: the number of words/phrases of each topic (equal to 10), lower case and upper case sensitivity (without sensitivity), the removal of stop words (in all experiments, the stop words have been aggressively removed), and sampling (census, sampling rate = 100 %).

Table 3. Manipulated parameters in the topic modeling experiments

Model number	Max. number of topics	Number of terms	Max. n-grams	Specified words excluded	Non-dictionary words excluded	Non-language characters excluded	Numeric digits excluded	Single tokens excluded
1	40	4096	Bigram	NO	NO	NO	NO	NO
2	40	4096	Unigram	YES	NO	NO	NO	NO
3	40	4096	Bigram	YES	NO	NO	NO	NO
4	40	4096	Bigram	YES	YES	YES	YES	NO
5	40	4096	Trigram	YES	YES	YES	YES	YES
6	10	4096	Trigram	YES	YES	YES	YES	YES
7	10	4096	Trigram	YES	YES	YES	YES	NO
8	20	4096	Trigram	YES	YES	YES	YES	NO
9	20	4096	Trigram	YES	YES	YES	YES	YES
10	30	2048	Bigram	YES	YES	YES	YES	NO
11	30	2048	Trigram	YES	YES	YES	YES	YES
12	30	1024	Trigram	YES	YES	YES	YES	YES

4. Research Results

4.1. Keywords Co-occurrence Network

Figure 1 represents the keywords co-occurrence network including 150 keywords (among 29833 ones) with at least 40 times repetition in our corpus. The relation between the keywords is determined based on the number of documents that have co-occurred. Accordingly, the keywords are categorized in the form of three clusters with red, green, and blue colors. We label the clusters based on three approaches: The management science concepts, the business model literature, and the most frequent keywords in each cluster. Hence, the authors call the red cluster as either Information Technology (IT) management, electronic business model, or

e-commerce; the green cluster as strategic management, business model innovation, or innovation; and the blue cluster as sustainable development management, sustainable business model, or sustainability. As a general analysis, because the red cluster has more keywords than other ones, it seems that IT management has a greater share of the business model research.

Additionally, the relation between keywords signifies a specific concept, i.e., the less is the distance between two phrases; the more is their relationship in the research studies of business model field. To briefly mention an example in each cluster: In the red cluster, the two-sided markets and the platform keywords are closely interrelated, as platform business models are considered as one of the appropriate mechanisms for actualizing two-sided markets. In the green cluster, keywords such as collaboration and co-creation are aligned with each other as they are repeatedly used beside each other for value creation in the strategic management literature. Finally, in the case of blue clusters, the low distance between the smart network and renewable energy is not accidental; rather it is because smart network technology is an instrument for creating sustainable business models in the domain of renewable energy.

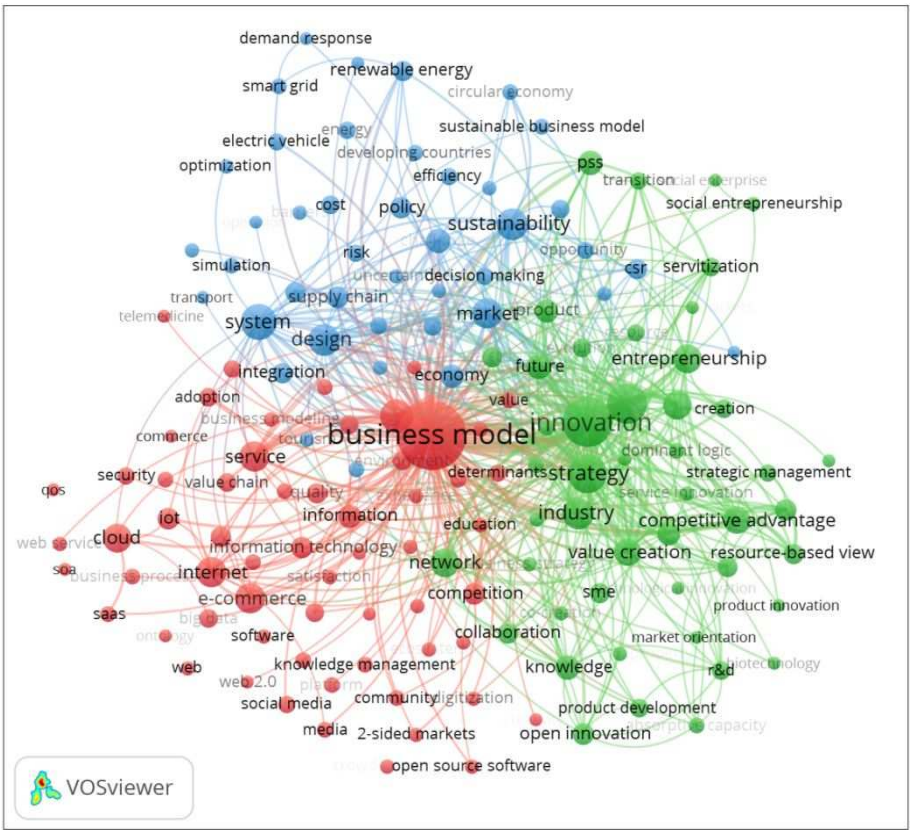


Figure 1. Keywords co-occurrence network

By noticing the frequent keywords in **Figure 1**, some other important points are perceivable. The frequency of keywords such as healthcare, telemedicine, energy, energy efficiency, renewable energy, tourism, and transportation reflects the fact that research studies related to the business model have been more common in the healthcare, energy, tourism, and transportation industries. Also, the frequent repetition of phrases such as platform, sharing

economy, and two-sided markets suggests that among different types of business models, platform models have been the focus of researchers' interest more than other models.

Furthermore, the keywords within each cluster can be investigated more profoundly to represent some meaningful sub-categories in each cluster. In the red cluster, two sub-themes are discernable. First of all, some keywords such as big data, cloud, digitization, information systems, information technology, Internet, IoT, open source software, QoS, SaaS, SOA, social network, software, web, and web service are mainly related to the technical aspects of IT management. As a respect, other keywords including two-sided markets, business process, e-business, e-commerce, knowledge management, and platform are not merely technical, but also have implications in the business domain. In the green cluster, frequent keywords analysis revealed three distinguished sub-themes. First, a significant number of keywords like business model innovation, disruptive innovation, innovation, open innovation, product innovation, service innovation, and technological innovation in this cluster are related to the concept of innovation. Moreover, some other important keywords in this cluster have roots in strategy or strategic management, among which we can refer to absorptive capacity, business strategy, competitive advantage, dominant logic, dynamic capabilities, resource-based view, strategic management, strategy, value creation, emerging markets, entrepreneurship, and social entrepreneurship. Of course, terms such as emerging markets, entrepreneurship, and social entrepreneurship can be grouped under a separate category called entrepreneurship. By investigating the blue cluster elements, it can be argued that keywords like developing countries, sustainability, sustainable business model, and sustainable development directly reflect the concepts of sustainable development management field. It can be also noted that keywords such as circular economy, consumption, cost, demand response, economy, financial performance, investment, market, sharing economy, and stakeholder are some economic and financial topics, while, the keywords of corporate governance, CSR, decision making, governance, and policy are related to the governance and policy topics. Likewise, in this cluster, some phrases like logistics, operation, supply chain, and supply chain management are included in the field of operation and supply chain management. **Table 4** represents the main themes and sub-themes of three clusters in the keywords co-occurrence network. Also, in **Table 4** the most frequent keywords related to each sub-theme are referenced as an evidence for the proposed categorization.

Table 4. The main themes and sub-themes of clusters in the keywords co-occurrence network

Theme	Sub-theme	Keywords
Electronic business model	Information technology	Big data, cloud, digitization, information systems, information technology, Internet, IoT (Internet of Things), open source software, QoS (Quality of Service), SaaS (Software as a Service), SOA (Service-Oriented Architecture), social network, software, web, web service
	E-business & e-commerce	Two-sided markets, business process, e-business, e-commerce, knowledge management, platform
Business model innovation	Innovation	Business model innovation, disruptive innovation, innovation, open innovation, product innovation, service innovation, technological innovation
	Strategy	Absorptive capacity, business strategy, competitive advantage, dominant logic, dynamic capabilities, resource-based view, strategic management, strategy, value creation
	Entrepreneurship	Emerging markets, entrepreneurship, social entrepreneurship

Sustainable business model	Sustainable development	Developing countries, sustainability, sustainable business model, sustainable development
	Economy & finance	Circular economy, consumption, cost, demand response, economy, financial performance, investment, market, sharing economy, stakeholder
	Governance & policy	Corporate governance, CSR (Corporate Social Responsibility), decision making, governance, policy
	Operation & supply chain	Logistics, operation, supply chain, supply chain management

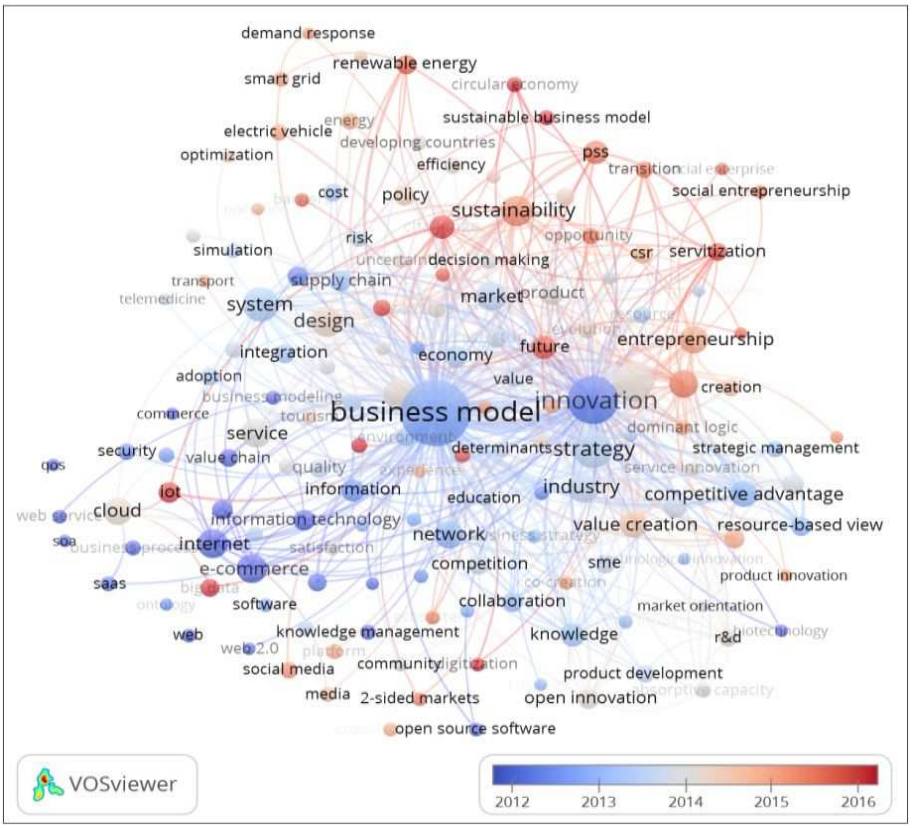


Figure 2. Temporal keywords co-occurrence network

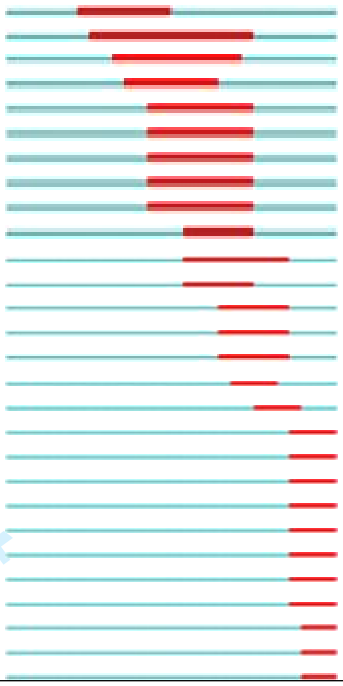
Along with the frequent keywords co-occurrence network, **Figure 2** shows the temporal analyses related to different topics and structurally is similar to **Figure 1**, except that its coloring has a different meaning. While colors in **Figure 1** represent different clusters, the coloring in **Figure 2** is according to the time of related publications. In fact, according to the figure's color bar, the color of each node represents the average publication year of documents contained the respective keyword. The blue color indicates the cool topics, while the red color points to the hot topics. For example, in the IT management cluster, the subject matter of IoT, in the strategic management cluster, the social entrepreneurship topic, and in the sustainable development management cluster, the subject of sustainable business model is among the newer issues in the business model studies. Moreover, it is revealed that research studies related to the field of business model in the IT management cluster have a longer history, while the subject of business model has recently entered into the field of sustainable development management. The strategic management cluster has a mediocre state, and the business model studies related to this subject are neither too old nor completely new.

4.2. Detected Bursts

As explained earlier, the CiteSpace software has been used in this paper to identify the various bursts of terms over time. Out of the top 313 frequent terms that have been extracted from the title, abstract, author's keywords, and Keywords Plus, the BDA has detected the top 28 bursts of terms for the burst period of 1991-2018 (**Table 5**). However, in order to remove terms that have been in the focus of attention just in a short period, the minimum burst period of 2 years has been set. **Table 5** demonstrates the different bursts of terms with their strength score, calculated by Kleinberg algorithm, and respective start and end years. To increase readability, the terms with a strength score more than 20 are bolded.

Table 5. Terms with the most powerful burst

Term	Strength	Begin	End	1991-2018
Electronic commerce	**28.37**	**1997**	**2004**	
Intellectual property	14.91	1998	2011	
E-business model	**32.13**	**2000**	**2010**	
Knowledge management	14.33	2001	2008	
Emerging business model	16.42	2003	2011	
Viable business model	15.24	2003	2011	
Supply chain management	13.28	2003	2011	
End user	14.25	2003	2011	
Web service	**32.16**	**2003**	**2011**	
Service-oriented architecture	15.14	2006	2011	
Service provider	16.04	2006	2014	
Open source	13.76	2006	2011	
Social network	13.4	2009	2014	
Financial crisis	14.21	2009	2014	
Mobile devices	13.36	2009	2014	
Business model concept	16.52	2010	2013	
Cloud computing	**25.23**	**2012**	**2015**	
Business model canvas	**22.63**	**2015**	**2018**	
Theoretical framework	15.13	2015	2018	
Corporate social responsibility	14.29	2015	2018	
Big data	**33.01**	**2015**	**2018**	
Social implications	14.0	2015	2018	
Main objective	13.66	2015	2018	
Digital technology	13.85	2015	2018	
Product-service system	17.71	2015	2018	
Semi-structured interviews	16.04	2016	2018	
Sharing economy	**23.6**	**2016**	**2018**	
Digital transformation	13.23	2016	2018	



There are a lot of extremely powerful bursts, including electronic commerce, e-business model, web service, cloud computing, big data, and sharing economy that are in some way related to the field of IT. However, the only powerful burst, purely related to the business field, is the burst of business model canvas term. The logic of BDA easily justifies this issue, and it shows while the development of business-related concepts take place gradually over the years, the IT-based concepts have been the dominate boom during a few years. Thus, the business model body of knowledge is greatly influenced by IT emerging trends. In fact, the attention of business model scholars to the IT topics is shaped based on the waves of concepts and emerging applications in that area, such that simultaneously with the emergence of a technology, the volume of documents on that subject has suddenly grown among business scholars. Therefore, even though the most frequent terms among the studies are related to the business domain (**Table 6**), these terms have rarely been taken into consideration abruptly and have been used almost monotonously over time.

Table 6. The most frequent terms extracted from the title, abstract, and keywords

Term	Count	Term	Count
Business model	6068	Sustainable business model	228
New business model	1352	Value creation	225
Business model innovation	469	Different business model	203
Practical implications	351	Supply chain	197
Competitive advantage	346	Service providers	195
Case study	321	Sustainable development	187
Cloud computing	290	Value chain	181
New technology	276	Communication technology	178
Information technology	271	Literature review	178
Business process	270	Traditional business model	157
Innovative business model	239	Conceptual framework	139

Based on the valuable information in **Table 5**, three notable periods are distinguished in the business model research history:

A) Digitalization flourishing (1997-2003): The strongest bursts in this period belong to the electronic commerce and e-business model terms, which could be interpreted as the momentum of business digitalization and using the Internet capabilities in business management.

B) The growth of online services (2003-2012): This period begins with the powerful burst of web service term and ends with the powerful burst of cloud computing term. In this period, the service-oriented architecture and service provider terms are also dominant. Therefore, this period can be named as "the growth of online services" that could be related to the increase of users' attention, especially commercial users, to affordable software, infrastructure, and computational power.

C) Data management boom (2012-2018): The most powerful burst in this period belongs to the big data term. Recently, the information explosion greatly attracted the researchers' attention and they became eager to benefit from the big data capabilities in business. Another powerful burst in this period is the sharing economy, which refers to platform businesses and peer-to-peer activities in online businesses.

Table 5 further points to the most influential events, which have provoked researchers to pay more attention to some specific topics over time. For example, the beginning of e-commerce term's burst in 1997 can be attributed to the establishment of the pioneer successful e-commerce websites such as Amazon and E-bay in 1994 and 1995. The rise of attention to intellectual property subject in 1998 could also be accredited to the creation of Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) between the World Trade Organization (WTO) members in 1996. The presentation of cloud services and approaches such as SaaS, PaaS, and IaaS by Microsoft, IBM, Oracle, and Google in the years 2010-2012 can also be considered as a powerful stimulus to boost the focus of business community into the cloud computing opportunity. Also, the increase of focus on social network and financial crisis topics in 2009 could be interpreted as reflecting Facebook's growth in 2007 and the financial crisis in 2008. In recent years, the boom of platform businesses such as Uber can be recognized as a driver for the widespread interest of researchers in sharing economy subject. Investigating these bursts triggers have two important functions:

1) Identifying these triggers can act alone as some narrators for the story of formation and evolution of a scientific trend in the field.

2) Understanding the characteristics of bursts triggers in the past can facilitate the prediction of future research avenues, which is valuable for both researchers and scientific institutions in identifying future scientific trends.

4.3. Timeline View

Figure 3 shows the co-occurrence network of highly frequent terms with the timeline view visualization. To enhance the readability, from among a total number of 281 frequent terms detected by the CiteSpace software and extracted from the title, abstract, author's keywords, and Keywords Plus, only 170 ones with the most frequency are displayed in this view. The CiteSpace software has identified and named seven clusters out of these terms, and the colored line on the axis is drawn in front of the name of each cluster represents the start and end years of the cluster.

As mentioned before, this type of visualization is a special state of mapping terms' co-occurrence network. Accordingly, the first point that can be noticed in **Figure 3** is the relationships established between highly frequent terms based on their co-occurrences. For example, by looking at the branches connected to the cloud computing term, which appeared in the cloud computing cluster around 2008, it is evident that the most important co-occurrences of this term are with the terms of business model, new business model, information technology, business process, and service providers. In **Figure 4**, to enhance readability, all branches and nodes, except those associated with the cloud computing term, have disappeared.

However, the main purpose of this kind of visualization is to identify the source of a term and its temporal relations with other terms, so attention to the location of related nodes can provide us with more information about the intended terms, such as cloud computing. As per **Figure 4**, the associated terms with the cloud computing on the left are: business model and new business model terms before 1995, the business strategy term in 1995, the information technology and business process terms in 1997, the service-related terms of service providers, service provider, web service, and new service between 2000 and 2006, and the rapid development term in 2006. Also, The cloud service term in 2012 and the European Union term in 2018 are appeared on the right. Therefore, the process of formation and development of the cloud computing topic can be evaluated among the under-review business model-related documents. Accordingly, we can sum up that the evolution of cloud computing subject in the business model literature (e.g., the topical growth of the field of cloud-based business models) was mainly associated with the evolution of service-oriented concepts and trends. Such analyses can also be performed about other important terms through scrutinizing **Figure 3**.

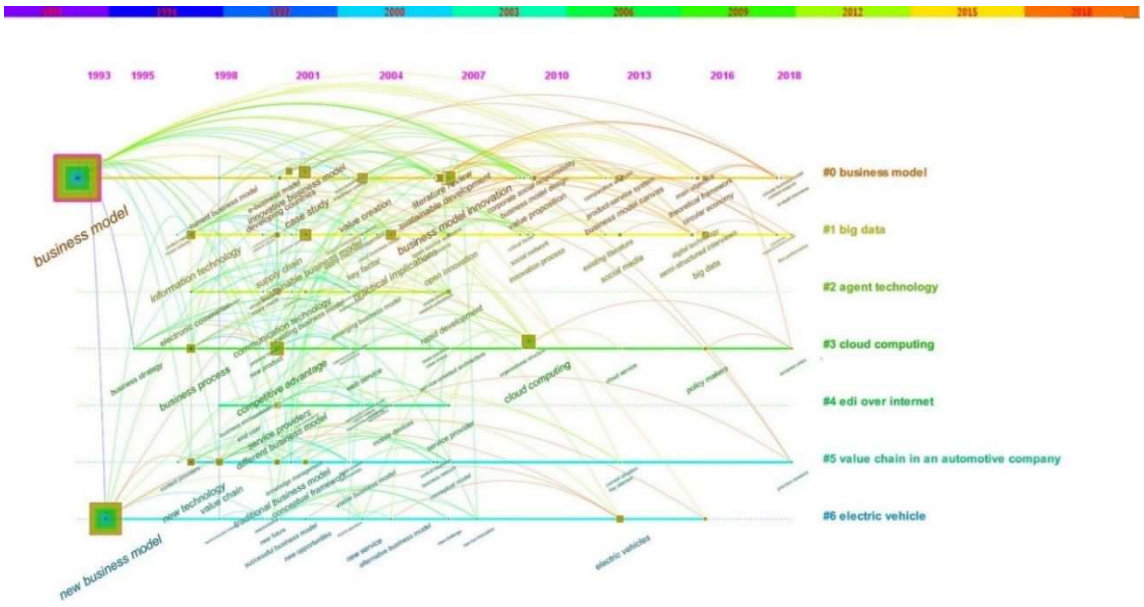


Figure 3. A timeline view of the most frequent terms

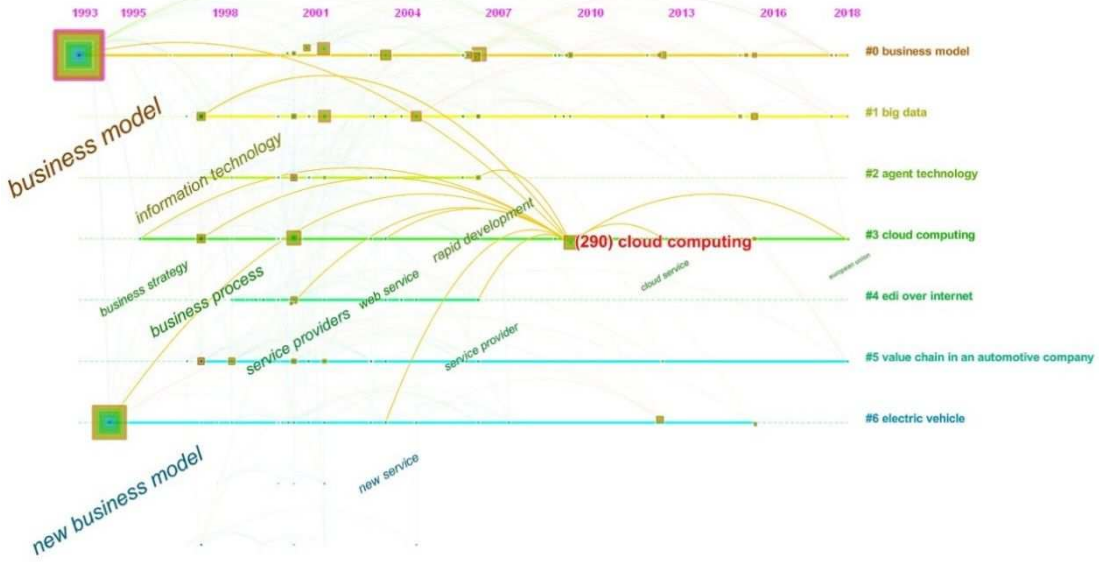


Figure 4. A timeline view of cloud computing and its adjacent terms

As another example, careful attention to the branches and nodes associated with the sustainable development term in the business model cluster reveals that, in 2007, this term together with the rapid development term were simultaneously in the focus of attention; it was also the largest node associated with the circular economy term in 2016. By following the branches attached to the circular economy term, it can be observed that this term was also linked to the circular business model term, which was first spotted in 2018 among the frequent terms. Therefore, the source of circular business model term comes from 2007 and even earlier. This kind of analysis along with the introduction of subjects' roots to researchers can lead to a forward function, and make researchers interested in a domain and acquainted with the emerging topics. For example,

a researcher interested in sustainable development can use this analysis to put his effort into the circular economy and circular business model topics that have been introduced in recent years.

4.4. Topic Map

From the experiments carried out in the topic modeling procedure, having done 12 repetitions and examining the results of each, we extracted 30 topics. **Figure 5** shows the topic map and the most probable terms extracted from the abstracts of business model-related documents and appeared in each topic. The size of each topic indicates the importance or average probability of appearance of the topic in the dataset. In our experiment, due to the removal of single words, the average probability of appearance of all topics is a constant value equal to 0.83%. Moreover, the distance between the topics represents the semantic affinity of them. When two topics are in close proximity, this means that they have common terms and/or have appeared together in more documents and are thematically closer to each other. The order of terms appearing in each topic is based on the probability of their existence in that topic. The topics' naming is according to the most likely term appearing in any topic and the subjective judgment of the authors to more accurately represent the concepts of the same category. **Figure 5** is divided into seven general categories according to the colors and based on the distances between the topics and their locations. Then, using the terms appearing in each topic, and considering the connections between the topics of each category, some new intuitions are obtained.

The first identified category is the blue topics section (the upper left corner of **Figure 5**), which includes the circular economy, product life cycle, e-commerce, airline industry, and supply chain management topics. The focus of this section is on the environmental impacts of commercial products throughout their life cycle from production to consumption, and ultimately, to decomposition or recycling. The airline industry, the fashion and apparel industry, the food industry, the mobile industry, and the vehicle industry are explicitly mentioned in this section, each having their own special environmental concerns in the production, consumption, or post-consumption phases. Additionally, solutions such as electric vehicles, alternative business models, and electronic commerce are implicitly referred to, and the role of policymakers in the economic models can also be highlighted.

The second examined category is the boundary topics located between the blue and green topics (the left side of **Figure 5**). These topics include the product development, public sector, health care, mobile network, and service providing. The core of this section is the provision of services for the public sector, and as the sub-topics, health care and mobile networks can be recognized. The development of software and systems to improve the public services, such as public health services and mobile networks, has attracted the attention of researchers. The emergence of phrases such as service systems, software development, personalized medicine, public services, application services, mobile communication, and public health confirm this impression.

The third category is a group of green topics (the bottom left corner of **Figure 5**) including the manufacturing, business process, and business model innovation topics. The focus of this category is on innovation, especially with regard to the processes and capabilities of business model in the manufacturing industry. The appeared expressions imply that technological development, the use of web services to improve business processes, and product innovation through the innovation in business processes are those subjects that researchers have paid more attention to.

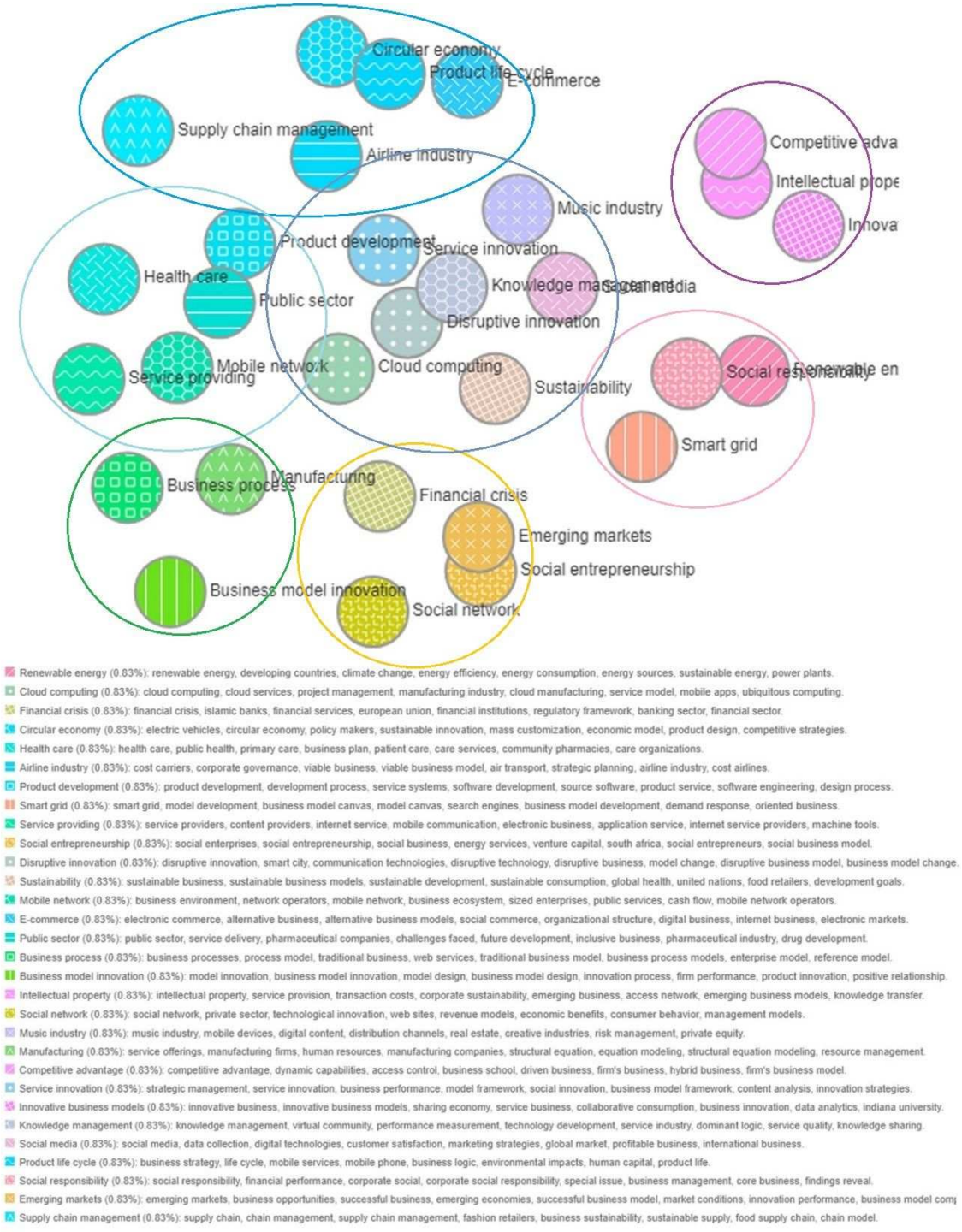


Figure 5. Topic map and appeared phrases sorted based on the probability

The fourth category includes brown topics located at the bottom of **Figure 5**. These topics involve the financial crisis, emerging markets, social entrepreneurship, and social network. As it is evident from the name of financial crisis topic and the terms appeared in it, this topic is related to the impacts of financial crisis in the European Union and regulatory frameworks about financial reports, especially in balance sheets. The phrases such as consumer behavior,

technological innovation, and revenue models imply that social network topic is related to the new technological enabled revenue models, and the possibility of a better understanding of consumer behavior through these networks. The great overlapping of two topics of emerging markets and social entrepreneurship indicates the prosperity of social business models and the business opportunities in the emerging markets (especially in South Africa).

In the right side of **Figure 5**, there are two triad categories. The lower category includes the smart grid, social responsibility, and renewable energy topics. The phrases like smart grid, power plants, renewable energy, greenhouse gas, and sustainable energy can well show one aspect of this category related to the field of renewable energies. The phrases like corporate social responsibility and oriented business model (that is, in fact, sustainability-oriented business model) clearly express the managerial aspect as regarded by the active researchers of this domain. The upper category involves the competitive advantage, intellectual property, and innovative business model topics. This category implies that innovation and the intellectual property of innovations are the prerequisites of competitive advantage in today's agile environment. Companies also need to move towards emerging business models gradually and traverse this transient state along with today's dynamic world using hybrid business models. Some of the important issues that attracted the researchers' attention are sharing economy and collaborative consumption, information-rich business models that generate data and information-based services around the core products, and insight-based business (often insights about customers, using a large amount of data) or purpose-based business (often social and environmental purposes beyond profit and financial purposes). Note that the phrase "driven business", appearing among the phrases of competitive advantage topic can encompass insight-driven business or purpose-driven business that in either case, they can be analyzed and interpreted in the similar way.

The seventh category includes the topics appeared in the center of **Figure 5**. According to their position in the figure, these topics are originally related to each of the previous six categories, and they can be considered beside the previous categories. This category includes the topics of music industry, social media, service innovation, knowledge management, disruptive innovation, cloud computing, and sustainability. There are some obvious points to be mentioned: First, there is close proximity between the music industry topic and the e-commerce and intellectual property topics from the adjacent categories. According to the phrases such as social capital, intellectual property, social commerce, e-commerce business models, and digital content, a distinctive semantic domain around the introduction of music industry in e-commerce is implied. Second, there is proximity between the cloud computing topic and the manufacturing and public-sector topics. The social media topic can be categorized in the marketing section of business model, mainly due to the emergence of phrases such as marketing strategy, customer satisfaction, global market, international business, and digital media. Moreover, the appearance of international and global concepts relates this topic to all the other 29 topics. Additionally, it is argued that the knowledge management topic, locating in the center of **Figure 5**, is generally relevant to all topics. The appearance of phrases virtual community and virtual enterprise in the knowledge management topic shows that these two concepts have been in the core attention of researchers in the knowledge management domain. Due to the relevance of sustainability topic to the other six topics (supply chain management, circular economy, competitive advantage, intellectual property, renewable energy, and health care), it can be argued that like the two previous topics, it involves a generalizability capacity. The disruptive innovation and service innovation topics are both grounded in innovation and are related to the circular economy, innovative business models, emerging markets, social network, and business model innovation topics.

5. Conclusion

The purpose of this study was to investigate the knowledge structure and research the trends of business model field of study. To this end, four different quantitative methods (i.e., co-word analysis, burst analysis, timeline analysis, and topic modeling) were employed on the title, abstract, and keywords of the business model-related scholarly documents that have been indexed in the WoS database until June 26, 2018.

The results show that the business model knowledge structure comprises three general research clusters: Electronic business model, business model innovation, and sustainable business model. These three research clusters are further categorized into nine sub-clusters namely: Information technology, e-business & e-commerce (belonging to the first cluster), innovation, strategy, entrepreneurship (belonging to the second cluster), sustainable development, economy & finance, governance & policy, and operation & supply chain (belonging to the third cluster). **Figure 6** shows the business model knowledge structure including the three research clusters and their respective sub-clusters.

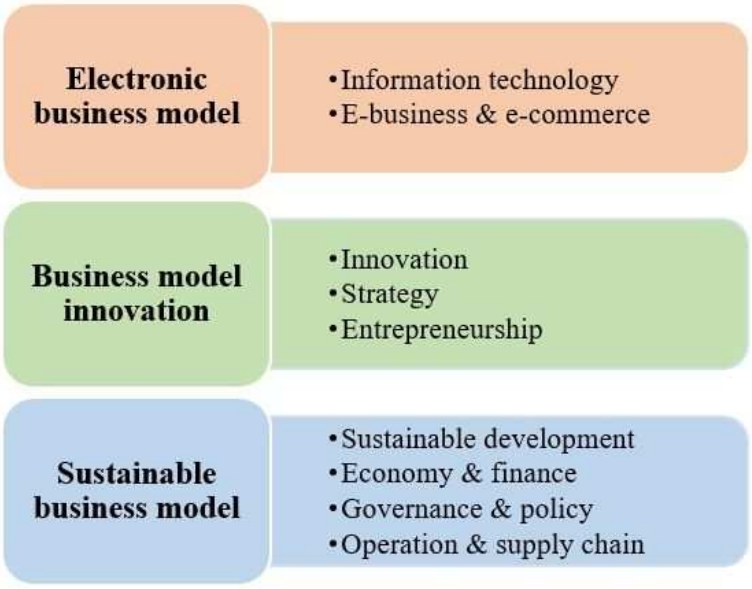


Figure 6. The knowledge structure of business model at a glance

Regarding business model research trends, the temporal analyses in this study illustrate that:

1. The business model field of study has three generic sequential research trends which are IT management (i.e., the electronic business model research cluster), strategic management (i.e., the business model innovation research cluster), and sustainable development management (i.e., the sustainable business model research cluster). As it is shown in **Figure 7**, the sustainable development management is the new trend of the field. Accordingly, we can suggest some managerial implications concerning the sustainability-related issues. The results show that the sustainability-related topics in the business model domain can be considered as one of the most attractive areas in the recent studies of this domain. Therefore, firstly, managers

should be acquainted with the conceptual framework of this emerging and growing area. They need to plan some initiatives toward more sustainable business models, which can broadly divided into inbound and outbound efforts. Secondly, managers should change their conventional business logic to reach some kind of sustainable business models that will finally lead to the businesses sustainability. Clinton and Whisnant (2019) have argued that business model innovation is one of the most important drivers for sustainability. They have discussed that innovation can bring us the business sustainability or sustainable business. Additionally, managers cannot ignore the environmental, societal, and economic issues and impacts, while designing a sustainable business model.

Figure 7. The generic research trends of business model

2. There are three specific streams of research in the business model field of study: digitalization flourishing, the growth of online services, and data management boom. These research streams with their important bursts are shown in **Figure 8**. Considering the powerful bursts of recent research stream, i.e., data management boom, it seems beneficial to explain a little more detailed about the big data and sharing economy topics in the business model literature and accordingly provide some managerial implications in regard to these trendy issues. In this way, it can compendiously be argued that:

2.1. Not surprisingly, big data is one of the trendy concepts in business model research. Data, as the new oil, will be a strategic resource in near-future businesses and the extraction of insights from raw data will be an important capability for building sustainable competitive advantage. Managers can consider tailoring their services based on the data-driven analyses fed with dynamic streams of customer data. The applications of data in business have a broad range from real-time big data generated in supply chain management to industries with the low volume of data (e.g., aviation industry). In every different preference (e.g., companies without data analytics expertise, companies which their departments have their own specific analytics or even companies that do not have enough data), managers can use data analytics solutions on the cloud. Recently, we have witnessed with some new kind of business models developed based on the emerging technologies, which bring a huge amount of raw data for organizations from both internal and external sources. Accordingly, managers who decided to establish this sort of business models in their firms can benefit from the analysis of big new data generated from such a new establishment to create value for their customers. In this regard, we can refer to Hajiheydari, Talafidaryani, and Khabiri (2019) as an example that has summarily discussed how to generate value from IoT big data based on the framework of business model canvas.

2.2. Historically, sharing behavior has been a vital concept in humankind life. Our ancestors shared their resources (e.g., food or fighting power) mostly in order to survive. A similar scenario is going to appear in the business world. All types of near future businesses must get involved in sharing economy and the phrase "share or die" (Murillo, Buckland, & Val, 2017) justifies this "must". Appearing the "sharing economy" as one of the main final-says in our comprehensive and hands-off study tremendously implies every single manager (whether in a small start-up or a well-established firm) to take serious steps toward sharing business models. They must position their businesses in a blue ocean among the various spectrums of sharing business model types (Ritter & Schanz, 2018), and incorporate in pro-social and altruistic initiatives accompanied with some free or nearly free offerings. Research evidence shows that sharing economy business models attract "impact investors" better than venture capitalist due to their mission-driven and collaborative mindsets (Munoz & Cohen, 2017). Thus, moving toward sharing business models with deliberated positioning and fund attraction is the managerial implication of this study regarding sharing economy.

Figure 8. The specific research trends of business model

Scholars also can consider the resulted research trends (i.e., the trends of sustainable development management and data management) as the research topics that include plenty of theoretical implications for them. In other words, these topics can be perceived as their research agenda and research priorities in the field of business model.

Collectively, **Figure 6**, **Figure 7**, and **Figure 8** represent a big picture of the intellectual structure of business model research domain and relatively address the identity crisis of the field. In other words, they help to achieve an approximate theoretical agreement between scholars on the boundaries of business model research.

The results of the present study can be compared with the findings of studies conducted by Hong and Jinho (2017) and X. Li et al. (2017). Although the extracted intellectual structure in this study is similar to the mentioned studies at the level of general topics and trends (and is expected to be so), this study goes further and discusses the topics and trends in a detailed manner. Hong and Jinho (2017) concluded six research areas as the main themes in the business model literature. These areas included "sustainability", "open model innovation", "globalization strategy", "communication technology", "case of value network and innovation", and "knowledge management". They also stated that the business model research has focused on the "innovation", "internet", "electronic commerce", and "strategy" topics. X. Li et al. (2017) introduced "technology-oriented articles" and "strategy-oriented articles" as the main perspectives of business model field of study. Their results indicated that "business model innovation" and "value creation" have been the business model-related hot topics. As it

can be seen, these studies generally have similar results and findings with our achievements; but there are some differences between the details of them. The main contribution of our findings is that we proposed the research clusters and respective sub-clusters in a novel hierarchical manner. Additionally, this study identified the research trends in both generic and specific levels, which are unprecedented in the business model literature due to the best knowledge of the authors.

Using a database (WoS) solely is one of the important limitations of this study. Furthermore, as it was discussed, the trend of review studies is changing from subjective studies (which are dependent on the judgment of authors) towards objective studies (that are independent of authors' judgment). Following such direction change, the approach of the authors in this study is mainly based on objective and hands-off methods. However, the point is that the subjective review of studies, relying on the author's understanding, could reveal findings that are beyond the understanding ability of machines. To partially address this inherent limitation, based on the researchers' knowledge and expertise, logical explanation and justification are provided for the results driven from machine outputs. Hence, future studies can extend the use of databases to the Scopus, EBSCO, and Google Scholar; use mixed-methods; use other bibliographic fields (e.g., authors, countries, journals, and organizations); employ other scientometrics methods such as citation analysis, co-citation analysis, and bibliographic coupling. Further research can consider the practical documents in their datasets to provide different view of the business model field from the practitioners communities rather than the scholars.

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"Business Model Analytics: Technically Review Business Model Research Domain"

	Review	Revision
Referee 1	Clearly discuss the contribution of the findings of this study It is necessary to provide descriptions and contributions regarding findings of the study as well. I can understand the methodology innovation in this study, but it is recommended to clarify the originality of the study in the finding section. In this way, the motivation of the study becomes clearer.	In order to clarify the contribution of study we have added three paragraphs in the Introduction section which are highlighted in yellow. Moreover, we have added two specific research questions which help the clarification of contribution and motivation of the current study. Also, we have carefully discussed and compared our findings in a separate paragraph (one before the last paragraph in the Conclusion section highlighted in yellow) with similar studies, in order to clarify the contribution of our findings.
	Synthesize the findings of different method in an integrated manner Although authors discussed the findings of each method separately in detail, it seems they have challenges to sum up the findings. Considering that this manuscript represented multiple methods, it is expected to present the results in an integrated manner in the final section of paper.	We have summed up our heterogeneous findings in an integrated manner and represented them in Figures 6, 7, and 8 which are intently explained in the Conclusion section.
	Discuss some suggestions for practitioners based on your finding especially regarding Sustainable Business Models as an emerging important subject Some suggestions for future research have been provided that could be present in more clear manner. Also, there is no suggestion for practitioners. Considering the fact that the business model domain is a practical field, it is expected to provide suggestions for practitioners. I advise to focus on Sustainable Business Models for this section.	Managerial implications added to the paper and well discussed based on practical business model issues related to the sustainability, big data, and sharing economy topics due to their emergence. These explanations are highlighted in the Conclusion section by green color.
	Provide some clear further research outlines	Further research directions are added in last sentences of the paper (highlighted in red color).
	Revise and make it more professional from academic writing viewpoint the text	We have revised the whole text and the Results section has had more improvements in terms of linguistics and grammar due to its importance.

	Although the topic of this research is attractive and new methods are also applied, the text needs revision and it is necessary to be reviewed. It should also be noted that the text has some flaws in terms of linguistics that must be addressed: Firstly, it is redundant. Secondly, some sentences are long and vague. Thirdly, it seems that this text can also be improved in terms of grammar.	
	Figure 5 in the text is missed or damaged, but it is clear in the appendix, Figure 1 is missed in appendix but it is presented in the text. Check the figures before re-submitting the manuscript.	We are surprised by this issue. In the new version of paper, all figures are presented clearly.
Referee 2	Poor quality of the Figure 3 in the main body of the work. Figure 5 is missing in the main body, Figure 1 in appendix is broken. Wrong comma symbol on the page 21 ("‹Emerging Markets ‹")	We are surprised by this issue. In the new version of paper, all figures are presented clearly. The comma issue is corrected.
Referee 3	Observing only WoS database makes the study itself a bit subjective. The results part is analyzed in an adequate and appropriate way. The conclusions part is the logical continuation of all previous parts, connecting all of them in an appropriate manner. However, there might be questions to objectivity and comprehensiveness of these research, as it includes only WoS database as source of data.	We agree with this comment and we have mentioned this limitation in our Conclusion section. We could not make any changes in our paper in position of this comment. Because the respective revision needed to collect new data from other databases that led to a set of completely new results.
	There is no possibility to predict future changes of the Business Model concept, using the results of these research. This particular paper gives a clear understanding on the evolution of terms and subjects, connected to the topic of Business Model. It identifies theoretical implications for research and society, however, due to its descriptive structure, it could not contribute much to practice, as it does not build any forecast for future tendencies. It might be used in teaching for giving a general understanding on Business Model innovation and structure evolution.	We totally agree with the idea. We have not asserted that we want to predict the future. The paper examined body of research on business model and identified trendy topics within the field. However, we believe that a comprehensive knowledge about the intellectual structure of a field can imply probable future research.

	In the literature review section, a deep analysis was done. A lot of works of the considered topic were mentioned and cited. However, there is not so much description of any particular paper, mentioned in the article.	All mentioned referred studies in the Literature Review section were described in more detail in the revised version. In this way, the paragraphs with yellow color in the Literature Review section indicate the revisions.