Approach to identify topics in collection of TIM Review articles
and their changes over time

by

Ali Nazari

A thesis submitted to the Faculty of Graduate and Postdoctoral Affairs in
partial fulfillment of the requirements for the degree of

Master of Applied Science

in

Technology Innovation Management Program

Carleton University

Ottawa, Ontario

© 2018

Ali Nazari

Abstract

Topic modeling can help better understand the content of large collections of text. The objective of the research is to develop an approach to identify latent topics in the Technology Innovation Management Review journal ([TIM Review](#)) and how topics have evolved using the LDA (Latent Dirichlet Allocation) and DTM (Dynamic Topic Model) algorithms. We applied the two approaches to a collection of TIM Review articles published between 2007 and 2017. We also examined extracted topics, most associated articles, topic labeling, topic/theme trends, and word trends produced by both approaches and identified the value of each approach. According to the results obtained, we identified 47 topics and categorized them into ten themes: open source, entrepreneurship, innovations, living labs, social technology innovation, growth, co-creation, cybersecurity, research, and ecosystem. While some topic trends became prominent over time, others disappeared. The distribution of the articles across topics in the LDA approach has been made more decisively so that of 597 articles, 503 most associated articles were identified, while this number is 299 articles in DTM. Furthermore, we discussed weaknesses and strengths of the algorithms to compare the performance of the two approaches based on defined criteria. We conclude that DTM provides more accurate word and topic trends over time, although it requires time slice settings and has a longer run-time compared to LDA. Finally, we document a set the steps of a process to carry out topic modeling analysis.

Key Words: Topic Modeling, Latent Dirichlet Allocation, Dynamic Topic Modeling, Statistical Analysis, Information Retrieval

Acknowledgements

Firstly, I would like to express my sincere gratitude to my supervisor Prof. Michael Weiss for his continuous support of my M.Sc. study and related research, and for his patience, motivation, and immense knowledge. His guidance helped me in all the time of research and writing of this thesis.

Besides my supervisor, I would like to thank the Director of the TIM program, Prof. Tony Bailetti for his leadership in conducting research and his insightful comments and encouragement, but also for the hard question which incited me to widen my research from various perspectives.

My sincere thanks also go to Daniel Craigen, the Director of Global Cybersecurity Resource (GCR) who provided me an opportunity to join their team as a data analyst, and who provided access to the data and research facilities. Without their precious support, it would not be possible to conduct this research.

Contents

Abstract	II
Contents	IV
List of figures	VI
List of tables	VII
List of acronyms and definitions	VIII
1. Introduction	1
1.1. Objective	2
1.2. Deliverables	2
1.3. Contributions	2
1.4. Relevance to stakeholders	2
1.5. Scope of research	3
1.6. Structure of the thesis	3
2. Literature review	4
2.1. Latent Dirichlet Allocation (LDA) and Dynamic Topic Modeling (DTM)	4
2.1.1. LDA assumptions	5
2.1.2. Approximation methods (approximate inference algorithms)	7
2.1.3. Perplexity and harmonic mean of log likelihood	7
2.2. The performance criteria of topic model techniques	9
3. Research method	11
3.1. Overview topic models	11
3.2. Data preparation	12
3.3. Application	13
3.3.1. Topic modeling	13
3.3.2. LDA and DTM algorithms settings	13
3.4. Visualization	14
3.4.1. Analyzing the results	14
3.4.2. Visualizing the results of LDA and DTM	14
3.4.3. Analyzing trends and distributions	15
3.5. Guideline and integrate insights developed in previous steps to articulate a repeatable process	15
4. Results	16

4.1.	Preparing files to run LDA and DTM algorithms	16
4.2.	Run LDA and DTM algorithms	18
4.3.	Distribution of articles across topics	19
4.4.	Distribution of words across topics and topic labeling	22
4.5.	Categorizing topics into themes	28
4.6.	Related, bridge, and unclassified articles	30
4.7.	Topic and theme trends	33
4.8.	Word trends	41
5.	Discussion on the performance of LDA and DTM approaches	44
5.1.	Comparing the performance of both algorithms based on five criteria.....	44
5.1.1.	Topics achieved and themes	44
5.1.2.	Topic trends in addition to dominant topics/themes, positive and negative trends	46
5.1.3.	Related, bridge and unclassified articles.....	48
5.1.4.	Word trends and combination of words.....	51
5.1.5.	Execution time of LDA and DTM	52
5.1.6.	Summary	52
5.2.	A detailed procedure to estimate, interpret, and visualize results.....	53
6.	Conclusion and future work	56
7.	References	57
	Appendix I: Top 20 articles per topic in LDA	60
	Appendix II: Top 20 articles per topic in DTM approach	73
	Appendix III: Topic trends in LDA	86
	Appendix IV: Topic trends in DTM	89
	Appendix V: Word clouds of collection of topic words in LDA.....	92
	Appendix VI: Top 20 topic words in different slices in DTM approach.....	95
	Appendix VII: Word clouds of collection of first slice topic words in DTM.....	110
	Appendix VIII: R Function: Harmonic mean log likelihood function to obtain proper topic number	113
	Appendix IX: R Function: Generate matrix (CSV file) of topic proportions to articles and topic probabilities of words in LDA	113
	Appendix X: R Function: Generate matrix (csv file) of topic proportions to articles in DTM ..	115
	Appendix XI: R Function: Generate matrix (CSV file) of topic probabilities to words in DTM	116

List of figures

Figure 1: Structure of observable and hidden variables in LDA	4
Figure 2: A graphical model of DTM (Blei and Lafferty, 2006).....	6
Figure 3: Graphical Model by Blei’s Latent Dirichlet Allocation (LDA)	6
Figure 4: Perplexity formula based on Blei et al. (2003).....	8
Figure 5: Perplexity results on the AP corpora for LDA, the unigram model, mixture of unigrams, and pLSI examined at Blei et al. (2003)	8
Figure 6: Optimal number of topics using Gibbs sampler (k=300) on TIM Review dataset	9
Figure 7: Sample of the result of a query on TIM Review database	16
Figure 8: Sample of refined text article with ID 82	17
Figure 9: Sample of text file name format	17
Figure 10: Relations of two required input files and IDs file	18
Figure 11: Weight of topics in corpus and weight of topics with the proportions more than 0.9	19
Figure 12: Topic weight in corpus and weights with the proportions more than 0.5	21
Figure 13: Word clouds of topics 1, 16, 28 in LDA	24
Figure 14: Word clouds of topics 25,45,12 in DTM.....	26
Figure 15: Word clouds of 20 top ranked words of topic 1 over 11 years	28
Figure 16: Topic trends related to co-creation theme and the theme trend over time in LDA.....	34
Figure 17: Topic trends related to cybersecurity theme and the theme trend over time in LDA .	34
Figure 18: Other topic and theme trends over time in LDA	36
Figure 19: Topic trends related to co-creation theme and the theme trend over time in DTM	37
Figure 20: Topic trends related to cybersecurity theme and the theme trend over time in DTM.	37
Figure 21: Other topic and theme trends over time in DTM	39
Figure 22: Topic trends in DTM approaches.....	40
Figure 23: Combination of three words trend in DTM.....	40
Figure 24: “Cybersecurity” weight in 47 topics and the trend over 11 years in LDA.....	41
Figure 25: “Entrepreneur” weight in 47 topics and the trend over 11 years in LDA	41
Figure 26: “Startup” weight in 47 topics and the trend over 11 years in LDA.....	41
Figure 27: Combination of three trends over time and topics in LDA	42
Figure 28: “Cybersecurity” weight in 47 topics and the trend over 11 years in DTM.....	42
Figure 29: “Entrepreneur” weight in 47 topics and the trend over 11 years in DTM.....	43
Figure 30: “Startup” weight in 47 topics and the trend over 11 years in DTM.....	43

Figure 31: Combination of three trends over time and topics in DTM	43
Figure 32: Five topic trends of cybersecurity theme	45
Figure 33: Five topic trends of cybersecurity theme	46
Figure 34: Theme trends in LDA and DTM	47
Figure 35: Number of related articles to themes in LDA and DTM approaches.....	49
Figure 36: Word trends using LDA and DTM approaches.....	51
Figure 37: Execution time of LDA and DTM with different number of topics	52
Figure 38: A detailed procedure for replication.....	54

List of tables

Table 1: Algorithms implementation settings.....	11
Table 2: Algorithms implementation settings.....	12
Table 3: Most associated articles to open source- software product	20
Table 4: Most associated articles to open source- project community	20
Table 5: Most associated articles to living-labs-development-process.....	21
Table 6: Most associated articles on entrepreneur-global-startup topic	22
Table 7: List of 20 top words, labels and weights of topics achieved by LDA	23
Table 8: Top 20 words and probabilities of topic 1	24
Table 9: List of 20 top words, labels and weights of topics achieved by DTM	26
Table 10: Three most knowledge-related articles of topic 1.....	27
Table 11: Top 20 words and probabilities of topic 1	27
Table 12: Categories of topics (themes)	29
Table 13: Obtained topics of DTM and the corresponding to topics gained by LDA.....	30
Table 14: Top 20 articles of topic 7- Ecosystem-business-value community	32
Table 15: Top 20 documents distributed over topic 22 (Ecosystem-business-value community).....	32
Table 16: Sample of proportions of articles per year and topic	33
Table 17: Collection of words of topic 17 overtime in DTM.....	40
Table 18: Security-related topics as cybersecurity theme and top 20 topic words in LDA and DTM.....	45
Table 19: Most associated articles to topic 17 in DTM.....	45
Table 20: Number of positive, negative, and no trend topics in different levels.....	47
Table 21: Number of related, bridge, and unclassified articles per topic and theme in LDA	50

Table 22: Articles related to ecosystem-business-value-community topic in LDA and DTM.....	50
Table 23: “Open_source” word in collection of words per year in DTM (topic 27).....	51
Table 24: Comparing the performance of LDA and DTM approaches	53

List of acronyms and definitions

LDA	Latent Dirichlet Allocation
DTM	Dynamic Topic Model
pLSI	Probabilistic Latent Semantic Indexing
Article=Document=Text	The text of article consists of all parts of articles including abstract, introduction, method, result, and conclusion without figures, numbers, tags, verb and words less than 3 letters
ItemId=NodeId=ID	A number that denotes articles in TIM Review website
Associated articles	Most associated articles to their topics that have high proportions to topics above determined threshold
Related articles	Most associated articles which are not common to other topics; have high proportion in the topic and very low proportion in other topics
Bridge articles	Most associated articles which are common to one or more other topics; have slightly high proportion in one or some other topics as well
Unclassified articles	Articles which are not classified to none of topics
Non-Related articles	Non-related articles that those are located below the threshold of each articles list of each topic and are marked with gray
TIM Review journal	Technology Innovation Management Review (http://timreview.ca/)

1. Introduction

Topic modeling can help better understand the content of large collections of text. In particular, topic modeling can be used to classify documents, discover patterns, and how topics evolve (Blei and Lafferty, 2009). There are various topic modeling techniques and it is important to understand how the techniques differ from each other in order to apply them properly. According to Nikolenko, Koltcov, & Koltsova (2017), there are two important problems in qualitative studies: there is no good quality metric understanding topics and a lack of mechanisms to indicate the most interesting subtopics. In this research, we examine the results of applying two topic modeling techniques, LDA (Latent Dirichlet Allocation) and DTM (Dynamic Topic Model), on a database of TIM Review articles, identify criteria to compare these techniques.

In our research, we focus on two topic modeling introduced by Blei et al. (2003) and Blei and Lafferty (2006). These techniques generate two types of distributions: topic-proportion-to-documents and topic-probability-to-words. The former indicates which documents belongs to which topics, the latter which words are associated with which topic. Using these distributions, we examine the trends and evolution of topics in a database of 597 TIM Review articles published between 2007 and 2017. The main questions of research are how to model topics in the journal, how the topics and themes have evolved, and how topic models can help us form hypothesis about the data. We used the LDA algorithm described in Blei et al. (2003) and applied the lessons from Ponweiser's (2012) thesis that describes an R-based implementation of LDA. We also applied the DTM algorithm described in Blei and Lafferty (2006), which extends LDA to obtain more accurate article and word distributions over time and compared those results to those obtained using LDA.

In the following, we use words as a basic unit of discrete data and as items from a vocabulary. We consider all parts of an article including abstract, introduction, research, and conclusion as entities. A corpus refers to a collection of articles. For the purposes of topic modeling, articles are considered "bags of words", that is, the order of the words does not matter, just how often they occur in each article. The LDA and DTM algorithms create a probabilistic model that assign topics to articles and words to topics. Finally, themes are sets of similar topics that refer to one subject.

Topic models are latent variable models based on probabilities that identify the relationship between words and documents in a corpus to extracted topics/themes. Topics, in fact, are variable

relations or distributions of words in the corpus and of documents distributed over topics (Blei and Lafferty, 2006).

1.1. Objective

The objective of the thesis is to identify themes and topics of a journal (TIM Review) and examine how these themes and topics changed over time using the methods in Blei et al. (2003) and Blei & Lafferty (2006), and applying the lessons from Ponweiser's (2012) thesis.

1.2. Deliverables

Our deliverables include 1) topics and themes in a given corpus (TIM Review), 2) the results of applying the LDA and DTM algorithms, including topic labels, topic/theme trends, dominant topics/themes, related¹, bridge², and unclassified³ articles, and word trends, 3) a detailed procedure to estimate, interpret, and visualize results obtained using these algorithms, and 4) comparison LDA and DTM based on criteria including i) topics achieved and themes, ii) topic trends in addition to positive and negative trends, iii) related, bridge and unclassified articles per topic, iv) word trends and their combination, and v) runtime performance.

1.3. Contributions

The thesis makes the following contributions to knowledge: 1) it defines a detailed process to extract topics from a collection of documents and examine the evolution of topics over time, and 2) it compares two prominent topic modeling techniques, LDA and DTM, in terms of their results and performance.

1.4. Relevance to stakeholders

Our research will be useful for three main groups:

Academics and businesses

We created R functions to convert the output of algorithms to displayable data that can be used by these stakeholders. R is an open-source environment for statistical analysis that is used widely

¹ Most associated articles which are not common to other topics; have high proportion in the topic and very low proportion in other topics

² Most associated articles which are common to one or more other topics; have slightly high proportion in one or some other topics as well

³ Articles which are not classified to none of topics

in academia and business. In marketing, finding the proper number of topics or finding a specific topic in a database will be useful as is finding related articles to a course in the academia.

Content managers (e.g. journal and news publishers)

Using probabilistic topic model algorithms such as LDA and DTM, content manager can manage large archives of documents, discover patterns, and topic trends (Blei, 2011), and articulate insights about their databases (Blei, Carin & Dunson, 2010).

Students and scholars

Students and scholars can use the process to categorize and allocate topic-related resources to their research. We introduced a practical guide into applying techniques to replicate the results. For example, LDA has been proposed as a tool for journalism scholars to analyze archives of text (Jacobi, Atteveldt & Welbers, 2016).

1.5. Scope of research

For more insights on the content of TIM Review journal database, we apply the LDA and DTM algorithms based on Blei's papers and the description of the process in Ponweiser's thesis. Our sample data comprises all TIM Review articles. The initial processing is done by Blei's LDA algorithm and the presentation of the graphs is conducted by R scripts created by the author.

1.6. Structure of the thesis

In section 2, we provide an overview of topic modeling components, entities and distributions, and explain the assumptions underlying LDA, approximation methods, performance evaluation measures (perplexity and harmonic mean of log likelihood), and criteria for evaluating the performance of topic modeling techniques. The research method is described next. In section 4, we provide the results of applying LDA and DTM algorithms such as article and word distributions across topics, topic/theme trends, related, bridge, and unclassified articles, and word trends. In addition, we discuss the performance of LDA and DTM based on five criteria and discuss the advantages of each approach in section 5 and in the second part of the section, we provide a framework of all steps needed to replicate the results. In conclusion section, we summarize our findings and identify future work.

2. Literature review

2.1. Latent Dirichlet Allocation (LDA) and Dynamic Topic Modeling (DTM)

Latent Dirichlet Allocation (LDA) is a generative probabilistic model that applies to sets of discrete data such as collections of the text articles (Blei et al, 2003). Formally, LDA consists is three-level hierarchical Bayesian model in which each article is modeled over a set of topics and each topic is modeled over a set of word probabilities. Topic probabilities specify the proportions of each document based on their probabilities' words in the corpus. The LDA idea is to model documents over a set of topics and the topics are shaped by a vocabulary of terms (Blei and Lafferty, 2009). There are several steps to present the result of LDA examination on sample database: 1- modeling which treats the data as arising from a generative process, 2- an inference which infers the conditional distribution (posterior) of the hidden variables given the observed variables, 3- analysis which checks the fit of the model, 4- makes a prediction based on new data, 5- explores the properties of the hidden variables. Figure 1 below shows three main elements of LDA algorithm and their affiliations along with charts of words and document distributions over topics. It shows words distribution of each topic that each topic has V-dimensional multinomial (β_k) over words. Based on the values of each word of each topic, the chart of the most ranked words for each topic will have been obtained. In addition, each document (article) has a K dimensional multinomial (θ_d) over topics that the proportion of each document will be achieved.

Figure 1: Structure of observable and hidden variables in LDA

In brief, each topic is a distribution of words, each document is a mixture of corpus-wide topics, and each word is drawn from one of those topics. In fact, we only observe documents. The other structures are hidden variables. the goal is to infer the hidden variables. The LDA model consists of sets of words that manually are labeled by topics. The main goals of topic models include annotate documents, organize and browse large corpora, model topic evolution, categorize source code archives, and discover influential articles.

2.1.1. LDA assumptions

LDA is built on the following assumptions on the variables:

- Word: the basic unit of discrete data
- Document (article): as a database entity that is a collection of words
- Corpus: a collection of documents in one defined database
- Topic (abstract label): a distribution over words that the number of topics K is known.

And other assumptions that generate the topics include drawing a multinomial over words $\beta_k \sim \text{Dir}(\eta)$ for each topic and draw a document topic proportion $\theta_d \sim \text{Dir}(\alpha)$ for each document.

By applying conditions on assumptions, different methods will be achieved. The conditions can be considering the order of the words so that words in a document do not exchange such as conditioning on the previous word based on Wallach (2006) and hidden Markov model based on Griffiths et al. (2005). In addition, the conditions can be the order of documents that is dynamic LDA based on Blei and Lafferty (2006) and the condition that the number of topics is not fixed based on Bayesian Non-parametric based on Blei et al. (2010).

In this thesis, we applied Blei's standard LDA and dynamic topic model or dynamic LDA (DTM) based on Blei and Lafferty (2006). In LDA, it is assumed that the order of documents does not matter and different topics over time investigated, but in DTM, topics evolve over time and DTM uses a logistic normal distribution to model topics evolving over time. In the below figure, a graphical model of DTM shown from Blei and Lafferty (2006).

Figure 2: A graphical model of DTM (Blei and Lafferty, 2006)

For more details of distribution variable, we describe the graphical model of LDA based on Blei's lecture, (2009). As shown in the below figure α and β are corpus level parameters so that α as Dirichlet parameter is a parameter over documents and θ_d is document-level variable and $Z_{d,n}$ and $W_{d,n}$ are word-level variables. To explore a corpus, we need to investigate three main hidden variables including the topic probability of a term, topic proportions of an article, and topic assignment of a word (Blei & Lafferty, 2009).

Figure 3: Graphical Model by Blei's Latent Dirichlet Allocation (LDA)

Considering metadata of the documents (articles) such as author, geographic location, links in documents can create various model including author-topic model based on Rosen-Zvi et al. (2004) that the topic proportions are attached to authors and allows for inferences about authors

like author similarity, relational topic model based on Chang and Blei (2010) that the documents are linked using citation or hyperlink, considering the distance among the document topic proportions, or considering the model of words in documents.

2.1.2. Approximation methods (approximate inference algorithms)

The main goal of inference of documents is obtaining posterior distribution of hidden variables and approximate a conditional density of hidden variables by documents (Blei, Kucukelbir, & McAuliffe, 2017). Because of the distribution is intractable, several approximate inference algorithms such as variational approximation, and Markov chain Monte Carlo (Gibbs sampling) be applied to LDA. Text mining package in R provides two interfaces for variational expectation-maximization algorithm and Phan and co-authors' algorithm using Gibbs sampling that provides basic infrastructure for fitting topic models (Grun, & Hornik, 2011). In the research, it is used the variational approximation as used in Blei's LDA approach. Two approximate inference algorithms include:

- ***Sampling-based algorithms*** such as Gibbs sampling and based on samples from the posterior, it is approximated by an empirical distribution. The Markov chain places on hidden topic variables and Gibbs sampling algorithm run the chain and collect samples and approximate the distribution with samples.
- ***Variational algorithms*** are a deterministic alternative to sampling-based algorithms and use a collection of variational parameters over the hidden structure of corpus to find closet lower bound parameters to the posterior. Some advantages of variational algorithms include optimization problem, optimization to have a practical impact in probabilistic modeling, and easily handles millions of documents.

2.1.3. Perplexity and harmonic mean of log likelihood

There are several ways to identify an optimal number of topics for databases such as an approach to find the correct number of topics using the symmetric divergence and maximum of the divergence values proposed by Arun et al. (2010) and the perplexity score in Blei et al. (2003). To obtain the optimal number of topics, we use Blei et al. (2003) approach to interpret perplexities gained the result of R package. According to Blei et al. (2003), the minimum of perplexity among a set of tests of different topic numbers is the proper number of topics. As shown in the below

figure, Perplexity measures the modeling power by calculating the inverse probability of unobserved documents.

$$perplexity(D_{test}) = \exp \left\{ - \frac{\sum_{d=1}^M \log p(\mathbf{w}_d)}{\sum_{d=1}^M N_d} \right\}$$

Average log-likelihood of articles
Log-likelihood of each article

$\mathbf{w}_d$ represents words in document d and N_d is the number of words of document d

Figure 4: Perplexity formula based on Blei et al. (2003)

In figure 5, Blei's paper compares four algorithms on one sample corpora (AP) and obtained their perplexity to determine the proper number of topics, although the number of topics can be considered by human interpretation. In addition, Zhao et al. (2015) provided a heuristic approach to determine an appropriate number of topics by computing the maximum rate of perplexity change on the gained figure. As shown in figure 6, we obtained the harmonic mean of log-likelihood values using R packages. Due to the perplexity is equivalent to the inverse of the geometric mean likelihood (Blei et al., 2003), we used the maximum value of the harmonic mean of log likelihood.

Figure 5: Perplexity results on the AP corpora for LDA, the unigram model, mixture of unigrams, and pLSI examined at Blei et al. (2003)

Figure 6: Optimal number of topics using Gibbs sampler ($k=300$) on TIM Review dataset

Blei (2012) suggested that a number within 50 to 150 is a right number of topics, however, it depends on the size of database and content of the database. We examined number 300 to evaluate the log likelihood and obtained the optimal number of topics (47) that is maximum harmonic mean of log likelihood as shown in figure 6. Given the number of articles and database size, different topics number can be considered for examination.

2.2. The performance criteria of topic model techniques

To compare the performance of LDA and DTM, first, we need to determine several criteria based on the results of LDA and DTM approaches from previous work. The criteria vary slightly depending on the nature of the data. We searched for related issues such as journals and newspapers. For example, Mathewa, Agrawala, and Menzies (2016) has worked on 15121 papers using Tuned Latent Dirichlet Allocation to identify relevant topics and conferences and look at terms in topics to label topics, and Blei et al., (2003) compared LDA to a mixture of unigrams model and the probabilistic LSI model using scientific 5,225 abstracts and a subset of 16,333 articles based on document modeling to evaluate generalization performance of these models.

We also overviewed some topic-model-related studies to identify most related criteria to examine and compare the performance of LDA and DTM. Zhou, Yu, and Hu (2017) examined three categories of topic evolution including the discrete time topic evolution model, the continuous time topic evolution model, and the online topic evolution model to provide comparative experimental results. To compare the performance of LDA and other topic models,

there are some evaluation methods that Zhou, Yu, and Hu (2017) mentioned including the model's generalization power that is based on perplexity to identify the number of topics, topic similarity identification that is based on symmetric divergence for measuring the similarity of a pair of topics, and topic evolution identification that is topic evolution evaluation results. Furthermore, Erosheva, Fienberg, & Lafferty, (2004) explored an internal soft-classification structure of abstract of articles that is a fixed number of internal categories with multinomial distributions over words and references. Blei and Lafferty (2006) compared three topic models to predict including DTM, LDA-prev that is a static topic model estimated on just the previous year's articles, and LDAall that is a static topic model estimated on all the previous articles. In addition, Günnemann et al. (2013) examined two collections of articles based on criteria including topics analysis, topic ranking (relevance of the topics), presentation of document analysis, and presentation of word analysis. Furthermore, Daud et al. (2010) mentioned three main challenges to provide a better understanding of the topics hidden in the corpus including finding hidden structures of corpus, identify proper relations among documents, researchers and social networks, providing time stamps to illustrate trends of topics and documents, and labeling documents to better predictions.

Identify the performance criteria

The criteria are selected based on the weaknesses and strengths of the two algorithms where the user seeks out the insight of his data that include: i) topics achieved and themes. ii) topic trends in addition to positive and negative trends iii) related articles, bridge and unclassified articles per topic. iv) word trends and their combination. v) runtime. We will examine the results of both algorithms based on these five criteria and discuss how each approach can provide better performance.

3. Research method

Table 1 shows the steps of the research method followed.

Step	Activity undertaken to produce deliverables	Outcome of the activity
1	Review Blei's LDA and dynamic topic model (DTM) based on LDA	Learn about using algorithms and distributions
2	Data Preparation: collect and refine/scrub TIM Review database	<ul style="list-style-type: none"> • Structured dataset • Documentation and procedures applied
3	Application: generate required files, words distribution over topics and document distribution over topics, to interpret related, bridge, and unclassified articles and topic/word trends	<ul style="list-style-type: none"> • Documentation and procedure for model evaluation and fitting parameters and settings
4	Visualization: <ul style="list-style-type: none"> • Design a strategy to specify related and bridge articles to each topic • Analyze topics/themes and word trends • Compare the performance of LDA and DTM approaches based on defined criteria 	<ul style="list-style-type: none"> • Topic trends • Theme trends • Word trends • Documentation of interpretation and visualization of topic, theme, and word trends
5	Guideline and integrate insights developed in previous steps to articulate a repeatable process: <ul style="list-style-type: none"> • Provide a detailed procedure to prepare raw data, estimate, interpret, and visualize results obtained from algorithms published by Blei et al. (2003), Blei & Lafferty (2006), and Ponweiser (2012) descriptions • Explain to users how to find proper number of topic, generate topic trends, labeling, and interpreting themes 	<ul style="list-style-type: none"> • Procedure • Guidelines

Table 1: Algorithms implementation settings

3.1. Overview topic models

Modularity and extensibility are two advantages of generative models such as LDA. In addition, there are multiple extensions extracted from LDA such as continuous data, non-multinomial data, or other mixture models (Blei et al., 2003). For example, we could model topics based on time slices or document exchangeability on one slice as well as on partial of articles. Furthermore, according to Blei and Lafferty (2009), there are two advantages of the generative probabilistic approaches such as LDA and DTM compared to non-probabilistic methods such as LSI and non-negative matrix factorization: they are easy to use for new articles, LDA-like models can be used as a component in processes, and the models are generally in use of various discrete data such as images, social networks etc. It is analyzed the archives of the journal Science from 1880 to 2000 in Blei and Lafferty (2006) using dynamic topic model and examined the results including the top

ten words of the topics, the frequency of several words from the same topics, article distribution across topics, and some words trends.

3.2. Data preparation

There are several ways to catch text of articles from journals such as web scraping through text processing tools that used in Ponweisor (2012) thesis or access to databases directly. We have retrieved collection of articles and metadata directly from the database including whole text of an article, author, publication date, and title from TIM Review database using SQL queries. Using Python and codes, it is removed stop words and refined all texts. For better data analysis, preprocessing raw data to suitable formats for analysis tasks is required and the data must be converted to partitions to have a more efficient analysis (Zhao & Cen, 2013).

Document-term matrix is generated based on the frequency of words in each document in the corpus and TermDocumentMatrix class in R (tm package) uses matrices for corpora and matrices can be filtered by the count of the frequency of words by filter functions such as findFreqTerms function (Feinerer, 2017). LDA-based algorithms need a document-term matrix file as input file. Using a C converter function, it is generated a document-term matrix file along with word index file and articles' ID file (see "Model Input of LDA and DTM" in the Results section and figure 10). In addition, we considered some assumptions to generate a document-term matrix including the minimum word length that is 4, the whole text of articles - abstract and body of an article, minimum of a count of the word per article that is 1, the order of articles based on the date of issues. In the below table, it is provided algorithms implementation settings for execution.

Assumptions	Applied in the research
Number of articles	597 of TIM Review articles published from 2007 to 2017
Remove punctuation, numbers	Done
Stop words	Standard stop list including names, numbers, individual characters, and some function words"
Tokenization	Done
Stemming	NO
Minimum word length	4
Minimum count of words per article	1
Minimum number of documents per words to compute tf-idf scores	1
Vocabulary size	43768

Table 2: Algorithms implementation settings

3.3. Application

3.3.1. Topic modeling

The LDA considers two main variables: observed data that are words in articles, and hidden variables that represent the latent topics. Topical classification of a collection of articles is determined by the posterior distribution of hidden variables and topic models use posterior estimates of hidden variables to data retrieval and documents classification (Blei & Lafferty, 2009). A hidden topic in a corpus arises from hidden variables posterior distribution using observed words in documents. To run Blei's LDA algorithm, we need to determine two main parameters including alpha parameter and number of topics. we considered 0.1 value for the alpha parameter and obtained 47 of a set of a number of topics that is a maximum of the mean log-likelihood using an R function which generates a figure of the mean log-likelihood of different number topics. as well as we need to approximate the posterior distribution using an approximation technique such as variational inference algorithm that used in our research.

3.3.2. LDA and DTM algorithms settings

To model latent topics by Blei's LDA algorithm, we need to compile open source C files and set some parameters to estimate topics in a corpus. The algorithm parameters include alpha value, number of topics, and setting file which consists of variational inference maximum iteration, variational inference convergence, variational EM maximum iteration, and variational EM convergence.

After compiling c file and generate an execution file, the execute file produces gamma and alpha variables that are the values of documents and words distribution across topics. The below command is an executive command to obtain the results of LDA algorithm with $\alpha = 0.1$ and setting file that consists of parameters including "var max iter [integer e.g., 10 or -1]", "var convergence [float e.g., 1e-8]", "em max iter [integer e.g., 100]", "em convergence [float e.g., 1e-5]", and "alpha [fit/estimate]".

```
➤ ldacmaster.exe est 0.1 47 .\lda-c-master\settings.txt .\lda-c-master\example47\txtfilesnew.dat  
random .\lda-c-master\example47
```

Other arguments include est = estimation, $\alpha = 0.1$ that can be a number between 0 and 1 and when the value be close to 0 means the topics are very similar or have more common words,

the number of topics = 47, setting.txt file, and “random/seeded/manual=filename/*” that “random” initializes each topic randomly.

3.4. Visualization

3.4.1. Analyzing the results

In order to generate graphs and data tables, we use R environment for converting the results of LDA and DTM algorithms to displayable CSV files. Moreover, we generate various graphs and data tables based on produced CSV files so that can be replicate easily by others. These functions visible in appendixes IX, X, and XI.

3.4.2. Visualizing the results of LDA and DTM

There are several exploratory tools that provide graphical user interfaces for end-users to explore topics in a collection of texts. While most of these tools use a static topic model such as LDA, Derntl et al. (2014) provide a web-based application to explore topics using a dynamic topic model in reasonable runtime. In this research, two methods of LDA and DTM have been used to explore topics and their trends. The topic probability of term, the topic proportion of document, and topic assignment of the word are three hidden variables in LDA and DTM that provide initial data for visualization. Chuang, Manning, & Heer (2012) presented a visual analysis tool (Termite) which uses a layout to compare a term across topics and within topics; they found a clustering structure of related terms to identify coherent and significant themes.

To analyze topic trends, there are two popular ways to explore the posterior topics through term probabilities of each topic. We use term probabilities per topic to visualize topics as well as obtain TFIDF (term frequency – inverse document frequency) term scores of each topic. In addition, we categorize topics to themes and provide theme trends in both approaches as well.

To specify articles on each topic, we use topic proportions of articles to illustrate most associated articles per topic and these articles what in case and topics. we examine related, bridge, and unclassified articles of each topic.

To illustrate word trends, we use word and document distribution across topics to show word trends, word-document, and word-topic graphs.

3.4.3. Analyzing trends and distributions

After converting results of LDA and DTM algorithms to CSV files and generate graphs and charts, we analyze topic words and topic words to label topic and then interpret topic trends. To further examine the trends, we also interpret related articles per topic in different years. We also examine topic proportion to articles, related, bridge and unclassified articles, word trends, and runtime of LDA and DTM algorithms. To better understand the performance of the two approaches, we consider five criteria for comparing two methods.

3.5. Guideline and integrate insights developed in previous steps to articulate a repeatable process

We compare the results of LDA and DTM approaches based on criteria including i) topics achieved and themes. ii) topic trends in addition to positive and negative trends iii) related articles, bridge and unclassified articles per topic. iv) word trends and their combination. v) execution time. In addition, we provide a detail process to replicate the results.

4. Results

4.1. Preparing files to run LDA and DTM algorithms

We determine the optimal number of topics by computing the harmonic mean of the log-likelihood function that is equivalent to the inverse of the perplexity (Blei et al., 2003). We considered five points to the right number of topics that the point 47 is the maximum value (figure 6). There are other likely numbers of topics, points 10, 17, 30, 37 that can be considered to run the LDA and DTM algorithms. The harmonic mean R function is included in appendix VIII.

We divided the process of generating topic models into three main layers, data preparation, application, and visualization. In data preparation layer, we retrieved data from the dataset and generated input files to execute LDA and DTM algorithms that it is designed in three steps including retrieving text from database, text files' preparation and generate LDA inputs by Python codes. In the below figure, we created a query on TIM Review database and fetched metadata and content of articles; metadata include ItemId (NodeId) or ID of the article, URL, date of the article published, issue titles, article's title, abstract, author.

NodeID	URL	YearMonth	title_issue	title_article	abstract
411	http://timreview.ca/article/411	201101	January 2011: The Business of Open Source	Private-Collective Innovation: Let There...	Many innovators (companies or indiv...
412	http://timreview.ca/article/412	201101	January 2011: The Business of Open Source	Control in Open Source Software Develo...	In this article, we examine typical fe...
413	http://timreview.ca/article/413	201101	January 2011: The Business of Open Source	Nokia's Hybrid Business Model for Ot...	In today's challenging economy, star...
399	http://timreview.ca/article/399	201012	December 2010: Humanitarian Open Source	Humanitarian Free and Open Source Sof...	Humanitarian free and open source s...
400	http://timreview.ca/article/400	201012	December 2010: Humanitarian Open Source	Developing a Service Industry to Suppor...	The Sahara Software Foundation oc...
403	http://timreview.ca/article/403	201012	December 2010: Humanitarian Open Source	Emerging Open Source Health Informati...	OpenMRS is a rapidly growing open s...
393	http://timreview.ca/article/393	201011	November 2010: Economic Development	Major Events: Good Economics and Exp...	Major events of all kinds, especiall...
401	http://timreview.ca/article/401	201012	December 2010: Humanitarian Open Source	IEEE Humanitarian Projects: Open Hard...	An opportunity to solve some of the...
404	http://timreview.ca/article/404	201012	December 2010: Humanitarian Open Source	The Humanitarian FOSS Project	The Humanitarian Free and Open So...
405	http://timreview.ca/article/405	201012	December 2010: Humanitarian Open Source	TriSano: Collaborating for the Good of G...	Healthcare and public health continu...
454	http://timreview.ca/article/454	201107	July 2011: Women Entrepreneurs	Which Gender Differences Matter for Hi...	With data from successful founders...
443	http://timreview.ca/article/443	201105	May 2011: Technology Entrepreneurship	Proving the Expertise of Freelance Andr...	Android continues to grow in popular...
388	http://timreview.ca/article/388	201010	October 2010: Sales Strategy	Strategies for Selling Services	With the service economy on the asc...
378	http://timreview.ca/article/378	201009	September 2010: Keystone Companies	Deals Without Borders: A Value Propositi...	The Ottawa Centre for Research and...
455	http://timreview.ca/article/455	201107	July 2011: Women Entrepreneurs	Building an Infrastructure to Support W...	This article describes a new program...

Figure 7: Sample of the result of a query on TIM Review database

After refining the content of each article using Python functions, stop words, images and HTML tags, and unnecessary tags and links are removed. Another Python algorithm generated required input files to run LDA and DTM algorithms by use of refined files. As shown in figure 8, the

algorithm generated a list of text files and refined words of each article. Each file name has a specific format that shown figure 9.

Figure 8: Sample of refined text article with ID 82

Figure 9: Sample of text file name format

The below command is a Python command that executes a Python code for converting raw text to LDA input files.

➤ `Python .\text2lda\text2lda.py .\text2lda\input -o .\output`

Python file “text2lda.py” runs with two arguments including a folder containing a list of refined files obtained from database and output folder that will contain LDA and DTM input files.

Model Input of LDA and DTM

After running the conversion algorithms, we obtained three main files to feed into LDA and DTM algorithms including `?.dat` (`txtfilenew.dat`): each document is succinctly represented as a sparse vector of word counts and each line is of the form: `[M] [term_1]: [count] [term_2]:[count] ... [term_N]:[count]`, `?.vocab` (`txtfilenew.vocab`): list of all tokenized words in corpus, and `?.dmap` (`txtfilenew.dmap`): list all articles (documents) IDs.

LDA assumes that all words are exchangeable and order of words in documents is not important (Blei et al., 2003). Using a tokenizing algorithm, the frequencies of words in articles are captured. Figure 10 shows relations among three input files ?.vocab, ?.dat, and ?.dmap and illustrates a sample of details of produced numbers such as the number of words in each article, the index of the word, and the frequency of the word. In addition, we added ?.dmap in the list of input files to denoted ID to the article. The algorithm identified 43768 unique words from 597 articles in the corpus (TIM Review database).

Figure 10: Relations of two required input files and IDs file

4.2. Run LDA and DTM algorithms

To run the LDA and DTM algorithms, we need three input files that were mentioned in the previous section and minimal hardware including a laptop with at least 2G RAM and 3G free space to save results.

Output files of LDA and DTM

The results of LDA will be saved in output directory with files including `<iteration>.other` contains alpha values, `<iteration>.beta` contains the log of the topic distributions and likelihood bound and convergence score at each iteration, and `<iteration>.gamma` which consists of variational posterior dirichlet. The structure of output files of LDA and DTM are slightly different

that is needed to consider different R functions to convert the results. The algorithm runs until the score is less than "em_convergence" or "em_max_iter" iterations are reached. We use final.gamma to fetch documents associated with topics and final.beta to fetch most ranked words of topics. In addition, we converted the results LDA and DTM using R code to CSV files including a matrix of words probabilities per topic to illustrate word and topic trends and a matrix of topic proportions to articles to illustrate most associated articles per topic, examine the thresholds and accuracy of association.

4.3. Distribution of articles across topics

In LDA:

Using final.gamma gained from the result of LDA algorithm, we obtained the proportions of each article to 47 topics. By getting the average of the proportions of all articles of each topic, the weight of each topic in the corpus is obtained. In figure 11, weights of 47 topics are compared. Topics 16,28,29,30 have more weight among topics.

Figure 11: Weight of topics in corpus and weight of topics with the proportions more than 0.9

In addition, we examined the weight of articles with more than 0.9 proportion that just there is one topic with high weight (topic 28: open-source-product-community).

Articles are sorted by their proportions per topic as shown in Appendix I. We considered the 20 first articles in these lists to illustrate most associated articles on each topic. Here we showed two

main topics gained from results of LDA algorithm. As shown in table 3, open-source-software-product (topic 16) consists of the 19 most associated articles which have proportions more than 0.6 (60 percent) that means the topic has high proportion compare to other gained topics as well as open-source-project community (topic 28) has 18 the most associated articles with the proportions more than 60 percent (table 4). Furthermore, topic 28 has more associated articles with 90 percent or more compared to other topics. As shown in figure 11, the weight of topic 28 is more than other topics based on the proportions of articles with 90 or more percentage.

ItemId	The most associated articles to topic 16: Open source-software product (Open source)	Year	Prop
220	The Benefits to ISVs of Working with Large Enterprise Consumers on Open-Source Projects	2009	0.9994
177	Is Open Source Right for your Library?	2008	0.9635
756	The Business of Open Source Software: A Primer	2014	0.9606
365	Improving Product-Market Fit by Engaging an Open Source Community	2010	0.958
84	Building an Open Source Company One Penguin at a Time	2007	0.9545
644	Code Forking, Governance, and Sustainability in Open Source Software	2013	0.9401
63	QNX Hybrid Software Model	2007	0.8718
74	Defining Open Source	2007	0.8656
234	Geospatial: An Open Source Microcosm	2009	0.8644
147	Open Source Software for Corporate IT	2008	0.8459
385	Differentiating Community from Customers in an F/LOSS Business	2010	0.8414
336	The State of Free Software in Mobile Devices	2010	0.788
67	Comparing the BSD and GPL Licenses	2007	0.7663
173	OSS Spending Trends in Education	2008	0.7161
441	Lessons from an Open Source Business	2011	0.6954
65	Open Source Licensing in the Enterprise	2007	0.6911
413	Nokia's Hybrid Business Model for Qt	2011	0.6794
286	Open Source: Shifting Buying and Evaluation Patterns of BI Users	2009	0.6722
691	Introducing "Business Source": The Future of Corporate Open Source Licensing?	2013	0.625
408	Cost Optimization Through Open Source Software	2011	0.5968

Table 3: Most associated articles to open source- software product

ItemId	The most associated articles to topic 28: Open source-project community (Open source)	Year	Prop
256	An International Look at Women in Open Source	2009	0.9995
261	The GNOME Foundation Is All About People	2009	0.9994
317	Community 101	2010	0.9994
258	Lessons on Community Management from the Open Source World	2009	0.9994
260	Community-Built Software: What I Learned from Calagator	2009	0.9994
263	Offline: Where Tech Communities Succeed With Women	2009	0.9993
257	The Human Factor in Open Source	2009	0.9992
264	So Are You A Contributor?: Women's Contributions to Linux and Open Source Span Technology and Business	2009	0.9988
222	The Role of Consumers Within an Open Source Community	2009	0.9973
272	A Model for Sustainable Student Involvement in Community Open Source	2009	0.9954
316	Open Source User Assistance: Ensuring That Everybody Wins	2010	0.9837
210	Experiments, Expertise and Google Summer of Code (TM)	2008	0.9465
315	How the FreeBSD Project's Processes Help Companies Build Products	2010	0.906
319	Developing a Successful Open Source Training Model	2010	0.7958
332	Low Cost Cellular Networks with OpenBTS	2010	0.7147
369	Open to Everyone: How Open Source Communities Can Benefit from Diversity Without Disunity	2010	0.7138
214	Creating Disruptive Value For Not-For-Profit Organizations Using Open Source	2008	0.7018
69	Free as in Adjective, Not as in Verb	2007	0.6912
223	So You Wanna be a Linus Torvalds? The Do's and Don'ts of Running a Small Open Source Project	2009	0.5938
195	Community Building: NetBSD in Hindsight	2008	0.5768

Table 4: Most associated articles to open source- project community

In these lists, those are marked with orange and light orange as bridge articles, and those are changed their text color to gray as unrelated articles to the topic (see Appendix I).

In DTM:

As in the LDA approach and using gam.dat gained from the result of examination of DTM algorithm, we obtained the proportions of each article to 47 topics. By getting the average of the proportions of all articles of each topic, the weight of each topic in the corpus is obtained. In figure 12, weight of 47 topics are compared. As shown in below figure, topics 25,45,6,12 have more weight among topics.

Figure 12: Topic weight in corpus and weights with the proportions more than 0.5

Living labs-development-process (topic 25) has the most weight with a big difference to other topics and entrepreneur-startup (topic 6), entrepreneur-global-startup (topic 12), and open-source-software-product (topic 45) topics are in the next place. Here we examined the most associated articles of topic 25 and 12. As shown in table 5 and 6, the first 20 articles of two topics have high proportion and almost all of them are associated with the topics. All lists of articles shown in Appendix II.

ItemId	Topic25: Living Labs - Development Process	Year	Prop
1046	Categorization of Innovation Tools in Living Labs	2017	0.953796
951	Places and Spaces within Living Labs	2015	0.908882
1055	Reflecting on Actions in Living Lab Research	2017	0.894477
1056	Action Research as a Framework to Evaluate the Operations of a Living Lab	2017	0.885845
740	Coordination and Participation in Living Lab Networks	2013	0.866339
748	Linking Living Lab Characteristics and Their Outcomes: Towards a Conceptual Framework	2013	0.854541
952	Contextuality and Co-Creation Matter: A Qualitative Case Study Comparison of Living Lab Concepts in Urban Research	2015	0.853266
958	Urban Living Labs for Sustainability in Suburbs in Need of Modernization and Social Uplift	2016	0.849333
1048	Heading for a FALL: A Framework for Agile Living Lab Projects	2017	0.826517
957	Enhancing Early Innovation in an Urban Living Lab: Lessons from Espoo, Finland	2016	0.811403
603	Mapping Living Labs in the Landscape of Innovation Methodologies	2012	0.811302
1054	Overcoming Barriers to Experimentation in Business-to-Business Living Labs	2017	0.810525
960	The Evolution of Intermediary Activities: Broadening the Concept of Facilitation in Living Labs	2016	0.804936
749	How Do We Keep the Living Laboratory Alive? Learning and Conflicts in Living Lab Collaboration	2013	0.804537
741	The Habitation Lab: Using a Design Approach to Foster Innovation for Sustainable Living	2013	0.803469
744	A Living Lab as a Service: Creating Value for Micro-enterprises through Collaboration and Innovation	2013	0.791205
956	The Impact of Living Lab Methodology on Open Innovation Contributions and Outcomes	2016	0.790827
1047	Taking Real-Life Seriously: An Approach to Decomposing Context Beyond "Environment" in Living Labs	2017	0.790695
1049	The Design-Driven Living Lab: A New Approach to Exploring Solutions to Complex Societal Challenges	2017	0.765332
607	Living Labbing the Rotterdam Way: Co-Creation as an Enabler for Urban Innovation	2012	0.763589

Table 5: Most associated articles to living-labs-development-process

ItemId	Topic12: Entrepreneur-Global Startup	Year	Peop
1073	Lean Internationalization: How to Globalize Early and Fast in a Small Economy	2017	0.710893
532	Global from the Start: The Characteristics of Born-Global Firms in the Technology Sector	2012	0.674047
1072	Is There a Lean Future for Global Startups?	2017	0.649853
1077	Initiating a New Research Phase in the Field of International Entrepreneurship: An Interview with Professor Nicole Coviello	2017	0.645062
557	An Overview of Four Issues on Technology Entrepreneurship in the TIM Review	2012	0.637902
1063	Hybrid Entrepreneurship: How and Why Entrepreneurs Combine Employment with Self-Employment	2017	0.632744
521	Entrepreneurial Effort in the Theory of the Firm	2012	0.619647
941	The Emergence of the Lean Global Startup as a New Type of Firm	2015	0.618183
520	Technology Entrepreneurship: Overview, Definition, and Distinctive Aspects	2012	0.614418
845	Cybersecurity Startups: The Importance of Early and Rapid Globalization	2014	0.595179
454	Which Gender Differences Matter for High-Tech Entrepreneurship?	2011	0.562042
1023	Entrepreneurial Growth Ambitions: The Case of Finnish Technology Startups	2016	0.540877
618	Market Channels of Technology Startups that Internationalize Rapidly from Inception	2012	0.524957
614	What Technology Startups Must Get Right to Globalize Early and Rapidly	2012	0.521406
880	Do Actions Matter More than Resources? A Signalling Theory Perspective on the Technology Entrepreneurship Process	2015	0.503689
555	Making Money from Exploiting Schumpeterian Opportunities: John Sanguinetti and the Electronic Design Automation Industry	2012	0.49043
692	From Ideas to Opportunities: Exploring the Construction of Technology-Based Entrepreneurial Opportunities	2013	0.479454
656	Key Factors Affecting a Technology Entrepreneur's Choice of Incubator or Accelerator	2013	0.474012
1007	Corporate Entrepreneurship: A Review and Future Research Agenda	2016	0.459471
826	Conceptualizing Innovation in Born-Global Firms	2014	0.458612

Table 6: Most associated articles on entrepreneur-global-startup topic

4.4. Distribution of words across topics and topic labeling

Topic words obtained from LDA approach

Using the R algorithm, we extracted the word distributions for all 47 topics and labeled each topic with these words. Table 7 shows 20 top words of each topic along with determined topic label and total amount of topic proportions to articles (Prop⁴). The 20 top words are sorted by their probabilities (Prob⁵) gained from the result of LDA algorithm in final.beta file. we categorized the topics into 10 themes.

Topic No	20 top Words	Topic Label	Prop
1	security system risk device cybersecurity vulnerability user threat information medical attack value control example model manufacturer access stakeholder also data	Cybersecurity-Threat-Risk	10.7
2	entrepreneur organization model service business innovation social crowdfunding design also platform agent development enterprise idea india practice successful product support	Entrepreneur-Enterprise	8.89
3	device field trial design study system technology attrition group also workshop application test world research business user participant organization would	Test-device-Application	9
4	user knowledge uncertainty research product company environment need activity study benefit environmental scale innovation public community idea lead development good	Lead-product-development	7.11
5	company customer startup market sale product process solution technology design entrepreneur case service need problem business early frugal value support	Entrepreneur-Startup	12.2
6	security information system f/loss business risk organization definition network threat cybersecurity trust control software action architecture attack process data example	Cybersecurity-OSS-Attack	10.7
7	business ecosystem model platform value community eclipse entrepreneur actor research design system technology different risk resource company developer innovation component	Ecosystem-business-value community	10.1
8	knowledge process project research urban development collaboration trust team organization university innovation also area actor role management network work integration	Research-Collaboration	10.7
9	knowledge entrepreneur social translation research change process problem health opportunity sustainable strategy need risk action well-being support organization development value	Research-Social	9.53
10	service research case data study industry analysis lean development cooperation process used model botnet procurement automation enterprise takedown engineering implementation	Co-Creation-Lean development	7.61
11	government data business information technology access software need people many canada public problem solution cost open challenge canadian citizen system	Technology-Data-Open challenge	15.3
12	firm marketing model business technology adoption resellers product patent market coercive channel patent-holding supplier value customer cybersecurity decision relationship digital	Adoption-Value customer	5.51
13	living_lab innovation user project process case research open network living study different stakeholder activity context development service also real-life co-creation	Living_lab-Innovation-project	19.5

⁴ Topic proportion to articles

⁵ Topic probability to words

14	data information service system privacy design smart individual security control device process also technology user grid trademark healthcare used provide	Cybersecurity-Data service system	7.92
15	research service open content community knowledge project innovation institution system education government information learning data university resource work support employee	Open source-content community	13.9
16	software open_source product community source open license project company support business vendor application code proprietary user development commercial customer solution	Open source-software product	42.6
17	problem company event innovation simulation business quebec open people solutions solution process idea market large first also lead local session	Innovation-Local innovation	10.4
18	ecosystem platform mashup apis business network customer model provider malware supplier research data process technology keystone used would service example	Ecosystem-Platform-network provider	12.8
19	data solution system tool customer application frugal time pattern problem business waiting service model software used market open_source digital park	Open source-data solution	10.1
20	crowdsourcing crowd research data cybersecurity technology domain example challenge used learning theory information science specific system problem focus also security	Cybersecurity-Crowdsourcing	8.72
21	value customer model business co-creation company product user creation service consumer process research need proposition platform market production community firm	Co-creation-value customer	17.2
22	process product project fiat would legitimacy time idea design creative also concept people need work development management many swatch knowledge	Growth-Legitimacy process	8.77
23	entrepreneur university technology india research business hybrid program development policy indian industry also science student defect country level spinoffs government	Entrepreneur-Academic Research	11.8
24	project living_lab user research innovation process context work system tool activity study different member action phase also panel decision framework	Living labs-Projects	9.51
25	city innovation citizen knowledge service process platform smart luxury creative collaborative public business urban also development organization different stakeholder ecosystem	Innovation-Public-Society	8.14
26	cybersecurity infrastructure design model critical project maturity provider word-of-mouth management capability organization process system small principle industry electronic connection security	Cybersecurity-design infrastructure	7.23
27	patent technology business company value property information strategic intellectual invention market right evaluation prior firm knowledge asset application potential relevant	Technology-value IP	9.84
28	project community open_source user developer people work software student code many need help support development member time team also open	Open source-project community	30.3
29	innovation company firm business ecosystem product knowledge open development strategy network process market resource industry case actor collaboration different customer	Innovation-Firm-Open innovation	23.6
30	company ecosystem business platform member technology customer development model value project service opportunity revenue product market entrepreneur keystone program organization	Ecosystem-business platform	25.8
31	health technology healthcare system patient information care research process organization service challenge also project need market commercialization development time standard	Technology-Patient	11.8
32	creative idea innovation process research activity management applied organization work student team value different individual firm type business organizational employee	Innovation-Creative Idea	9.17
33	social innovation organization tool problem work open sector change people solution process technology community collaboration need data model partnership project	Ecosystem-Social innovation	16.2
34	supply_chain company network technology information value vulnerability organization figure innovation management resilience business data field partner competitive process participant different	Technology-value network	9.32
35	work club data power organization device information electric vehicle license type also copyright bicycle intention mobile technology member theory sharing	Open source-Organizing	8.48
36	service customer data provider value communication business solution security experience company information system mobile process quality cost saas market product	Open source-Data service provider	12.2
37	project process system design management incubator cider tool route research development application engineering stakeholder accelerator data technology goal production step	Accelerator-Project process	8.09
38	mobile application device gamification system user case service game woman technology network successful entrepreneur business process study founder experience android	Entrepreneur-successful gamification	8.53
39	social value woman process creative co-creation actor system level online world network information safety future deal people example kibs personal	Co-creation-Social value	9.22
40	firm entrepreneur technology innovation employee research business project service activity relationship investment management value also development study process context theory	Entrepreneur-Internal activities	13.7
41	region innovation woman development ecosystem process program research local university national business culture support activity organization need system global strategy	Ecosystem-Native Actors	9.54
42	network entrepreneur growth venture firm capital knowledge innovation social investment market corporate stage resource company business funding fund startup development	Growth-network-venture	10.7
43	startup firm global entrepreneur market business lean international technology research product born-global internationalization venture early model network customer resource development	Entrepreneur-Global Startup	14.1
44	game software system online user development industry computer open_source service server information project platform university access many also developer operating	Open source-Game software	13.4
45	process business capability cloud function firm technology management computing change organization improvement need application product cost maturity demand performance level	Growth-Capability-Improvement	11.4
46	open_source project software open development model code source hardware company community design governance standard developer tool license process business control	Open Source-Development	20
47	license software code open_source product project user work licensed organization case consumer copyright legal source free many licensing element also	Open Source-License	15.5

Table 7: List of 20 top words, labels and weights of topics achieved by LDA

Topic labeling

In addition, to improve labeling, we provided word clouds of the bag-of-words that give us better abstraction and relations of words in each topic. As shown in figure 13, we can find main words in topic 1 and 28 such as security, risk and vulnerability words in topic 1 and community, software, and development in topic 28. Topic 16 has not any important word, however, there is a relation between product, development, and application words that can consider as the topic label.

Figure 13: Word clouds of topics 1, 16, 28 in LDA

Topic 1	security system risk device cybersecurity vulnerability user threat information medical attack value control example model manufacturer access stakeholder also data
Prob	0.027634574, 0.013550794, 0.013495538, 0.013387091, 0.009621068, 0.008409906, 0.00642709, 0.006237623, 0.006017718, 0.005881627, 0.0058195, 0.005731776, 0.005481023, 0.004940107, 0.004358688, 0.004246153, 0.004205355, 0.003980066, 0.003905083, 0.003819955

Table 8: Top 20 words and probabilities of topic 1

Table 8 as a sample of probabilities of words of topics shown the difference of values of words in topic 1 and a corresponding image of the topic word cloud in figure 13.

Topic words obtained from DTM approach

Like LDA, we run DTM algorithm with 47 topic number and 0.1 alpha value, however, we obtained somewhat different topic words and weights. Due to the similarities of the topics of LDA and DTM approaches, we have corresponded DTM topics to the topics obtained by LDA.

Topic words are listed in below table and as the same way of LDA, the topics are labeled by high-probabilities words and word clouds.

Topic No	Ranked 20 topic's words of first year	Topic Label	Prop
1	research researcher knowledge collaboration transfer study practice intermediary case publication tool health translation strategy academic mobilization smes planning support would	Research – knowledge-collaboration	4.7
2	open enterprise company innovation partner case development industry technology service firm process simulation model customer collaboration cooperation smes market external	Innovation- firm-open innovation	6.9
3	ecosystem company business keystone member value niche lead player role provides organization supplier health compete model technology around world section	Co-Creation-Lean development	7.6
4	field trial factor test survey dimension participant technology culture user bias search figure component competitive application context national management correlation	Research - Test-Application	3
5	creative idea world process team individual work thinking human online environment behaviour safety condition future think people knowledge time organizational	Innovation-Creative Idea	6
6	company product customer market business offer solution cost model sale revenue strategy companies technology value benefit need money sell competitor	Entrepreneur-Startup	31
7	phase marketing customer test supplier action intention technology model resellers adoption subject behaviour user study process agent selling mode advertising	Adoption-Value customer	4.2
8	public citizen city innovation uncertainty collaborative environmental sector scale smart government environment organization stakeholder collaboration study decision intermediary pilot service	Innovation-Public-Society	3.6
9	network knowledge innovation actor social process change resource relationship role technological interaction sharing collaboration venture institution type organization organizational networked	Entrepreneur-Enterprise	6.1
10	information system domain network decision analysis data peer threat dynamic layer making device search dashboard attack architecture host detection example	Cybersecurity-OSS-Attack	4.3
11	region local program development transformation innovation support university incubation national collaborative centre global collaboration partnership activity shared cluster networking around	Ecosystem-Native Actors	6.1
12	entrepreneur startup technology firm founder opportunity venture global market business early capital successful international growth resource incubator theory support internationalization	Entrepreneur-Global Startup	29
13	service provider customer experience electronic local proximity word-of-mouth communication small solution virtual legitimacy information pattern problem connection medium travel interaction	Entrepreneur-Startup	3.8
14	platform stakeholder model program development business opportunity technology group company lesson provide economic decision owner kots help revenue participant support	Ecosystem-business-value community	6.4
15	design service innovation logic employee problem methodology work sector sustainable organization manufacturing outcome result used study implementation procurement change observation	Accelerator-Project process	5.4
16	group competition participant workshop centre team business organization design building would health identity campus developed shopping service participatory individual facility	Research-Collaboration	1.7
17	security vulnerability defect code system information risk program control threat analysis problem osvdb error access report result attack language would	Cybersecurity-Threat-Risk	8
18	data information health system healthcare access technology device power care patient solution record challenge provide mobile medical management application also	Technology-Healthcare	11
19	student content university education learning course educational institution project resource open technology program access initiative developing development country world school	Open source-content community	11
20	crowd crowdsourcing actor risk value business resource firm relationship process kibs biotechnology pharmaceutical task strategic category engagement type different client	Cybersecurity-Crowdsourcing	3.3
21	organization business process management technology need maturity capability change product function must level solution requirement team required improvement firm within	Growth-Capability-Improvement	14
22	eclipse platform deal ecosystem collective member common business system foundation individual asset resource modularity base architecture participation technology player research	Ecosystem-business-value community	6.7
23	risk value device cybersecurity botnet stakeholder action club medical step takedown route cider type blueprint legal sourcing dimension design group	Living_lab-Innovation-project	3.7
24	event problem idea innovation solution company open solutions world solve people international quebec first knowledge collaboration session adaptive local process	Innovation-Local innovation	4.8
25	process need development also open technology different project important work tool first many within organization level time people well result	Growth-Legitimacy process	173
26	hardware device software project technology netbsd code design free humanitarian could documentation tool component volunteer developer first book problem radio	Open Source-Development	7.2
27	software license f/loss open_source source code open copyright free right work commercial proprietary program licensing used legal public term project	Open Source-License	30
28	service application computing cloud communication provider customer infrastructure vendor value model channel business capability digital quality saas cost market relationship	Open source-Data service provider	11
29	model score good impact economy economic global public private direct entity benefit high path example marketplace society figure analysis infrastructure	Entrepreneur-Academic Research	4.5
30	value co-creation customer business model creation research product firm chain company framework component service resource proposition point offering relationship practice	Co-creation-value customer	12
31	user data computer internet network authentication device used system text server online voice consumer mobile access password however card using	Cybersecurity-Data service system	5.3
32	social people woman organization change work business sector world entrepreneur impact support success opportunity family need poverty population client among	Ecosystem-Social innovation	12
33	model digital partnership partner constellation research cgbp adoption omeka applied library funders collection skill evergreen platform college blog work crowdfunding	Technology-value network	2.5
34	development industry internet game standard market china online product computer chinese developer company service partner design video growth hardware physical	Open source-Game software	4.3
35	open_source project developer member work code people foundation community software system team governance release gnome contributor contribute linux contribution google	Open source-project community	16
36	mobile device platform phone android network alliance symbian manufacturer space firm area theory decision supplier outsourcing industry work landscape governance	Entrepreneur-successful gamification	2.7
37	community member user communities open_source contribution online participant collaboration group value participate forum active share barrier idea lesson brand leader	Living labs: Lead-product-development	6.8
38	language measure trademark learner indicator would kibs innovation frugal instructor protection need ottercall sustainability collective group corporate learning solution even	Open source-data solution	1.6
39	government canada canadian policy capital investment venture funding innovation business industry economic organization country federal fund sector ottawa technology global	Growth-network-venture	13

40	research science critical infrastructure cybersecurity system management standard model scientific design principle engineering challenge definition section specific domain capability information	Cybersecurity-design infrastructure	8.9
41	mashup apis trust data ontario relationship ecosystem network provider analysis research google leader visualization show member finnish team maps growth	Ecosystem-Platform-network provider	5.5
42	study motivation table theory variable decision adopter system time survey factor contribution commercialization driver adoption science word-of-mouth identified attitude waiting	Living labs-Projects	3.6
43	evaluation supply_chain strategic information patent business technology value printing relevant prior based supplier firm methodology knowledge cyber-resilience resilience identify cited	Ecosystem-business platform	4.2
44	patent technology property business intellectual court right invention licensing protection infringement firm asset application cost potential also patenting portfolio year	Technology-value IP	5.6
45	software open_source support source application project system many available vendor code tool proprietary solution commercial using product developer standard need	Entrepreneur-Internal activities	59
46	consumer employee production activity co-production apple engage iphone creative good personal service luxury consumption experience individual gamification knowledge game also	Co-creation-Social value	3.9
47	innovation firm strategy competitive market management growth resource leadership product strategic corporate business company culture capability performance external change radical	Open source-software product	11

Table 9: List of 20 top words, labels and weights of topics achieved by DTM

Labeling topics

For example, three top topics are growth-legitimacy-process (topic 25), entrepreneur-Internal activities (topic 45, and entrepreneur-global startup (topic 12) that their word clouds are shown in the figure below. We used first slice topic words to illustrate the word clouds. All word clouds have shown in Appendix III.

Figure 14: Word clouds of topics 25,45,12 in DTM

As a sample, we examined topic 1 words over time. While the weight of words including “research”, “researcher”, “knowledge”, and “collaboration” almost is the same, the weight of “knowledge”, “translation”, and “research” increase and in the last slice “knowledge” and follow it “translation” reach the peak. In addition, the most associated articles to topic 1 are about knowledge translation such as

ItemId	Article Title	Year	Prop
1015	Building Scientist Capacity in Knowledge Translation: Development of the Knowledge Translation Planning Template	2016	0.565
1016	Implementing Knowledge Translation Strategies in Funded Research in Canada and Australia: A Case Study	2016	0.555
668	University-SME Collaboration and Open Innovation: Intellectual-Property Management Tools and the Roles of Intermediaries	2013	0.273

Table 10: Three most knowledge-related articles of topic 1

According to word probabilities, word clouds, meaning the words, and articles associated with topic 1, we can conclude that topic is about research knowledge translation. Other topic words and word clouds are shown in Appendix IV.

Probs & words 2007		Probs & words 2008		Probs & words 2009		Probs & words 2010		Probs & words 2011		Probs & words 2012	
0.21053	research	0.20355	research	0.18656	research	0.16487	research	0.14228	research	0.11847	research
0.03251	researcher	0.03249	researcher	0.03158	researcher	0.03139	researcher	0.03135	knowledge	0.03344	knowledge
0.02993	knowledge	0.02996	knowledge	0.03007	knowledge	0.03053	knowledge	0.03107	researcher	0.03068	study
0.02577	collaboration	0.02684	collaboration	0.02864	collaboration	0.0278	collaboration	0.02962	study	0.03052	researcher
0.02406	transfer	0.02341	study	0.02517	study	0.02723	study	0.02683	collaboration	0.02668	collaboration
0.02243	study	0.02135	transfer	0.01828	transfer	0.01586	transfer	0.01547	case	0.01606	case
0.01256	practice	0.01293	intermediary	0.01346	practice	0.01436	case	0.01446	practice	0.0148	practice
0.01248	intermediary	0.01291	practice	0.01327	case	0.01407	practice	0.01384	transfer	0.01438	intermediary
0.01198	case	0.01124	case	0.0131	intermediary	0.01345	intermediary	0.01378	intermediary	0.013	publication
0.01171	publication	0.01202	publication	0.01254	publication	0.0132	publication	0.01375	publication	0.0128	translation
0.01074	tool	0.01089	tool	0.01113	tool	0.01126	tool	0.01162	translation	0.0121	transfer
0.00968	health	0.00997	health	0.01038	health	0.01095	health	0.01133	tool	0.01193	health
0.00894	translation	0.00922	translation	0.00985	translation	0.01067	translation	0.01133	health	0.01143	tool
0.00887	strategy	0.0088	strategy	0.00885	strategy	0.0089	strategy	0.00884	strategy	0.00957	smes
0.00799	academic	0.00784	academic	0.00785	mobilization	0.00821	smes	0.00878	smes	0.00888	mobilization
0.0075	mobilization	0.00771	mobilization	0.00779	academic	0.00808	mobilization	0.0084	mobilization	0.00881	strategy
0.00708	smes	0.00727	smes	0.00766	smes	0.00786	academic	0.0079	academic	0.00875	university-enterprise
0.00701	planning	0.00718	planning	0.00741	planning	0.00761	planning	0.00786	university-enterprise	0.00812	planning
0.00693	support	0.00703	support	0.00724	support	0.00749	support	0.00781	planning	0.00803	support
0.00672	would	0.00684	would	0.0071	would	0.00739	would	0.00774	support	0.00794	would

Probs & words 2013		Probs & words 2014		Probs & words 2015		Probs & words 2016		Probs & words 2017	
0.09482	research	0.08409	research	0.07866	knowledge	0.10275	knowledge	0.10886	knowledge
0.04025	knowledge	0.05506	knowledge	0.07493	research	0.06785	research	0.0649	research
0.02898	collaboration	0.02746	researcher	0.03145	translation	0.04788	translation	0.0477	translation
0.02804	researcher	0.02145	collaboration	0.02532	researcher	0.02304	researcher	0.02271	researcher
0.02405	study	0.02094	translation	0.01896	health	0.02213	health	0.022	health
0.01587	practice	0.01917	study	0.01548	collaboration	0.0159	mobilization	0.01584	mobilization
0.01582	intermediary	0.01604	practice	0.01546	study	0.01415	practice	0.01396	practice
0.01545	translation	0.01585	health	0.01545	practice	0.01247	study	0.01225	study
0.01338	case	0.01195	intermediary	0.01348	mobilization	0.01129	collaboration	0.01099	collaboration
0.01324	health	0.01125	mobilization	0.01048	strategy	0.01095	strategy	0.01091	strategy
0.01183	tool	0.01086	case	0.00946	planning	0.00956	planning	0.00943	planning
0.01132	publication	0.01042	publication	0.00932	intermediary	0.00922	plan	0.00919	plan
0.01109	smes	0.01019	tool	0.00912	publication	0.00838	mental	0.00831	mental
0.01098	transfer	0.00972	strategy	0.00881	case	0.00837	would	0.0083	would
0.0103	university-enterprise	0.00941	transfer	0.00878	plan	0.00799	program	0.00797	program
0.00969	mobilization	0.00915	planning	0.00876	tool	0.00797	support	0.00787	support
0.00903	strategy	0.00885	smes	0.00854	would	0.00768	implementation	0.00761	canada
0.00849	support	0.00852	support	0.00833	support	0.00767	canada	0.00761	implementation
0.00847	planning	0.00852	would	0.00778	transfer	0.00745	tool	0.00741	funding
0.00827	would	0.00826	plan	0.00765	program	0.00745	funding	0.00736	tool

Table 11: Top 20 words and probabilities of topic 1

Cybersecurity	Cybersecurity-Threat-Risk	Living labs	Innovation-Creative Idea
	Cybersecurity-OSS-Attack		Lead-product-development
	Cybersecurity-Data service system		Adoption-Value customer
	Cybersecurity-Crowdsourcing		Living_lab-Innovation-project
	Cybersecurity- design infrastructure		Living labs-Projects
Ecosystem	Ecosystem-business-value community	Open source	Open source-content community
	Ecosystem-Platform-network provider		Open source-software product
	Ecosystem-business platform		Open source-data solution
	Ecosystem-Social innovation		Open source-project community
	Accelerator-Project process		Open source-Organizing
	Ecosystem-Native Actors		Open source-Data service provider
Entrepreneur	Entrepreneur-Enterprise		Open source-Game software
	Entrepreneur-Startup		Open Source-Development
	Entrepreneur-Academic Research		Open Source-License
	Entrepreneur-successful gamification	Research	Test-device-Application
	Entrepreneur-Internal activities		Research-Collaboration
	Entrepreneur-Global Startup		Research-Social
Growth	Growth-Legitimacy process	Social Tech. Innovation	Technology-Data-Open challenge
	Growth-network-venture		Technology-value IP
	Growth-Capability-Improvement		Technology-Patient
			Technology-value network

Table 12: Categories of topics (themes)

In addition, to improve better labeling, we tried to consider all words of topics related to each other as a collection of words so that represents the content of all related articles.

In DTM:

The most topics extracted from DTM approach correspond to topics obtained from LDA approach. We labeled DTM topics the same way we did for LDA. It is clear that the topics from the results of LDA and DTM on another corpus may be completely different.

DTM			LDA			
Topic No	Topic Label	Prop	Topic No	Topic Label	Prop	Theme
1	Research – Knowledge-Social	4.7	9	Research-Social	9.53	Research
2	Innovation- firm-open innovation	6.9	29	Innovation-Firm-Open innovation	23.6	Innovation
3	Co-Creation-Lean development	7.6	10	Co-Creation-Lean development	7.61	Co-Creation
4	Research - Test-Application	3	3	Research -Test-device-Application	9	Research
5	Innovation-Creative Idea	6	32	Innovation-Creative Idea	9.17	Innovation
6	Entrepreneur-Startup	31	5	Entrepreneur-Startup	12.2	Entrepreneur
7	Adoption-Value customer	4.2	12	Adoption-Value customer	5.51	Living labs
8	Innovation-Public-Society	3.6	25	Innovation-Public-Society	8.14	Innovation
9	Entrepreneur-Enterprise	6.1	2	Entrepreneur-Enterprise	8.89	Entrepreneur
10	Cybersecurity-OSS-Attack	4.3	6	Cybersecurity-OSS-Attack	10.7	Cybersecurity
11	Ecosystem-Native Actors	6.1	41	Ecosystem-Native Actors	9.54	Ecosystem
12	Entrepreneur-Global Startup	29	43	Entrepreneur-Global Startup	14.1	Entrepreneur
13	Entrepreneur-Startup	3.8	35	Open source-Organizing	8.48	Open source
14	Ecosystem-business-value community	6.4	30	Ecosystem-business platform	25.8	Ecosystem
15	Accelerator-Project process	5.4	37	Accelerator-Project process	8.09	Ecosystem
16	Research-Collaboration	1.7	8	Research-Collaboration	10.7	Research

17	Cybersecurity-Threat-Risk	8	1	Cybersecurity-Threat-Risk	10.7	Cybersecurity
18	Technology-Healthcare	11	31	Technology-Healthcare	11.8	Social Tech. Innovation
19	Open source-content community	11	15	Open source-content community	13.9	Open source
20	Cybersecurity-Crowdsourcing	3.3	20	Cybersecurity-Crowdsourcing	8.72	Cybersecurity
21	Growth-Capability-Improvement	14	45	Growth-Capability-Improvement	11.4	Growth
22	Ecosystem-business-value community	6.7	7	Ecosystem-business-value community	10.1	Ecosystem
23	Living lab-Innovation-project	3.7	13	Living lab-Innovation-project	19.5	Living labs
24	Innovation-Local innovation	4.8	17	Innovation-Local innovation	10.4	Innovation
25	Growth-Legitimacy process	173	22	Growth-Legitimacy process	8.77	Growth
26	Open Source-Development	7.2	46	Open Source-Development	20	Open source
27	Open Source-License	30	47	Open Source-License	15.5	Open source
28	Open source-Data service provider	11	36	Open source-Data service provider	12.2	Open source
29	Entrepreneur-Academic Research	4.5	23	Entrepreneur-Academic Research	11.8	Entrepreneur
30	Co-creation-value customer	12	21	Co-creation-value customer	17.2	Co-creation
31	Cybersecurity-Data service system	5.3	14	Cybersecurity-Data service system	7.92	Cybersecurity
32	Ecosystem-Social innovation	12	33	Ecosystem-Social innovation	16.2	Social Tech. Innovation
33	Technology-value network	2.5	34	Technology-value network	9.32	Ecosystem
34	Open source-Game software	4.3	44	Open source-Game software	13.4	Open source
35	Open source-project community	16	28	Open source-project community	30.3	Open source
36	Entrepreneur-successful gamification	2.7	38	Entrepreneur-successful gamification	8.53	Entrepreneur
37	Living labs: Lead-product-development	6.8	4	Living labs: Lead-product-development	7.11	Living labs
38	Open source-data solution	1.6	19	Open source-data solution	10.1	Open source
39	Growth-network-venture	13	42	Growth-network-venture	10.7	Growth
40	Cybersecurity- design infrastructure	8.9	26	Cybersecurity- design infrastructure	7.23	Cybersecurity
41	Ecosystem-Platform-network provider	5.5	18	Ecosystem-Platform-network provider	12.8	Ecosystem
42	Living labs-Projects	3.6	24	Living labs-Projects	9.51	Living labs
43	Ecosystem-business platform	4.2	11	Ecosystem-business platform	15.3	Social Tech. Innovation
44	Technology-value IP	5.6	27	Technology-value IP	9.84	Social Tech. Innovation
45	Entrepreneur-Internal activities	59	40	Entrepreneur-Internal activities	13.7	Entrepreneur
46	Co-creation-Social value	3.9	39	Co-creation-Social value	9.22	Co-creation
47	Open source-software product	11	16	Open source-software product	42.6	Open source

Table 13: Obtained topics of DTM and the corresponding to topics gained by LDA

4.6. Related, bridge, and unclassified articles

In LDA:

Final.gamma file consists of values of the proportion of each article to topics. In fact, the file is a matrix with a number of topics (47) as columns and number of involved articles (597) as rows that articles distributed across topics with the proportions (Prop). In Appendix V, we provided 20 high-proportion articles to each topic in separate lists. As shown in the below table, there are five columns in each list, ItemId/NodeId or ID (the ID of the article in the TIM Review database), article title (the title of the article), published year of each article, bridge column which is a list of topic numbers that have common articles in their list, and prop column which is the proportion of

article to the topic. For example, in table 14, article 685 with title “*Navigating Risk When Entering and Participating in a Business Ecosystem*” has published in 2013 with 0.99974 proportion to topic 7; the article has other 46 proportions to other topics that are very fewer values because the sum of the values of the proportions of an article across topics is one.

How to detect related, bridge, and unclassified articles

There are several ways to identify related articles to topics such as determining threshold in each list of articles per topic, identifying a sudden drop in articles proportion to topics, and interpreting the articles per topic manually. Because the articles are distributed across topics, articles with a high proportion of topics are related articles generally which are recognizable with a threshold. The amount of this threshold depends on the user's determination. In this research, we have identified three types of articles in each list of articles in relation to the topic which include related articles, bridge, and unclassified articles. Related articles are those with a high proportion to a topic and a very low proportion to other topics, bridge articles are those with a relatively high proportion of two or more topics (generally up to 5 topics in our research) and a very low proportion to other topics, and unclassified articles are not significantly related to any topic. Almost in each list of articles per topic like in below list, we identified a sudden drop in a set of props that means the above of this reduction, articles are most associated with the topic. In addition, we also investigated other articles in the list manually to verify whether or not to be on the related list. Furthermore, some have been introduced in other topics as a related article. In LDA results, for instance, article 685 in topic 7 is recognized as a related article that shown in the below list. It is recognized only one article as bridge article with three topics that marked with light orange (see article 758 in topics 27,29,47 provided in Appendix I). Other articles in the lists that marked with gray are not related to their topics. Another 46 tables (lists) of articles provided in Appendix I.

ItemId	The most associated articles to topic 7: Ecosystem-business-value community (Ecosystem)	Year	Bridge to topic	Prop
685	Navigating Risk When Entering and Participating in a Business Ecosystem	2013		0.99974
495	Business Ecosystems as Institutions of Participation: A Systems Perspective on Community-Developed Platforms	2011		0.99845
655	Platforms, Communities, and Business Ecosystems: Lessons Learned about Technology Entrepreneurship in an Interconnected World	2013		0.99375
807	Designing Business Models for the Internet of Things	2014		0.92943
545	Business Model Discovery by Technology Entrepreneurs	2012		0.89714
684	Rapid Prototyping Using a Configurable Platform	2013		0.80177
94	Eclipse: A Premier Open Source Community	2007		0.63223
392	When Small is Big: Microcredit and Economic Development	2010		0.5013
758	Overcoming Barriers to Collaboration in an Open Source Ecosystem	2014	46	0.4845
443	Proving the Expertise of Freelance Android Developers	2011		0.35789
55	Special Considerations for Financial Services Firms	2007		0.32324
1033	A Process for Co-Creating Shared Value with the Crowd: Tourism Case Studies from a Regional Innovation System in Western Switzerland	2016		0.3112
102	Improving Application Development by Managing Licensing Issues	2007		0.25903

751	Risk Management in Crowdsourcing-Based Business Ecosystems	2013	0.23368
949	Exploring the Benefits of Integrating Business Model Research within Living Lab Projects	2015	0.21785
919	Business, Innovation, and Knowledge Ecosystems: How They Differ and How to Survive and Thrive within Them	2015	0.18721
597	Predicting Ecosystem Alliances Using Landscape Theory	2012	0.17295
564	Ecosystem Under Construction: An Action Research Study on Entrepreneurship in a Business Ecosystem	2012	0.16379
245	Measuring Modularity in Open Source Code Bases	2009	0.10332
370	Integrating Lessons from Other Disciplines into Open Source Practice	2010	0.09404

Table 14: Top 20 articles of topic 7- Ecosystem-business-value community

As mentioned in previous section, to have a better view of the results of the implementation of the LDA, it is divided the applied articles into three groups, first related articles that those are the most associated to their topic, second bridge articles that those are common among two or more topics, and the last group is unclassified articles that those do not belong to any topics. From a number of 597 articles applied, 503 are related articles and 32 articles identified as bridge articles which 31 articles are common on two topics and just there is one article on three topics. In addition, there are 62 of all 597 applied articles are unclassified with low proportions to topics.

In DTM:

To obtain articles list per topic, we need use gam.dat file in the results of DTM algorithm that consists of values of the proportion of each article to topics. Like LDA, we can generate article lists per topic based on high article proportion to each topic. We provided 20 articles to each topic in separate lists in Appendix II.

ItemId	Topic22: Ecosystem-business-value community corresponding to topic 7 in LDA	Year	Prop
896	Who Inhabits a Business Ecosystem? The Technospecies as a Unifying Concept	2015	0.549
495	Business Ecosystems as Institutions of Participation: A Systems Perspective on Community-Developed Platforms	2011	0.45
434	Defining Good Deals in Business Collectives	2011	0.397
376	Keystone: Adjective or Noun?	2010	0.384
488	Economics of Software Product Development Collectives	2011	0.365
655	Platforms, Communities, and Business Ecosystems: Lessons Learned about Technology Entrepreneurship in an Interconnected World	2013	0.286
245	Measuring Modularity in Open Source Code Bases	2009	0.254
556	Applying the Theory of the Firm to Examine a Technology Startup at the Investment Stage	2012	0.24
94	Eclipse: A Premier Open Source Community	2007	0.225
372	Implementing a Deal Development Platform for Business Ecosystems	2010	0.224
436	Control and Diversity in Company-led Open Source Projects	2011	0.215
647	Going Open: Does it Mean Giving Away Control?	2013	0.177
919	Business, Innovation, and Knowledge Ecosystems: How They Differ and How to Survive and Thrive within Them	2015	0.145
378	Deals Without Borders: A Value Proposition for the Open Global Commerce Keystone	2010	0.131
276	Enabling the Creative Entrepreneur: Business Ecosystems	2009	0.102
219	Collaborative Software Development in the Enterprise	2009	0.09
683	Niche Formation in the Mashup Ecosystem	2013	0.08
751	Risk Management in Crowdsourcing-Based Business Ecosystems	2013	0.071
203	The Emerging Role of Open Source in Healthcare	2008	0.071
807	Designing Business Models for the Internet of Things	2014	0.069

Table 15: Top 20 documents distributed over topic 22 (Ecosystem-business-value community)

We examined 20 high-proportion articles per topic to detect related, bridge, and unclassified articles. To identify related, bridge, and unclassified articles as in “*How to detect related, bridge,*

unclassified articles?” LDA section mentioned, we considered sudden drop point in proportions of articles in each topic and interpretation of the content of articles around of this point. In DTM, the proportions of the articles are closer to each other and more articles are related to the topics, but with a lower proportion compared to the LDA. For example, article 355 - “*Blueprint and Approach to Grow Revenue in Small Technology Companies*” distributed over topics including topic 3 (co-creation- ecosystem- lean development) with 0.33 proportion or %33 relevance to the topic 3, topic 6 (entrepreneur-startup) with %27 relevance, topic 14 (ecosystem-business-value community) with %12 relevance, topic 25 (growth-legitimacy process) with %12 relevance, and other topics have less than 0.1 (%10) proportions, while there is only one topic with a proportion of 0.99 or above 99% relevance in LDA. From 597 articles, 299 related articles are identified, 189 articles are considered jointly by 2 topics, 61 articles with 3 topics, 15 articles with 4 topics, and 4 articles with 5 topics, and 29 unclassified articles.

4.7. Topic and theme trends

In LDA:

To illustrate figures of the evolution of topics over time, we used proportions of articles and their published date to generate the weight of each topic per year. In table 16, there are average the topic proportions to articles of each year. This CSV file is a matrix with 47 topics columns and 11 years average of the topic proportion of articles.

Year	Topic1	Topic2	Topic3	Topic4	Topic5	Topic6
2007	0.093595	0.000863	0.000863	0.29248	0.000863	.
2008	0.490724	0.340664	0.026594	0.652246	0.00074	.
2009	0.091587	0.000852	0.000852	0.168981	0.481805	.
2010	0.035563	1.492121	1.041283	0.018448	3.260583	.
2011	0.000567	0.121033	0.456105	0.161002	1.142853	.
2012	0.059636	1.573371	0.512215	1.529418	4.949597	.
2013	4.157139	0.008098	1.39516	1.64517	0.033127	.
2014	1.207728	3.729063	0.744617	2.014088	0.869978	.
2015	2.471341	0.186889	0.742692	0.62465	0.00038	.
2016	0.000381	1.047662	3.322584	0.001383	1.49113	.
2017	2.095246	0.384709	0.753705	0.000157	0.000157	.

Table 16: Sample of proportions of articles per year and topic

Based on the above table, we provided each trend of the topic over 11 years that indicated in Appendix III. In figure 17 as a sample, topic 1 (cybersecurity-threat-risk) trend is shown. The figure increases in 2013 and with a reduction in 2014, it increases again the next year. There are four articles in 2013 in articles list of topic1 (Appendix I) and the fifth item in the list has more than 0.9 proportions and two articles with high proportions are in 2015. Obtaining the topics and

then labeling, it will be useful observe trends of themes based on a combination of a set of topics related to each theme. In figure 16 for instance, co-creation theme consists of three identified topics 10,21,39 that its trend shows there are more associated documents to these topics in 2009 and the trend decline by zero in 2017. Topic 21 has a high amount in 2009 compared to two other topics. While topic 10 is increasing, two other topics are a downtrend.

Figure 16: Topic trends related to co-creation theme and the theme trend over time in LDA

The topics related to cybersecurity decreased by zero in 2012 and after that, we have seen some articles about cybersecurity, however, the trends decreased the next years. All topics and the cybersecurity trend are fairly positive.

Figure 17: Topic trends related to cybersecurity theme and the theme trend over time in LDA

Figure 18: Other topic and theme trends over time in LDA

Other topic trends along with their themes provided in figure 18. We examined topic trends with different slope level (0.01, 0.02, 0.2). Considering slope 0.01, 26 topics are significantly increasing, 18 topics are significantly decreasing, and 3 topics almost have no any trend. In addition, the open source, social technology innovation, and ecosystem themes are downtrend and research, living labs, growth, innovation, and entrepreneurship are an uptrend, and two themes – cybersecurity and co-creation - almost have no trends.

In DTM:

We used the probability of words per topic to obtain topics weight in each slice. In addition, we tried to identify corresponding topics of LDA in the results of DTM because of similarities between the topic words in both approaches, although it is clear that the matching topics for all datasets are not possible. We corresponded topics 3, 30, and 46 related to co-creation with those topics in LDA, although the trends do not match. For example, topic 46 (co-creation-social value) is increased over time, while two other topics 3 and 30 are decreased and co-creation theme decreased over time.

Figure 19: Topic trends related to co-creation theme and the theme trend over time in DTM

Figure 20: Topic trends related to cybersecurity theme and the theme trend over time in DTM

Figure 21: Other topic and theme trends over time in DTM

Figures 19, 20, and 21 show topic trends over time and their change over eleven years. Topics 31, 23, 38, 37, 39, 41, 24 have become more prominent in 2017 that are about Ecosystem-platform-network-provider, Growth-network-venture, Open-source-data-solution, Living-labs-lead-product-development, Cybersecurity-data-service-system, Innovation-local-innovation, Living-

labs-innovation-project respectively and topics 3 (Co-creation-lean development) and 14 (Ecosystem-business-value community) disappeared in this year.

Figure 22: Topic trends in DTM approaches

Topic trend shapes on its words probability in each year. As shown in below table, “security” word has the most probability in all years and “risk” word probability increased over time, although, “threat” word probability increased by 2012 and decreased by 2017. As shown in below figure, the topic 17 increased over time with a drop in 2015.

Table 17: Collection of words of topic 17 overtime in DTM

Figure 23: Combination of three words trend in DTM

4.8. Word trends

In LDA:

Using final.beta file, we can obtain word distribution across 47 topics and by comparing the probabilities of the word can obtain most related topics. For example, based on figure 24 “cybersecurity” word used more in topics 26, 1, 6, 12, 20 respectively and the word trend rises in 2013 to 2015. In addition, “entrepreneur” and “startup” trends fluctuated from 2011 to 2016 and in 2017 “startup” word increases unlike “entrepreneur” which has fallen (figure 25,26).

Figure 24: “Cybersecurity” weight in 47 topics and the trend over 11 years in LDA

Figure 25: “Entrepreneur” weight in 47 topics and the trend over 11 years in LDA

Figure 26: “Startup” weight in 47 topics and the trend over 11 years in LDA

Figure 27 compares the trends for three words: entrepreneur, startup and cybersecurity. Although the entrepreneur word declined in 2017, it has the same proportion with startup.

Figure 27: Combination of three trends over time and topics in LDA

In DTM:

Due to being the probability of words in each year and topic in DTM, calculating the word trends is easier than LDA. For example, based on figure 28 “cybersecurity” word has more weight in topics 40, 23, 17 respectively and by calculating the total word possibilities each year, the word trend is obtained; the “cybersecurity” trend rises in 2013 to 2015. In addition, the entrepreneur trend is ascending, while startup trend is descending (figure 29,30).

Figure 28: “Cybersecurity” weight in 47 topics and the trend over 11 years in DTM

Figure 29: “Entrepreneur” weight in 47 topics and the trend over 11 years in DTM

Figure 30: “Startup” weight in 47 topics and the trend over 11 years in DTM

Figure 31: Combination of three trends over time and topics in DTM

We also provided a combination of words to illustrate the words weights together and the trends over time. In figure 31, the weight of words in topics and their trends over time have shown. Entrepreneur word has had the highest increase for 11 years.

5. Discussion on the performance of LDA and DTM approaches

In this section we compare the performance of LDA and DTM and describe a detailed procedure to estimate, interpret, and visualize results.

5.1. Comparing the performance of both algorithms based on five criteria

We examined the results of both approaches. While DTM is an extension of LDA, the results of LDA and DTM somewhat are different. The main goal of the research is to compare the performance of LDA and DTM algorithms on TIM Review database to identify the value and accuracy of the results. Because to this, we needed to generate a more precise model of topics to compare more accurate of two approaches. That is why we considered the optimal number of topics and whole text of articles (abstract and body) and only published articles (without lectures and editorial). Due to some restrictions in LDA approach such as accuracy of the document and word distributions over topics and topic trends, we applied one extension of LDA (DTM) to fix these restrictions. We examined topic high-probability words in corresponding topics, the accuracy of topic trends, dominant topics/themes in different years, positive and negative topic trends, related, bridge, and unclassified articles and word trends in LDA and DTM approaches.

We will discuss the performance of LDA and DTM based on criteria including topic achieved and themes, topic and theme trends, related, bridge, and unclassified articles, word trends, and execution time and then will provide a detailed process to apply the algorithms.

5.1.1. Topics achieved and themes

The majority of topics in both results are fairly similar words in top 20 words with different probabilities. A few topics in DTM have different words compare to corresponded topics in LDA, but we could extract same themes from them. In table 18, five corresponding topics of the security-related theme in LDA and DTM are shown and have been brought their 20 high-probability words along with their topic number.

DTM security-related topics words	LDA security-related topics words
Topic:17 (Cybersecurity-Threat-Risk) security vulnerability defect code system information risk program control threat analysis problem osvdb error access report result attack language would	Topic:1 (Cybersecurity-Threat-Risk) security system risk device cybersecurity vulnerability user threat information medical attack value control example model manufacturer access stakeholder also data
Topic:10 (Cybersecurity-OSS-Attack) information system domain network decision analysis data peer threat dynamic layer making device search dashboard attack architecture host detection example	Topic:6 (Cybersecurity-OSS-Attack) security information system f/loss business risk organization definition network threat cybersecurity trust control software action architecture attack process data example

Topic:31 (Cybersecurity-Data service system) user data computer internet network authentication device used system text server online voice consumer mobile access password however card using	Topic:14 (Cybersecurity-Data service system) data information service system privacy design smart individual security control device process also technology user grid trademark healthcare used provide
Topic:20 (Cybersecurity-Crowdsourcing) crowd crowdsourcing actor risk value business resource firm relationship process kibs biotechnology pharmaceutical task strategic category engagement type different client	Topic:20 (Cybersecurity-Crowdsourcing) crowdsourcing crowd research data cybersecurity technology domain example challenge used learning theory information science specific system problem focus also security
Topic:40 (Cybersecurity- design infrastructure) research science critical infrastructure cybersecurity system management standard model scientific design principle engineering challenge definition section specific domain capability information	Topic:26 (Cybersecurity- design infrastructure) cybersecurity infrastructure design model critical project maturity provider word-of-mouth management capability organization process system small principle industry electronic connection security

Table 18: Security-related topics as cybersecurity theme and top 20 topic words in LDA and DTM

Despite the importance of high-probability words to label topics, the articles associated with topics to have a proper classification of latent topics are significant. In the next section, we investigated the accuracy of topic trends in terms of related articles in each year.

The accuracy of trends in LDA and DTM

In figure 32 as shown in DTM security-related topics graph, topics 31 and 10 have the most positive change over time, while topics 7, 40, 20 decreased. We merged five security-related topics as cybersecurity theme that has a positive trend. We examined DTM and LDA security-related topic trends to identify which theme/topic trend is more accurate. For example, topic 17 in DTM that is corresponded to topic 1 in LDA is weighted in 2008 and as shown in table 18, there are four related articles to topic 17 in this year, while there is no considerable article in LDA (topic 1 in Appendix I).

Figure 32: Five topic trends of cybersecurity theme

ItemId	DTM_Topic:17 (Cybersecurity-Threat-Risk) security vulnerability defect code system ...	Year	Prop
713	An Enterprise Security Program and Architecture to Support Business Drivers	2013	0.555
712	Quantitative Metrics and Risk Assessment: The Three Tenets Model of Cybersecurity	2013	0.545
715	A Research Agenda for Security Engineering	2013	0.507
157	Security Hardening of Open Source Software	2008	0.487
158	Language Insecurity	2008	0.437
889	Challenges in Maritime Cyber-Resilience	2015	0.35
156	Coverity Report	2008	0.316
155	Open Source Vulnerability Database Project	2008	0.3
888	Cybersecurity and Cyber-Resilient Supply Chains	2015	0.227
863	Securing the Car: How Intrusive Manufacturer-Supplier Approaches Can Reduce Cybersecurity Vulnerabilities	2015	0.163
58	Ensuring the Quality of Open Source Software	2007	0.159

Table 19: Most associated articles to topic 17 in DTM

Although the database is too small for more detailed examination of the trends, the difference between the two approaches is evident in the trends. The DTM trends are smoother than LDA and have some related articles in each year.

In the below cybersecurity theme figure, although cybersecurity themes in LDA and DTM are increasing, the slope of the DTM line has been greater than LDA's, and there is almost one relative of the security articles in each year. In addition, we provided two trends using the sum of top 20 topic proportions of articles so that show a clearer image of both trends (right image of figure 33). Furthermore, the cybersecurity theme trend in DTM is weighted in 2012, while in LDA is almost zero. Among top 20 articles to these five topics in DTM results, there are 8 security-related articles published in 2012 are identified, while 2 articles published in 2012 in LDA as non-related⁶ articles are identified and just 1 article as bridge article is identified. In fact, in LDA, there is no any security-related article in 2012.

Figure 33: Five topic trends of cybersecurity theme

Because of time slices and posterior distribution in the DTM method, the topic trends are more accurate than the LDA method. On the other hand, if the ordering of the articles is not relevant to the time and the goal is to get just latent topics from the corpus or few related articles per topic, then LDA may get a better result. Considering selected topics and themes and the TIM Review content, DTM has provided a better distribution of articles across topics over the years.

5.1.2. Topic trends in addition to dominant topics/themes, positive and negative trends

The number of articles per year is roughly equally distributed; 50 to 70 articles are in each year. As shown in figure 34, we provided theme trends of both approaches. In the first half of journal

⁶ Non-related articles that those are located below the threshold of each articles list of each topic and are marked with gray

life in LDA graph, most articles are associated with the Open source, Technology Innovation, and Ecosystem themes and in recent years, TIM Review journal published more articles about Living labs, Entrepreneurship, Innovation, Cybersecurity, and Research; Growth, and Co-creation trends are almost uniform over time. While the Open source theme has a severe negative slope, living-labs has a steep positive slope over the years. In 2017, the most associated articles are related to the Living labs and Entrepreneurship themes. In DTM, trends are slightly different. As shown in the graphs, some theme trends have changed, for example, Ecosystem and Technology Innovation trends are positive, while in LDA the trends are negative, and the Co-creation is negated while in LDA is no trend. All other positive trends have taken more slope in compared to LDA such as Growth and Entrepreneurship, Innovation, Cybersecurity, Research, Living labs.

Figure 34: Theme trends in LDA and DTM

In addition, we provided a table of positive and negative trends at different slopes to examine the evolution of the topics. Considering the 0.01 slope level of the LDA trends, of 47 topics 26 topics are significant increasing, 18 topics are significant decreasing, and 3 topics almost have no any trend, while the number of DTM trends are 31, 16, and none respectively. Increasing slope to 0.1 and then 0.2, the number of positive trends in LDA decreased sharply and in turn, no trends increased, while in DTM this decreasing is slight and there are 26 positive trends and 12 negative trends at 0.2 or more slope level. All topic trends provided in Appendix III and IV.

Different slopes of topic trend line (X)	X: 0.01		X: 0.1		X: 0.2	
	LDA	DTM	LDA	DTM	LDA	DTM
Positive trends ($\geq X$)	26	31	16	29	6	26
Negative trends ($\leq -X$)	18	16	11	14	8	12
No trend ($>-X$ & $<X$)	3	0	20	4	33	9

Table 20: Number of positive, negative, and no trend topics in different levels

In total, the number of positive trends is greater than the negative trends at 0.01 and 0.1 slope levels in LDA results, however, considering slope higher, the number of no trend topics is more than both. In LDA, the top three positive trends include topics 13 (Living labs-innovation-project), topic 29 (Innovation-firm-open innovation), and topic 24 (Living labs-projects) and the top three negative trends are topics 16 (Open source-software product), 28 (Open source-project community), and 30 (Ecosystem-business platform) respectively and in DTM, the top three positive trends are topics 31 (Cybersecurity- data- service- system), 36 (Entrepreneur- successful-gamification), and 13 (Entrepreneur - startup) and the top three negative trends are topics 14 (Ecosystem-business-value community), 40 (Cybersecurity- design infrastructure), and 19 (Open source-content community) respectively. Apart from the difference between the positive and negative trends of the topics in two approaches, the greater difference in slopes in DTM may give a clearer image of the corpus.

5.1.3. Related, bridge and unclassified articles

We examined 20 high-proportion articles per topic to detect related, bridge, and unclassified articles. To identify related, bridge, and unclassified articles as in LDA results section mentioned, we considered sudden drop point in proportions of articles in each topic and interpretation of the content of articles around of this threshold. In DTM, the proportions of the articles are closer to each other and more articles are related to the topics with a lower proportion compared to the LDA. For example, article 355 - “*Blueprint and Approach to Grow Revenue in Small Technology Companies*” distributed over topics including topic 3 (co-creation- ecosystem- lean development) with 0.33 (%33) proportion, topic 6 (entrepreneur-startup) with 0.27 (%27), topic 14 (ecosystem-business-value community) with 0.12 (%12), topic 25 (growth-legitimacy process) with 0.12 (%12), and other topics have less than 0.1 (%10) proportions, while there is only one topic with a proportion of 0.99 or 99% relevance in LDA. Reviewing the article, the LDA proportion cannot be accurate instead, distribution in DTM is much accurate. We identified 503 related articles in LDA that majority of them have more than 0.6 proportions, while 299 related articles are identified in DTM. Instead, the number of bridge articles in DTM is much higher than LDA. With surveys done, bridge articles with their considerable proportions are distributed between 2 to 5 topics in DTM approach so that 189 articles are considered jointly by 2 topics, 61 articles with 3 topics, 15 articles with 4 topics, and 4 articles with 5 topics as well as 29 unclassified articles are identified that are lower than the LDA (62 articles). The number of bridge articles in LDA is much lower

than that of DTM that indicates LDA is more decisive in the distribution of articles on topics. In addition, we compared the number of related articles to each theme in two algorithms. As shown in figure 35, the number of related articles are lower than the LDA with the same ratio in each theme.

Figure 35: Number of related articles to themes in LDA and DTM approaches

The number of related, bridge, unclassified articles per topic

As shown in table 6, we have identified 10 themes from 47 gained topics including Co-creation, Cybersecurity, Ecosystem, Entrepreneur, Growth, Innovation, Living labs, Open source, Research, and Social technology innovation. Open source theme consists of 9 topics that are the most number among themes and Ecosystem and Entrepreneur with 6 topics, Cybersecurity with 5 and Growth, Innovation, Living-labs, and Social technology innovation each one with 4 topics and Co-creation, Growth, and Research themes each one with 3 topics are determined. In terms of the number of articles attached to each topic as table 9 shows, Innovation-Firm-Open innovation, Open source-software product, Open source-content community, Open source-project community have the most related articles, however, just Open source-project community has 20 related articles without any bridge articles. In addition, there is a sum of number of related and bridge articles per theme in below table and shown in table 21. Open source has the most number of 143 articles, in turn, Research theme has just 27 articles.

Theme	Topic No	Topics	Related articles	Related articles	Classified articles	Sum Props
Co-Creation	10	Co-Creation-Lean development	8	0	8	6.69
	21	Co-creation-value customer	12	0	12	9.82
	39	Co-creation-Social value	9	0	9	7.68
			29	0	29	24.2
Cybersecurity	1	Cybersecurity-Threat-Risk	9	0	9	8.44
	6	Cybersecurity-OSS-Attack	8	1	9	7.11
	14	Cybersecurity-Data service system	10	0	10	7.4
Innovation	17	Innovation-Local innovation	11	0	11	8.61
	25	Innovation-Public-Society	8	1	9	6.55
	29	Innovation-Firm-Open innovation	15	5	20	12
	32	Innovation-Creative Idea	9	2	11	8.41
			43	8	51	35.6
Living labs	4	Lead-product-development	4	0	4	3.86
	12	Adoption-Value customer	5	0	5	4.65

	20	Cybersecurity-Crowdsourcing	7	0	7	6.73
	26	Cybersecurity- design infrastructure	7	3	10	6.46
			41	4	45	36.1
Ecosystem	7	Ecosystem-business-value community	8	1	9	7.24
	18	Ecosystem-Platform-network provider	14	1	15	11.5
	30	Ecosystem-business platform	17	2	19	14.4
	34	Technology-value network	12	0	12	8.56
	037	Accelerator-Project process	6	2	8	6.56
	41	Ecosystem-Native Actors	8	0	8	6.19
			65	6	71	54.4
Entrepreneur	2	Entrepreneur-Enterprise	6	2	8	6.56
	5	Entrepreneur-Startup	9	1	10	8.89
	23	Entrepreneur-Academic Research	11	1	12	8.52
	38	Entrepreneur-successful gamification	9	2	11	7.06
	40	Entrepreneur-Internal activities	13	2	15	11.7
	43	Entrepreneur-Global Startup	9	0	9	8.06
			57	8	65	50.8
Growth	22	Growth-Legitimacy process	11	0	11	8.16
	42	Growth-network-venture	10	5	15	9.32
	45	Growth-Capability-Improvement	10	1	11	8.56
			31	6	37	26

	13	Living_lab-Innovation-project	17	2	19	14.3
	24	Living labs-Projects	9	3	12	9.09
			35	5	40	31.9
Open source	16	Open source-software product	18	2	20	16.3
	15	Open source-content community	13	7	20	12
	19	Open source-data solution	11	0	11	8.86
	28	Open source-project community	20	0	20	17.6
	35	Open source-Organizing	9	1	10	7.46
	36	Open source-Data service provider	9	0	9	7.82
	44	Open source-Game software	12	2	14	10.9
	46	Open Source-Development	18	1	19	14.5
	47	Open Source-Licence	16	4	20	13.2
			126	17	143	109
Research	3	Test-device-Application	8	1	9	7.11
	8	Research-Collaboration	10	0	10	8.6
	9	Research-Social	8	0	8	7.58
			26	1	27	23.3
Social Tech. Innovation	11	Technology-Data-Open challenge	12	0	12	9.93
	27	Technology-value IP	10	4	14	8.86
	31	Technology-Health-Patient	14	3	17	10.9
	33	Social innovation	16	3	19	13.4
			52	10	62	43.1

Table 21: Number of related, bridge, and unclassified articles per topic and theme in LDA

DTM				LDA			
ItemId	Topic22: Ecosystem - business, Community	Year	Prop	ItemId	Topic 7: Ecosystem-business-value community	Year	Bridge Prop
896	Who Inhabits a Business Ecosystem? The Technospecies as a Unifying Concept	2015	0.5485	685	Navigating Risk When Entering and Participating in a Business	2013	0.9997
495	Business Ecosystems as Institutions of Participation: A Systems Perspective on Community-Developed Platforms	2011	0.4501	495	Business Ecosystems as Institutions of Participation: A Systems Perspective on Community-Developed Platforms	2011	0.9985
434	Defining Good Deals in Business Collectives	2011	0.3966	655	Platforms, Communities, and Business Ecosystems: Lessons Learned about Technology Entrepreneurship in an Interconnected	2013	0.9938
376	Keystone: Adjective or Noun?	2010	0.3839	807	Designing Business Models for the Internet of Things	2014	0.9294
488	Economics of Software Product Development Collectives	2011	0.365	545	Business Model Discovery by Technology Entrepreneurs	2012	0.8971
655	Platforms, Communities, and Business Ecosystems: Lessons Learned about Technology Entrepreneurship in an Interconnected World	2013	0.2857	684	Rapid Prototyping Using a Configurable Platform	2013	0.8018
245	Measuring Modularity in Open Source Code Bases	2009	0.2537	94	Eclipse: A Premier Open Source Community	2007	0.6322
556	Applying the Theory of the Firm to Examine a Technology Startup at the Investment Stage	2012	0.2396	392	When Small is Big: Microcredit and Economic Development	2010	0.5013
94	Eclipse: A Premier Open Source Community	2007	0.225	758	Overcoming Barriers to Collaboration in an Open Source Ecosystem	2014	0.4845
372	Implementing a Deal Development Platform for Business Ecosystems	2010	0.2237	443	Proving the Expertise of Freelance Android Developers	2011	0.3579
436	Control and Diversity in Company-led Open Source Projects	2011	0.2145	55	Special Considerations for Financial Services Firms	2007	0.3232
647	Going Open: Does it Mean Giving Away Control?	2013	0.1773	1033	A Process for Co-Creating Shared Value with the Crowd: Tourism Case Studies from a Regional Innovation System in Western	2016	0.3112
919	Business, Innovation, and Knowledge Ecosystems: How They Differ and How to Survive and Thrive within Them	2015	0.1455	102	Improving Application Development by Managing Licensing Issues	2007	0.259
378	Keystone	2010	0.1308	751	Risk Management in Crowdsourcing-Based Business Ecosystems	2013	0.2337
276	Enabling the Creative Entrepreneur: Business Ecosystems	2009	0.1022	949	Exploring the Benefits of Integrating Business Model Research within Living Lab Projects	2015	0.2178
219	Collaborative Software Development in the Enterprise	2009	0.0902	919	Business, Innovation, and Knowledge Ecosystems: How They Differ and How to Survive and Thrive within Them	2015	0.1872
683	Niche Formation in the Mashup Ecosystem	2013	0.0801	597	Predicting Ecosystem Alliances Using Landscape Theory	2012	0.1729
751	Risk Management in Crowdsourcing-Based Business Ecosystems	2013	0.0715	564	Ecosystem Under Construction: An Action Research Study on Entrepreneurship in a Business Ecosystem	2012	0.1638
203	The Emerging Role of Open Source in Healthcare	2008	0.0711	245	Measuring Modularity in Open Source Code Bases	2009	0.3098
807	Designing Business Models for the Internet of Things	2014	0.0687	370	Integrating Lessons from Other Disciplines into Open Source	2010	0.094

Table 22: Articles related to ecosystem-business-value-community topic in LDA and DTM

In the above table, the ranking of articles of Ecosystem-business-value-community topic in both approaches has been compared. From 9 related articles in LDA in the topic, 4 articles are in DTM list. Although comparing the list of articles in the common topic is not as valuable as it is, it more reveals how the articles are distributed according to their content.

5.1.4. Word trends and combination of words

The DTM will prevent abrupt changes over the years because words distribution over years is inflexible (Hall et al., 2008). We examined some word trends including open_source, cybersecurity, entrepreneurship, living labs, growth, ecosystem, innovation, research to identify differentiation of LDA and DTM in word distributions across topics. As shown in below DTM figure, “open_source” word trend changes are much lower than those of LDA. In LDA, the word trend declined sharply in 2012 and decreased by zero in 2015, 2016, and 2017, while in DTM, the word trend decreased smoothly, and it has still considerable weight in 2016 and 2017. In table 23 related to DTM result, “open_source” word distributed over time uniformly and almost it has the high probability in all years; the journal has an article in 2016: “*License Compliance in Open Source Cybersecurity Projects*” that is ranked in second place of articles list in topic 27. Thus, with caution, it can be inferred that the DTM provides better results of word distributions across topics compared to LDA.

Figure 36: Word trends using LDA and DTM approaches

DTM Topic:27 (Open Source-License)											
2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
software license f/loss open_source source code open copyright free	software license f/loss open_source source code open copyright free	software license open_source f/loss source open code free commercial	software license open_source source f/loss open code free commercial	software license open_source source open code f/loss commercial business	software license open_source source code open f/loss program business	software open_source software code source open program business licensing	open_source open_source license code software source open program business licensing	open_source open_source license code software source open program business licensing	license open_source code software source open program licensing business	license code open_source software source open program licensing licensed	

Table 23: “Open_source” word in collection of words per year in DTM (topic 27)

5.1.5. Execution time of LDA and DTM

Given the same input parameters of the two algorithms, the execution time of two algorithms can be different. As shown in the figure below, the execution time of LDA and DTM algorithms is compared based on different numbers of topics (7,10,17,30,47). The execution time of LDA is half of the DTM with 7 topics, while these two runtimes come to one another in 17 topics and with the number of topics 30 and 47, this difference increases again. In general, the execution time of LDA has always been lower than DTM based on a different number of topics, the same setting parameters such alpha with 0.1, and the same dataset (TIM Review).

Figure 37: Execution time of LDA and DTM with different number of topics

5.1.6. Summary

In the table below, we compare the algorithms in terms of parameter settings and performance criteria. Almost all settings are the same in both approaches, however, we need to define time slices and the number of articles in each slice in DTM. The slices file is essential for DTM algorithm to identify set of articles per year. In addition, we discussed the results and compared both approaches based on five the performance criteria. According to our findings on the sample, the DTM provides better word and article distributions across topics. consequently, for sequential corpora such as TIM Review journal, word trends over time and distribution of articles across topics will be more specific and accurate than LDA, although LDA has fewer execution time than DTM and there is no need to set slices file.

	LDA	DTM
Settings		
Input files	?.dat, ?.map, ?.vocab	Like LDA

Estimation settings parameter	var max iter 20 var convergence 1e-6 em max iter 100 em convergence 1e-4 alpha estimate	Like LDA
Proposed time slices	Whole corpus	Years from 2007 to 2017
Alpha parameter	0.1	0.1
Topic number	47 fixed	47 fixed
Corresponding topics	47	47
Programming environment	C, Python	C, Python
Output format	Text files	Text files
Theme categorizing	Manually	Manually
Performance criteria:		
Word distribution across topics	<ul style="list-style-type: none"> - Words are exchangeable in corpus - Using TFIDF score 	<ul style="list-style-type: none"> - Words are exchangeable in slice - Using probabilities of words (Better performance)
Document distribution across topics	<ul style="list-style-type: none"> - Articles are exchangeable in corpus - Considered most associated articles on their topics - Using average of article proportions per topic to illustrate topic trends 	<ul style="list-style-type: none"> - Articles are exchangeable in its slice - Considered more articles per topic - Use of probabilities of words per topic to illustrate topic trends (Better performance)
Topic labeling	Based on high-probability words and word clouds	Based on high-probability words in high-weight slice and tracking those words in other slices
Related articles	503 articles that association of some of them do not make sense	299 articles (Better related articles model)
Bridge articles	1 bridge:31 2 bridges:1 3 bridges:0 4 bridges:0	1 bridge:189 2 bridges:61 3 bridges:15 4 bridges:4
Unclassified articles	62	29
Negative slopes ($p=0.2$)	8	12
Positive slopes ($p=0.2$)	6	26
Runtime (section 5.5)	~1.3 hours on a PC with specifications Intel® Core™ i5 Processors and 4G RAM	~2 hours on a PC with specifications Intel® Core™ i5 Processors and 4G RAM

Table 24: Comparing the performance of LDA and DTM approaches

5.2. A detailed procedure to estimate, interpret, and visualize results

For ease of use of our method on other databases, we provided a detailed procedure for all steps done. As shown in the figure below, there are three main stages including data preparation, estimation, and visualization and two transitional stages including data transfer and data standardization in this process. The retrieving and refining data steps are done in the preparation section and then the texts are prepared in a format that can be used for LDA and DTM algorithms in data transfer layer. Setting parameters, executing programs, and outputs are the activities of the application section and after that, we need to a standardization process to generate a dataset of all needed distributions of documents, words, and topics etc. Data standardization helps user to have one specific format to illustrate topic and word trends or any graphs he needs. In the last stage, as

we are shown in previous sections in this research, we generate graphs, tables, images to articulate insights about the corpus. The detailed procedure articulates all needed steps to replicate not only for the results which are generated through use of optimal number of topics, but for the results which will be generated with the arbitrary number of topics. The number of articles, article length, number of topics, and sparsity and distance of topics play important role to get desired results. Thus, depending on the nature of the expected results, the number of topics, length and variety of articles can vary. For example, selecting only abstracts may keep hidden some of the sub-streams of the articles in the results.

Figure 38: A detailed procedure for replication

Below, we describe each of the steps:

- *Read text from the database:* it is used a SQL query to fetch all text of articles.
- *Refined text files:* Using a Python code, it is removed all stop words, defined words, and HTML tags from the text and tokenized the words and generate word-based text files.
- *Text file preparation:* Besides of refined text files, metadata file that consists of the publication date of articles, authors, article ID is prepared.
- *Convert text files to Blei's algorithms format:* we used a Python code to convert refined text files to Blei's LDA input files. As shown in Appendix VII.VI, the algorithm tokenizes the texts to a bag of words and count all the words per article. "txt2ldac.py" is a python command line

tool that takes a directory containing .txt files as input and generates three output files that can be used by the LDA or DTM implementations by David Blei.

- *LDA and DTM executable files*: before running the LDA and DTM, we compiled two LDA and DTM source codes and set the required values such as the minimum number of words in each article and minimum length of words. These algorithms are available in the GitHub repository (<https://github.com/blei-lab/lda-c> and <https://github.com/blei-lab/dtm/tree/master/dtm>).
- *Reprocessing outputs to generate graphs (R functions)*: we provided some functions to generate the matrix of distributions based on LDA and DTM results. It is provided a set of the functions used in our research in Appendix VIII, IX, X, XI.

6. Conclusion and future work

Contributions

This thesis makes the following four main contributions. First, we compared two popular topic modeling techniques based on five criteria. Second, we obtained topic words and categorized the topics into ten themes. The themes include Open source, Entrepreneurship, Innovations, Ecosystem, Living labs, Cybersecurity, Co-creation, Research, Social technology innovation, and Growth. Third, we described strategies to identify the key articles for each topic, bridge articles, and unclassified topics and to label the topics. Finally, we defined a detailed process for applying LDA and DTM that allows researchers to repeat the results reported in. We concluded the DTM provides more precise evolution of topics and the more accurate article and word distributions across topics due to being time slices, although the LDA can be useful to get faster results and several other advantages including easy to use, no need for time stamps and categorizing articles, more explicit analysis of results, and fewer execution time.

Limitations

There were some limitations in our research such as small size of the database that somewhat affects the results analysis and the existence of unrelated data in the journal may distort the model, as well as there is no criterion to fix the parameters of the algorithms in the new corpus.

Future work

There are several related areas for future work such as replication of the detailed process and research how to interpret the model. As other domains of future work can mention to correlated topic model to find bridge articles, topics labeling automatically using labeling techniques, categorize topics and generate themes using clustering techniques, prediction topic and theme of new article, author-topic trends and categorize articles using citations, number of views, and location, and explore similar articles using the document similarity metric.

7. References

- Arun, R., Suresh, V., Veni Madhavan, C. E., & Narasimha Murthy, M. N. (2010). On finding the natural number of topics with latent dirichlet allocation: Some observations. (pp. 391-402). Berlin, Heidelberg: Springer Berlin Heidelberg. doi:10.1007/978-3-642-13657-3_43
- Blei, D. (2011). Probabilistic topic models. Paper presented at the 1-1. doi:10.1145/2107736.2107741
- Blei, D. M. (2012). Probabilistic topic models. *Communications of the ACM*, 55(4), 77-84.
- Blei, D. M., & Lafferty, J. D. (2007). A correlated topic model of science. *The Annals of Applied Statistics*, 1(1), 17-35. doi:10.1214/07-AOAS114
- Blei, D. M., & Lafferty, J. D. (2009). Topic models. *Text mining: classification, clustering, and applications*, 10(71), 34.
- Blei, D. M., and Lafferty, J. D. (2006). "Dynamic topic models," in *Proceedings of the 23rd international conference on Machine learning (ICML 2006)*, pp. 113–120 (doi: 10.1145/1143844.1143859).
- Blei, D. M., Kucukelbir, A., & McAuliffe, J. D. (2017). Variational inference: A review for statisticians. *Journal of the American Statistical Association*.
- Blei, D. M., Ng, A. Y., & Jordan, M. I. (2003). Latent dirichlet allocation. *Journal of machine Learning research*, 3(Jan), 993-1022.
- Blei, D., Carin, L., & Dunson, D. (2010). Probabilistic topic models. *IEEE Signal Processing Magazine*, 27(6), 55-65.
- Chandra, Y., Jiang, L. C., & Wang, C. (2016). Mining social entrepreneurship strategies using topic modeling: E0151342. *PLoS One*, 11(3) doi:10.1371/journal.pone.0151342
- Chuang, J., Manning, C. D., & Heer, J. (2012). Termite: Visualization techniques for assessing textual topic models. In *Proceedings of the international working conference on advanced visual interfaces* (pp. 74-77).

- Daud, A., Li, J., Zhou, L., & Muhammad, F. (2010). Knowledge discovery through directed probabilistic topic models: A survey. *Frontiers of Computer Science in China*, 4(2), 280-301. doi:10.1007/s11704-009-0062-y
- Derntl, M., Günnemann, N., Tillmann, A., Klamma, R., & Jarke, M. (2014). Building and exploring dynamic topic models on the web. Paper presented at the 2012-2014. doi:10.1145/2661829.2661833
- Erosheva, E., Fienberg, S., & Lafferty, J. (2004). Mixed-membership models of scientific publications. *Proceedings of the National Academy of Sciences of the United States of America*, 101(Suppl 1), 5220-5227. doi:10.1073/pnas.0307760101
- Feinerer, I. (2017). Introduction to the tm Package Text Mining in R. 2013-12-01]. [http://www.dainf.ct.utfpr.edu.br/~kaestner/Min-eracao/RDataMining/tm, pdf](http://www.dainf.ct.utfpr.edu.br/~kaestner/Min-eracao/RDataMining/tm.pdf).
- Griffiths, T. L., & Steyvers, M. (2004). Finding scientific topics. *Proceedings of the National Academy of Sciences of the United States of America*, 101(Suppl 1), 5228-5235. doi:10.1073/pnas.0307752101
- Grun, B., & Hornik, K. (2011). topicmodels: An R package for fitting topic models. *Journal of Statistical Software*, 40(13)
- Günnemann, N., Derntl, M., Klamma, R., & Jarke, M. (2013). An interactive system for visual analytics of dynamic topic models. *Datenbank-Spektrum*, 13(3), 213-223. doi:10.1007/s13222-013-0134-x
- Hannah, L. A., & Wallach, H. M. (2014). Summarizing topics: From word lists to phrases. In *NIPS 2014 Workshop on Modern Machine Learning and Natural Language Processing* (pp. 1-5).
- Jacobi, C., van Atteveldt, W., & Welbers, K. (2016). Quantitative analysis of large amounts of journalistic texts using topic modelling. *Digital Journalism*, 4(1), 89-106.
- Jockers, M. L., & Mimno, D. (2013). Significant themes in 19th-century literature. *Poetics*, 41(6), 750-769.
- Mathewa, G., Agrawala, A., & Menzies, T. (2016). Trends in Topics in Software Engineering Conferences, 1992 to 2016. *arXiv preprint arXiv:1608.08100*.

- Phan, X., Nguyen, L., & Horiguchi, S. (2008). Learning to classify short and sparse text & web with hidden topics from large-scale data collections. Paper presented at the 91-100. doi:10.1145/1367497.1367510
- Ponweiser, M. (2012). Latent Dirichlet allocation in R, 2–21. Austria: Institute for Statistics and Mathematics, WU (Wirtschaftsuniversitat Wien)
- Steyvers, M., & Griffiths, T. (2007). Probabilistic topic models. *Handbook of latent semantic analysis*, 427(7), 424-440.
- Zhao, W., Chen, J. J., Perkins, R., Liu, Z., Ge, W., Ding, Y., & Zou, W. (2015). A heuristic approach to determine an appropriate number of topics in topic modeling. *BMC bioinformatics*, 16(13), S8.
- Zhao, Y., & Cen, Y. (2013). *Data mining applications with R*. Academic Press.

Appendix I: Top 20 articles per topic in LDA

ItemId	The most associated articles to topic 1: Cybersecurity-Threat-Risk (Cybersecurity)	Year	Bridge to topic	Prop
1069	A Cybersecurity Risk Assessment Framework that Integrates Value-Sensitive Design	2017		0.99978
715	A Research Agenda for Security Engineering	2013		0.99976
716	Multifactor Authentication: Its Time Has Come	2013		0.99975
714	Protecting Critical Infrastructure by Identifying Pathways of Exposure to Risk	2013		0.99962
712	Quantitative Metrics and Risk Assessment: The Three Tenets Model of Cybersecurity	2013		0.99784
1066	The Internet of (Vulnerable) Things: On Hypponen's Law, Security Engineering, and IoT Legislation	2017		0.94297
903	A Value Blueprint Approach to Cybersecurity in Networked Medical Devices	2015		0.88966
888	Cybersecurity and Cyber-Resilient Supply Chains	2015		0.87456
765	Enhancing Innovation through Virtual Proximity	2014		0.73486
157	Security Hardening of Open Source Software	2008		0.29456
863	Securing the Car: How Intrusive Manufacturer-Supplier Approaches Can Reduce Cybersecurity Vulnerabilities	2015		0.24523
887	Building Cyber-Resilience into Supply Chains	2015		0.20442
1068	Combining Exploratory Analysis and Automated Analysis for Anomaly Detection in Real-Time Data Streams	2017		0.15237
847	Crimeware Marketplaces and Their Facilitating Technologies	2014		0.14091
889	Challenges in Maritime Cyber-Resilience	2015		0.13895
848	Assessing the Intentions and Timing of Malware	2014		0.13749
155	Open Source Vulnerability Database Project	2008		0.11851
771	IT Consumerization: A Case Study of BYOD in a Healthcare Setting	2014		0.09613
703	Keystone Business Models for Network Security Processors	2013		0.08111
158	Language Insecurity	2008		0.07694
ItemId	The most associated articles to topic 2: Entrepreneur-Enterprise (Entrepreneur)	Year	Bridge to topic	Prop
973	Crowdfunding: Finding the Optimal Platform for Funders and Entrepreneurs	2016		0.99973
817	Entrepreneurship Education in India: A Critical Assessment and a Proposed Framework	2014		0.9995
819	The Role of Managers as Agents in Successful Service Innovations: Evidence from India	2014		0.93766
394	Youth Entrepreneurship: Ottawa's Portfolio in Talent Development	2010		0.89561
854	Does Social Innovation Require Social Entrepreneurship?	2014		0.78936
793	Integrating Design for All in Living Labs	2014		0.65692
554	Results-Based Organization Design for Technology Entrepreneurs	2012	26	0.65261
565	Developmental Impact Analysis of an ICT-Enabled Scalable Healthcare Model in BRICS Economies	2012	31	0.62871
399	Humanitarian Free and Open Source Software	2010		0.40019
1076	Digital Technology Entrepreneurship: A Definition and Research Agenda	2017		0.36263
791	Widening the Perspective on Industrial Innovation: A Service-Dominant-Logic Approach	2014		0.34526
114	Open Carrier Grade Base Platform	2008		0.33994
595	Creating Tomorrow's Global Entrepreneurs: A Case Study of the Stu Clark Centre for Entrepreneurship	2012		0.23418
392	When Small is Big: Microcredit and Economic Development	2010		0.19242
921	Women Entrepreneurs in Developing Nations: Growth and Replication Strategies and Their Impact on Poverty Alleviation	2015		0.13035
453	Creating an Environment That Encourages Women Entrepreneurs	2011		0.07895
895	Viability Radar: A Practical Tool for Assessing the Viability of Transformative Service Innovations in a Healthcare Context	2015		0.05076
523	Social Entrepreneurship: Definition and Boundaries	2012		0.04755
485	Fostering Student Entrepreneurship and University Spinoff Companies	2011		0.04154
1026	The Concept of the Entrepreneurial University Applied to Universities of Technology in Austria: Already Reality or a Vision of the Future?	2016		0.02546
ItemId	The most associated articles to topic 3: Test-device-Application (Research)	Year	Bridge to topic	Prop
1018	Mobilizing Knowledge: The Evidence Gap for Assistive Devices	2016		0.98431
1039	The Cuckoo's Nest Approach for Co-Creating Business Ecosystems in Smart Cities	2016		0.92257
682	Evolution of Wireless Sensor Networks for Industrial Control	2013		0.85672
959	Factors Affecting the Attrition of Test Users During Living Lab Field Trials	2016		0.75936
1049	The Design-Driven Living Lab: A New Approach to Exploring Solutions to Complex Societal Challenges	2017		0.74708
771	IT Consumerization: A Case Study of BYOD in a Healthcare Setting	2014		0.74424
333	CRC Mobile Broadcasting F/LOSS Projects	2010		0.73402
863	Securing the Car: How Intrusive Manufacturer-Supplier Approaches Can Reduce Cybersecurity Vulnerabilities	2015		0.70597
1011	A Proposed Approach for Idea Selection in Front End of Innovation Activities	2016	32	0.65597
741	The Habitation Lab: Using a Design Approach to Foster Innovation for Sustainable Living	2013		0.53802
566	The Physical Internet and Business Model Innovation	2012		0.51148
453	Creating an Environment That Encourages Women Entrepreneurs	2011		0.45555
347	Communications Enabled Applications: Building Value, not Monetising APIs	2010		0.30645
869	A Technology-Assisted Design Methodology for Employee-Driven Innovation in Services	2015		0.03636
128	The OpenTTT Approach	2008		0.02587
1047	Taking Real-Life Seriously: An Approach to Decomposing Context Beyond "Environment" in Living Labs	2017		0.00648
103	Ensuring Software IP Cleanliness	2007		0.00026
604	Designing Viable Business Models for Living Labs	2012		4.84E-05
557	An Overview of Four Issues on Technology Entrepreneurship in the TIM Review	2012		4.45E-05
97	Software Licensing	2007		3.43E-05
ItemId	The most associated articles to topic 4: Lead-product-development (Living labs)	Year	Bridge to topic	Prop
820	Perceived Environmental Uncertainty for Startups: A Note on Entrepreneurship Research from an Indian Perspective	2014		0.99973
546	User Frustrations as Opportunities	2012		0.98594
810	Commercialization and Public Good: Conflict, Complement, or Critical Component?	2014		0.97145
750	From Idea Crowdsourcing to Managing User Knowledge	2013		0.90041
927	The Organization of Living Labs: Coordinating Activities for Regional Innovation	2015		0.58921
135	Open Source Telecom	2008		0.52519
602	Living Labs as Open-Innovation Networks	2012		0.3888
748	Linking Living Lab Characteristics and Their Outcomes: Towards a Conceptual Framework	2013		0.38508
742	Actor Roles in an Urban Living Lab: What Can We Learn from Suurpelto, Finland?	2013		0.35925
96	Ontario Research Commercialization Program	2007		0.29164

300	Viable Business Models for Corporate Co-creation Communities	2009		0.16814
215	Driving Innovation Through Interoperability	2008		0.12634
497	Entrepreneurial Orientation and Company Performance: Can the Academic Literature Guide Managers?	2011		0.11861
510	How Open Source Has Changed the Software Industry: Perspectives from Open Source Entrepreneurs	2012		0.09217
535	Minimum Viable Product and the Importance of Experimentation in Technology Startups	2012		0.04694
763	Generative Innovation Practices, Customer Creativity, and the Adoption of New Technology Products	2014		0.04254
864	Identifying the Challenges in Commercializing High Technology: A Case Study of Quantum Key Distribution Technology	2015		0.03502
411	Private-Collective Innovation: Let There Be Knowledge	2011		0.02825
380	Assessing Trust Between Members of a Marketplace	2010		0.01763
448	A Rapid Prototyping Environment for Student Entrepreneurs	2011		0.01361
Itemid	The most associated articles to topic 5: Entrepreneur-Startup (Entrepreneur)	Year	Bridge to topic	Prop
386	Building a Business-to-Business Sales Process	2010		0.99936
614	What Technology Startups Must Get Right to Globalize Early and Rapidly	2012		0.98656
618	Market Channels of Technology Startups that Internationalize Rapidly from Inception	2012		0.98567
491	A Sales Execution Strategy Guide for Technology Startups	2011		0.97872
362	Go-to-Market Targeting: Know the Market and Whether It Cares	2010		0.93606
977	Corporate and Grassroot Frugal Innovation: A Comparison of Top-Down and Bottom-Up Strategies	2016		0.92763
784	Finnish Knowledge-Intensive Business Services in China: Market Entry and Position in the Value Chain	2014		0.81291
615	To Internationalize Rapidly from Inception: Crowdsourcing	2012		0.8008
357	Entrepreneurial Growth: An Entrepreneur's Choice	2010	42	0.74002
617	Global Mindset: An Entrepreneur's Perspective on the Born-Global Approach	2012		0.72691
522	Organizational Ambidexterity: How Small Technology Firms Balance Innovation and Support	2012		0.637
997	Outcomes from Applying Design-Led Innovation in an Australian Manufacturing Firm	2016		0.56312
616	Using Social Media to Accelerate the Internationalization of Startups from Inception	2012		0.43833
280	Entrepreneurship in an Established Company	2009		0.42361
388	Strategies for Selling Services	2010		0.26816
629	TIM Lecture Series - 29 Lessons Learned in Entrepreneurship	2012		0.18184
419	Software-as-a-Service Offer Differentiation by Business Unit	2011		0.14982
608	A Small-Firm Perspective on the Benefits of Living Labs	2012		0.11922
351	Integrating the Power of Open Source Telephony with Web 2.0 Technology	2010		0.11161
385	Differentiating Community from Customers in an F/LOSS Business	2010		0.07429
Itemid	The most associated articles to topic 6: Cybersecurity-OSS-Attack (Cybersecurity)	Year	Bridge to topic	Prop
835	Defining Cybersecurity	2014		0.9997
701	Peer-to-Peer Enclaves for Improving Network Defence	2013		0.99963
713	An Enterprise Security Program and Architecture to Support Business Drivers	2013		0.99941
717	On the Road to Holistic Decision Making in Adaptive Security	2013		0.9923
861	Cybersecurity Skills Training: An Attacker-Centric Gamified Approach	2015	38	0.67208
380	Assessing Trust Between Members of a Marketplace	2010		0.67042
127	Free and Open Source Software: Overview and Preliminary Guidelines for the Government of Canada	2008		0.61498
176	Hybrid Software Boosts High Performance Computing Productivity	2008		0.58984
129	Open Source e-Procurement Software	2008		0.56818
229	F/LOSS is Commercial Software	2009		0.48304
56	Supporting Not-for-Profits: an Opportunity for the Commons	2007		0.44507
167	The Need for F/LOSS (Governance) Operations	2008		0.41651
408	Cost Optimization Through Open Source Software	2011		0.40272
846	Cyber-Attack Attributes	2014		0.34928
55	Special Considerations for Financial Services Firms	2007		0.28236
57	Competitive Actions of Open Source Firms	2007		0.28117
103	Ensuring Software IP Cleanliness	2007		0.27523
286	Open Source: Shifting Buying and Evaluation Patterns of BI Users	2009		0.25456
189	The CUE Factor: Community-University Engagement for Social Innovation	2008		0.2323
105	An Introduction to Rights Expression Languages	2007		0.06833
Itemid	The most associated articles to topic 7: Ecosystem-business-value community (Ecosystem)	Year	Bridge to topic	Prop
685	Navigating Risk When Entering and Participating in a Business Ecosystem	2013		0.99974
495	Business Ecosystems as Institutions of Participation: A Systems Perspective on Community-Developed Platforms	2011		0.99845
655	Platforms, Communities, and Business Ecosystems: Lessons Learned about Technology Entrepreneurship in an Interconnected World	2013		0.99375
807	Designing Business Models for the Internet of Things	2014		0.92943
545	Business Model Discovery by Technology Entrepreneurs	2012		0.89714
684	Rapid Prototyping Using a Configurable Platform	2013		0.80177
94	Eclipse: A Premier Open Source Community	2007		0.63223
392	When Small is Big: Microcredit and Economic Development	2010		0.5013
758	Overcoming Barriers to Collaboration in an Open Source Ecosystem	2014	46	0.4845
443	Proving the Expertise of Freelance Android Developers	2011		0.35789
55	Special Considerations for Financial Services Firms	2007		0.32324
1033	A Process for Co-Creating Shared Value with the Crowd: Tourism Case Studies from a Regional Innovation System in Western Switzerland	2016		0.3112
102	Improving Application Development by Managing Licensing Issues	2007		0.25903
751	Risk Management in Crowdsourcing-Based Business Ecosystems	2013		0.23368
949	Exploring the Benefits of Integrating Business Model Research within Living Lab Projects	2015		0.21785
919	Business, Innovation, and Knowledge Ecosystems: How They Differ and How to Survive and Thrive within Them	2015		0.18721
597	Predicting Ecosystem Alliances Using Landscape Theory	2012		0.17295
564	Ecosystem Under Construction: An Action Research Study on Entrepreneurship in a Business Ecosystem	2012		0.16379
245	Measuring Modularity in Open Source Code Bases	2009		0.10332
370	Integrating Lessons from Other Disciplines into Open Source Practice	2010		0.09404
Itemid	The most associated articles to topic 8: Research-Collaboration (Research)	Year	Bridge to topic	Prop
668	University-SME Collaboration and Open Innovation: Intellectual-Property Management Tools and the Roles of Intermediaries	2013		0.9613
936	Scaling Spatial Transformation: Smart Specialization of Urban Capabilities in the Helsinki Region	2015		0.95966

567	Building Trust in High-Performing Teams	2012		0.9248
1060	Opening the Black Box of Ambidexterity: Three Product Development Stories	2017		0.87229
1025	Boundary Objects as Part of Knowledge Integration for Networked Innovation	2016		0.86579
957	Enhancing Early Innovation in an Urban Living Lab: Lessons from Espoo, Finland	2016		0.86046
958	Urban Living Labs for Sustainability in Suburbs in Need of Modernization and Social Uplift	2016		0.82959
429	Trusted to Lead: Trustworthiness and its Impact on Leadership	2011		0.80839
1001	Assessing Cooperation between Industry and Research Infrastructure in Hungary	2016		0.7706
674	Partner Selection for Open Innovation	2013		0.74225
952	Contextuality and Co-Creation Matter: A Qualitative Case Study Comparison of Living Lab Concepts in Urban Research	2015		0.47895
742	Actor Roles in an Urban Living Lab: What Can We Learn from Suurpelto, Finland?	2013		0.32904
722	Strategic Innovation for Business Performance: The Art and Science of Transformation	2013		0.29501
937	Orchestrators of Innovation-Driven Regional Development: Experiences from the INNOFOKUS Project and Change2020 Programme	2015		0.24497
741	The Habitation Lab: Using a Design Approach to Foster Innovation for Sustainable Living	2013		0.20648
1033	A Process for Co-Creating Shared Value with the Crowd: Tourism Case Studies from a Regional Innovation System in Western Switzerland	2016		0.16838
914	The Creativity Canvas: A Business Model for Knowledge and Idea Management	2015		0.07887
666	Local Open Innovation: How to Go from Ideas to Solutions	2013		0.07147
979	Insights from Stimulating Creative Behaviours in a Project-Based Organization Team	2016		0.07133
677	Incubation Programs from Public Research Organizations as Catalysts for Open Business Ecosystems	2013		0.06099
ItemId	The most associated articles to topic 9: Research-Social (Research)	Year	Bridge to topic	Prop
1016	Implementing Knowledge Translation Strategies in Funded Research in Canada and Australia: A Case Study	2016		0.99973
435	The Social Management of Risk	2011		0.99945
692	From Ideas to Opportunities: Exploring the Construction of Technology-Based Entrepreneurial Opportunities	2013		0.99024
536	A Guide for Entrepreneurs Who Lead and Manage Change	2012		0.96405
523	Social Entrepreneurship: Definition and Boundaries	2012		0.95195
935	Governance Solutions for Wicked Problems: Metropolitan Innovation Ecosystems as Frontrunners to Sustainable Well-Being	2015		0.94111
1015	Building Scientist Capacity in Knowledge Translation: Development of the Knowledge Translation Planning Template	2016		0.9205
1014	Perspectives on Knowledge Mobilization: An Introduction to the Special Issue	2016		0.8135
934	Sustainable Innovation: A Competitive Advantage for Innovation Ecosystems	2015		0.49552
880	Do Actions Matter More than Resources? A Signalling Theory Perspective on the Technology Entrepreneurship Process	2015		0.22645
854	Does Social Innovation Require Social Entrepreneurship?	2014		0.16843
188	How Universities Can Enable Social Innovation	2008		0.16384
616	Using Social Media to Accelerate the Internationalization of Startups from Inception	2012		0.1237
809	Improvising Entrepreneurship	2014		0.121
439	Shifting an Entrepreneur's World View	2011		0.08059
861	Cybersecurity Skills Training: An Attacker-Centric Gamified Approach	2015		0.07398
782	Accessing Value-in-Use Information by Integrating Social Platforms into Service Offerings	2014		0.06288
369	Open to Everyone: How Open Source Communities Can Benefit from Diversity Without Disunity	2010		0.062
564	Ecosystem Under Construction: An Action Research Study on Entrepreneurship in a Business Ecosystem	2012		0.05452
726	A Heritage Economy: Business Model Innovation for Economic Wealth, Social Well-Being, and Environmental Health	2013		0.05032
ItemId	The most associated articles to topic 10: Co-Creation-Lean development (Co-Creation)	Year	Bridge to topic	Prop
872	Agile New Service Development in an Interdisciplinary Context	2015		0.99981
533	Towards More Case Study Research in Entrepreneurship	2012		0.99968
870	Implementation Prerequisites for Electronic Procurement of Services	2015		0.99964
862	Botnet Takedown Initiatives: A Taxonomy and Performance Model	2015		0.97362
344	Enterprise Mashups: Cloud-Based, Cloud-Driven and Cloud-Derived Applications	2010		0.84647
1068	Combining Exploratory Analysis and Automated Analysis for Anomaly Detection in Real-Time Data Streams	2017		0.7897
301	Components of Co-creation	2009		0.54371
879	Optimizing Innovation with the Lean and Digitize Innovation Process	2015		0.53994
607	Living Labbing the Rotterdam Way: Co-Creation as an Enabler for Urban Innovation	2012		0.39395
645	Sustainability in Open Source Software Commons: Lessons Learned from an Empirical Study of SourceForge Projects	2013		0.17443
419	Software-as-a-Service Offer Differentiation by Business Unit	2011		0.1583
1001	Assessing Cooperation between Industry and Research Infrastructure in Hungary	2016		0.09746
790	Using Trademarks to Measure Innovation in Knowledge-Intensive Business Services	2014		0.02648
625	Simulation of Supply-Chain Networks: A Source of Innovation and Competitive Advantage for Small and Medium-Sized Enterprises	2012		0.02554
792	The Promoting Force of Technology for Service Innovation in High-Tech Industries	2014		0.01897
564	Ecosystem Under Construction: An Action Research Study on Entrepreneurship in a Business Ecosystem	2012		0.01147
869	A Technology-Assisted Design Methodology for Employee-Driven Innovation in Services	2015		0.00545
784	Finnish Knowledge-Intensive Business Services in China: Market Entry and Position in the Value Chain	2014		0.00386
103	Ensuring Software IP Cleanliness	2007		0.00026
604	Designing Viable Business Models for Living Labs	2012		4.84E-05
ItemId	The most associated articles to topic 11: Technology-Data-Open challenge (Tech. Innovation)	Year	Bridge to topic	Prop
447	Learning from Failure: A Case Study in Entrepreneurship	2011		0.95334
401	IEEE Humanitarian Projects: Open Hardware for the Benefit of the Poorest Nations	2010		0.92434
120	Data Access in Canada: CivicAccess.ca	2008		0.91712
186	Social Innovation: Access and Leadership	2008		0.89585
358	Plumbing the Internet with PostgreSQL: An Open Source Case Study	2010		0.84174
166	Software Accessibility: Where Are We Today?	2008		0.8296
130	Open Source in Canada's Public Sector	2008		0.80573
87	Adding Value to Information Systems Using Free Data	2007		0.77879
323	Building Canada's Culture of Entrepreneurship: Sure-bet to Startup Survival	2010		0.76879
250	Use of Open Source Software by the Brazilian Government	2009		0.75296
259	The 100-Mile Client Roster	2009		0.73434
205	Mirth: Standards-Based Open Source Healthcare Interface Engine	2008		0.72472
579	Hacking Health: Bottom-up Innovation for Healthcare	2012		0.64488
503	Software Patents: Current Challenges and Future Solutions	2011		0.58637
252	Transparency in Government	2009		0.54949

391	A New Engine of Economic Development	2010		0.4757
886	Cyber-Resilience: A Strategic Approach for Supply Chain Management	2015		0.4277
251	The Feds are Ready for a Change	2009		0.42651
564	Ecosystem Under Construction: An Action Research Study on Entrepreneurship in a Business Ecosystem	2012		0.39028
230	Government Transparency via Open Data and Open Source	2009		0.26416
ItemId	The most associated articles to topic 12: Adoption-Value customer (Living labs)	Year	Bridge to topic	Prop
836	Effective Digital Channel Marketing for Cybersecurity Solutions	2014		0.99975
568	A Business Application of the System Dynamics Approach: Word-of-Mouth and Its Effect in an Online Environment	2012		0.99957
894	Disrupting the Disrupter: Strategic Countermeasures to Attack the Business Model of a Coercive Patent-Holding Firm	2015		0.9392
196	Treasury of the iCommons: Reflections of a Commons Sourcing Lawyer	2008		0.88017
732	Reinventing the Wheel: Contextualizing Existing Innovations as a Path to Market Success	2013		0.82909
925	Using Entrepreneurial Marketing to Foster Reseller Adoption of Smart Micro-Grid Technology	2015		0.35833
763	Generative Innovation Practices, Customer Creativity, and the Adoption of New Technology Products	2014		0.19634
364	Open Source Partner Strategy: Are Your Core Businesses Aligned?	2010		0.17894
731	A Firm-Level Innovation Management Framework and Assessment Tool for Increasing Competitiveness	2013		0.0328
216	Open Innovation 2.0	2008		0.02735
491	A Sales Execution Strategy Guide for Technology Startups	2011		0.02079
363	Fundamentals of a Volume Market Engine	2010		0.01408
57	Competitive Actions of Open Source Firms	2007		0.01197
128	The OpenTTT Approach	2008		0.00748
410	How Firms Relate to Open Source Communities	2011		0.00445
700	Cybersecurity Futures: How Can We Regulate Emergent Risks?	2013		0.00273
114	Open Carrier Grade Base Platform	2008		0.00218
103	Ensuring Software IP Cleanliness	2007		0.00026
604	Designing Viable Business Models for Living Labs	2012		4.84E-05
557	An Overview of Four Issues on Technology Entrepreneurship in the TIM Review	2012		4.45E-05
ItemId	The most associated articles to topic 13: Living_lab-Innovation-project (Living labs)	Year	Bridge to topic	Prop
740	Coordination and Participation in Living Lab Networks	2013		0.99974
1055	Reflecting on Actions in Living Lab Research	2017		0.99971
603	Mapping Living Labs in the Landscape of Innovation Methodologies	2012		0.99259
956	The Impact of Living Lab Methodology on Open Innovation Contributions and Outcomes	2016		0.99131
951	Places and Spaces within Living Labs	2015		0.96895
743	Open Innovation Processes in Living Lab Innovation Systems: Insights from the LeYLab	2013		0.94844
1045	Innovation in the Public Sector: Exploring the Characteristics and Potential of Living Labs and Innovation Labs	2017		0.90393
948	The Grey Areas Between Open and Closed in Innovation Networks	2015		0.89114
1054	Overcoming Barriers to Experimentation in Business-to-Business Living Labs	2017		0.7989
605	Living Labs for Cross-Border Systemic Innovation	2012		0.75155
608	A Small-Firm Perspective on the Benefits of Living Labs	2012		0.67936
489	Managing the Challenges of Becoming an Open Innovation Company: Experiences from Living Labs	2011		0.64363
748	Linking Living Lab Characteristics and Their Outcomes: Towards a Conceptual Framework	2013		0.61327
1031	Empowering Local Tourism Providers to Innovate through a Living Lab Process: Does Scale Matter?	2016	23	0.57658
602	Living Labs as Open-Innovation Networks	2012		0.56854
949	Exploring the Benefits of Integrating Business Model Research within Living Lab Projects	2015		0.52347
1046	Categorization of Innovation Tools in Living Labs	2017	24	0.517
952	Contextuality and Co-Creation Matter: A Qualitative Case Study Comparison of Living Lab Concepts in Urban Research	2015		0.50722
604	Designing Viable Business Models for Living Labs	2012		0.47423
607	Living Labbing the Rotterdam Way: Co-Creation as an Enabler for Urban Innovation	2012		0.41931
ItemId	The most associated articles to topic 14: Cybersecurity-Data service system (Cybersecurity)	Year	Bridge to topic	Prop
1067	Big Data and Individual Privacy in the Age of the Internet of Things	2017		0.99985
1017	Developing Tacit Knowledge of Complex Systems: The Value of Early Empirical Inquiry in Healthcare Design	2016		0.99301
702	Security Challenges in Smart-Grid Metering and Control Systems	2013		0.97044
700	Cybersecurity Futures: How Can We Regulate Emergent Risks?	2013		0.90987
236	Open Source Web Based Geospatial Processing with OMAR	2009		0.80157
146	Method for Qualification and Selection of Open Source Software	2008		0.63735
895	Viability Radar: A Practical Tool for Assessing the Viability of Transformative Service Innovations in a Healthcare Context	2015		0.60188
790	Using Trademarks to Measure Innovation in Knowledge-Intensive Business Services	2014		0.53168
204	Developing an Open Source Reference Implementation of the Canadian Electronic Health Records Solution	2008		0.52494
331	Establishing and Engaging an Active Open Source Ecosystem with the BeagleBoard	2010		0.42599
237	Geospatial Primer: in Search of the Next Killer App\''''	2009		0.13746
238	A RESTful Implementation of Geospatial Web Services	2009		0.12803
575	From Stories to Evidence: How Mining Data Can Promote Innovation in the Nonprofit Sector	2012		0.06302
122	Implementing Open Data: The Open Data Commons Project	2008		0.04741
234	Geospatial: An Open Source Microcosm	2009		0.03707
771	IT Consumerization: A Case Study of BYOD in a Healthcare Setting	2014		0.02859
1068	Combining Exploratory Analysis and Automated Analysis for Anomaly Detection in Real-Time Data Streams	2017		0.02417
325	Technical Entrepreneurs Benefit From Business Ecosystems	2010		0.02238
335	The Open Source Mobile Cloud: Delivering Next-Gen Mobile Apps and Systems	2010		0.01853
165	Sharing Information on the Semantic Web: The Reminiscence of an Old Legal Issue	2008		0.01151
ItemId	The most associated articles to topic 15: Open source-content community (Open source)	Year	Bridge to topic	Prop
1020	Research on Fire: Lessons Learned in Knowledge Mobilization	2016		0.9996
175	Why Give Knowledge Away for Free? The Case for Open Educational Resources	2008		0.92416
563	Collective Value Creation and Empowerment in an Online Brand Community: A Netnographic Study on LEGO Builders	2012		0.91336
869	A Technology-Assisted Design Methodology for Employee-Driven Innovation in Services	2015		0.87002
593	Managing Innovation under Time Pressure: A Practical Perspective	2012		0.85157
59	Conference Report: Open Education 2007	2007		0.84071
575	From Stories to Evidence: How Mining Data Can Promote Innovation in the Nonprofit Sector	2012		0.82821
230	Government Transparency via Open Data and Open Source	2009		0.71705
271	Open Source Resources in Education: Opportunities and Challenges	2009	47	0.59816

77	Open Educational Resources	2007		0.59765
821	Reviewing the Knowledge Systems of Innovation and the Associated Roles of Major Stakeholders in the Indian Context	2014		0.57792
349	Inspired by Open Source and CEAs: The Future of Collaborative Healthcare Delivery in Canada	2010	31	0.56828
68	Evolution of an Open Source Strategy	2007		0.51155
241	An Introduction to Open APIs	2009		0.50417
174	A Flat Network for the Unflat World: Open Educational Resources in Developing Countries	2008		0.34911
189	The CUE Factor: Community-University Engagement for Social Innovation	2008	33	0.2974
213	Social Innovation in Sub-Saharan Africa	2008	15	0.2815
173	OSS Spending Trends in Education	2008	16	0.26804
658	An Ecosystem-Based Job-Creation Engine Fuelled by Technology Entrepreneurs	2013	30	0.25863
123	The Personal Research Portal	2008	37	0.23455
ItemId	The most associated articles to topic 16: Open source-software product (Open source)	Year	Bridge to topic	Prop
220	The Benefits to ISVs of Working with Large Enterprise Consumers on Open-Source Projects	2009		0.9994
177	Is Open Source Right for your Library?	2008		0.96354
756	The Business of Open Source Software: A Primer	2014		0.96064
365	Improving Product-Market Fit by Engaging an Open Source Community	2010		0.95801
84	Building an Open Source Company One Penguin at a Time	2007		0.95452
644	Code Forking, Governance, and Sustainability in Open Source Software	2013		0.94009
63	QNX Hybrid Software Model	2007		0.87176
74	Defining Open Source	2007		0.86558
234	Geospatial: An Open Source Microcosm	2009		0.8644
147	Open Source Software for Corporate IT	2008		0.84587
385	Differentiating Community from Customers in an F/LOSS Business	2010		0.84138
336	The State of Free Software in Mobile Devices	2010		0.78802
67	Comparing the BSD and GPL Licenses	2007		0.76632
173	OSS Spending Trends in Education	2008	15	0.71607
441	Lessons from an Open Source Business	2011		0.69541
65	Open Source Licensing in the Enterprise	2007	47	0.69111
413	Nokia's Hybrid Business Model for Qt	2011		0.67941
286	Open Source: Shifting Buying and Evaluation Patterns of BI Users	2009		0.67221
691	Introducing "Business Source": The Future of Corporate Open Source Licensing?	2013		0.62504
408	Cost Optimization Through Open Source Software	2011		0.59678
ItemId	The most associated articles to topic 17: Innovation-Local innovation (Innovation)	Year	Bridge	Prop
267	Collaborating Across Disciplines	2009		0.99962
664	The Seeking Solutions Approach: Solving Challenging Business Problems with Local Open Innovation	2013		0.99694
667	Quebec Seeks Solutions: An Economic Development Agency's Role in Local Open Innovation	2013		0.90696
490	Acquisition Integration Models: How Large Companies Successfully Integrate Startups	2011		0.8123
666	Local Open Innovation: How to Go from Ideas to Solutions	2013		0.81031
371	OpenOttawaLibre: An Interdisciplinary Approach to Building Creative Cities	2010		0.78605
548	How Do Large Companies Manage Their Investments Across the Three Horizons?	2012		0.77336
363	Fundamentals of a Volume Market Engine	2010		0.72085
402	Mifos: Ending Poverty with Software	2010		0.65096
625	Simulation of Supply-Chain Networks: A Source of Innovation and Competitive Advantage for Small and Medium-Sized Enterprises	2012		0.5832
334	Experiences From the OSSIE Open Source Software Defined Radio Project	2010		0.57436
325	Technical Entrepreneurs Benefit From Business Ecosystems	2010		0.38872
455	Building an Infrastructure to Support Women Founders: Lead to Win for Women	2011		0.36039
97	Software Licensing	2007		0.28283
393	Major Events: Good Economics and Exposure to the World	2010		0.20226
429	Trusted to Lead: Trustworthiness and its Impact on Leadership	2011		0.19112
128	The OpenTTT Approach	2008		0.14473
216	Open Innovation 2.0	2008		0.0871
629	TIM Lecture Series - 29 Lessons Learned in Entrepreneurship	2012		0.08201
112	Open Source Interoperability: It's More than Technology	2008		0.03004
ItemId	The most associated articles to topic 18: Ecosystem-Platform-network provider (Ecosystem)	Year	Bridge to topic	Prop
634	Neuromarketing: Understanding Customers' Subconscious Responses to Marketing	2012		0.99973
242	Mapping Mashup Ecosystems	2009		0.99944
965	Examining the Modes Malware Suppliers Use to Provide Goods and Services	2016		0.98999
896	Who Inhabits a Business Ecosystem? The Technospecies as a Unifying Concept	2015		0.98894
683	Niche Formation in the Mashup Ecosystem	2013		0.98348
376	Keystone: Adjective or Noun?	2010		0.95014
417	Key Player Identification in the Mashup Ecosystem	2011		0.94938
848	Assessing the Intentions and Timing of Malware	2014		0.86211
418	Competition in the Mashup Ecosystem	2011		0.85172
647	Going Open: Does it Mean Giving Away Control?	2013		0.6129
703	Keystone Business Models for Network Security Processors	2013		0.57623
439	Shifting an Entrepreneur's World View	2011		0.44466
782	Accessing Value-in-Use Information by Integrating Social Platforms into Service Offerings	2014		0.42624
440	Leveraging Collectives as a Technology Startup: A Case Study	2011		0.42021
372	Implementing a Deal Development Platform for Business Ecosystems	2010	30	0.41353
241	An Introduction to Open APIs	2009		0.26625
243	Licensing of Open APIs	2009		0.26202
216	Open Innovation 2.0	2008		0.16447
597	Predicting Ecosystem Alliances Using Landscape Theory	2012		0.14958
347	Communications Enabled Applications: Building Value, not Monetising APIs	2010		0.14879
ItemId	The most associated articles to topic 19: Open source-data solution (Open source)	Year	Bridge to topic	Prop
1034	Priority Systems at Theme Parks from the Perspective of Managers and Customers	2016		0.99968
289	Enabling Geospatial Business Intelligence	2009		0.99957
971	A Pattern-Based Approach to the Development of Frugal Innovations	2016		0.87704

288	Open Source BI Reporting Tool Review	2009		0.87301
287	Open Source BI: A Market Overview	2009		0.86399
249	The Steady March of the European Penguins	2009		0.83792
284	Business Intelligence: A Primer	2009		0.78216
555	Making Money from Exploiting Schumpeterian Opportunities: John Sanguinetti and the Electronic Design Automation Industry	2012		0.72237
157	Security Hardening of Open Source Software	2008		0.70491
1008	A Digital Maturity Model for Telecommunications Service Providers	2016		0.59935
464	Anystone Technologies: Lessons from the First Year of a Mobile Applications Startup	2011		0.59577
290	BIRT: Building Next Generation BI Using Open Source	2009		0.28372
251	The Feds are Ready for a Change	2009		0.28165
413	Nokia's Hybrid Business Model for Qt	2011		0.22927
285	Special Considerations for Business Intelligence Projects	2009		0.10478
238	A RESTful Implementation of Geospatial Web Services	2009		0.0896
128	The OpenTTT Approach	2008		0.07088
286	Open Source: Shifting Buying and Evaluation Patterns of BI Users	2009		0.06337
237	Geospatial Primer: in Search of the Next Killer App\	2009		0.04269
416	Open Source License Selection in Relation to Business Models	2011		0.03712
ItemId	The most associated articles to topic 20: Cybersecurity-Crowdsourcing (Cybersecurity)	Year	Bridge to topic	Prop
844	Assessing Scientific Contributions: A Proposed Framework and Its Application to Cybersecurity	2014		0.99968
964	Intrusion Learning: An Overview of an Emergent Discipline	2016		0.99953
770	HarassMap: Using Crowdsourced Data to Map Sexual Harassment in Egypt	2014		0.99803
705	Managing Cybersecurity Research and Experimental Development: The REVO Approach	2013		0.96851
963	Crowdsourcing Literature Reviews in New Domains	2016		0.94273
657	How Can Entrepreneurs Motivate Crowdsourcing Participants?	2013		0.91222
704	Securing Canada's Information-Technology Infrastructure: Context, Principles, and Focus Areas of Cybersecurity Research	2013		0.90729
855	Disruptive Innovation vs Disruptive Technology: The Disruptive Potential of the Value Propositions of 3D Printing Technology Startups	2014		0.41011
269	Social Actions: Making the Web More Philanthropic	2009		0.35083
757	The Businesses of Open Data and Open Source: Some Key Similarities and Differences	2014		0.28264
615	To Internationalize Rapidly from Inception: Crowdsourcing	2012		0.19869
751	Risk Management in Crowdsourcing-Based Business Ecosystems	2013		0.1879
950	Leveraging Living Lab Innovation Processes through Crowdsourcing	2015		0.14937
410	How Firms Relate to Open Source Communities	2011		0.12705
665	Problemsourcing: Local Open Innovation for R&D Organizations	2013		0.10293
1033	A Process for Co-Creating Shared Value with the Crowd: Tourism Case Studies from a Regional Innovation System in Western Switzerland	2016		0.06152
645	Sustainability in Open Source Software Commons: Lessons Learned from an Empirical Study of SourceForge Projects	2013		0.05767
370	Integrating Lessons from Other Disciplines into Open Source Practice	2010		0.03078
210	Experiments, Expertise and Google Summer of Code (TM)	2008		0.00977
1068	Combining Exploratory Analysis and Automated Analysis for Anomaly Detection in Real-Time Data Streams	2017		0.00738
ItemId	The most associated articles to topic 21: Co-creation-value customer (Co-creation)	Year	Bridge to topic	Prop
1010	Audience Commodification: A Source of Innovation in Business Models	2016		0.99971
302	Value Co-Creation and New Marketing	2009		0.97077
113	Ladder of Participation: Business Models for Peer Production	2008		0.93461
635	An Enterprise Perspective on Customer Value Propositions for Open Source Software	2012		0.90239
309	Value Co-creation as Part of an Integrative Vision of Innovation Management	2009		0.88728
942	3D Printing and Its Disruptive Impacts on Supply Chains of the Future	2015		0.88454
534	A Customer Value Creation Framework for Businesses That Generate Revenue with Open Source Software	2012		0.87156
726	A Heritage Economy: Business Model Innovation for Economic Wealth, Social Well-Being, and Environmental Health	2013		0.86345
423	The Future of Co-Creation	2011		0.73721
300	Viable Business Models for Corporate Co-creation Communities	2009		0.62691
395	Developing a Replicable and Sustainable Model of Business Incubation	2010		0.60889
381	Migrating an Existing Business to a New Approach to Revenue Generation	2010		0.5296
294	Opening the Source of Art	2009		0.49523
301	Components of Co-creation	2009		0.4441
855	Disruptive Innovation vs Disruptive Technology: The Disruptive Potential of the Value Propositions of 3D Printing Technology Startups	2014		0.40717
304	Co-creation: a New Way of Doing Business in an Age of Uncertainty	2009		0.36122
1000	A Framework for Sustainable Circular Business Model Innovation	2016		0.35277
566	The Physical Internet and Business Model Innovation	2012		0.3499
311	Motivating Stakeholders for Co-created Innovation	2009		0.34694
425	Using Value Co-Creation to Redefine Business Models	2011		0.34174
ItemId	The most associated articles to topic 22: Growth-Legitimacy process (Growth)	Year	Bridge to topic	Prop
915	Setting the Stage for Collaborative Creative Leadership at Cirque du Soleil	2015		0.99972
912	Lessons in Creativity from the Innovative Design of the Swatch	2015		0.95791
829	Challenging the Stage-Gate Model in Crowdsourcing: The Case of Fiat Mio in Brazil	2014		0.93387
734	Using Boundary Management for More Effective Product Development	2013		0.91183
809	Improvising Entrepreneurship	2014		0.81129
649	Sustainability and Governance in Developing Open Source Projects as Processes of In-Becoming	2013		0.76722
107	Protecting Information Technology Property Rights	2007		0.64859
370	Integrating Lessons from Other Disciplines into Open Source Practice	2010		0.61115
801	Resolving Legitimacy Deficits in Technology Startups through Professional Services Practices	2014		0.57889
985	Creating Brand India: Strategies, Issues, and Challenges	2016		0.51865
387	Open Source Contributions as a Complement to Your Sales Strategy	2010		0.42339
1026	The Concept of the Entrepreneurial University Applied to Universities of Technology in Austria: Already Reality or a Vision of the Future?	2016		0.32832
595	Creating Tomorrow's Global Entrepreneurs: A Case Study of the Stu Clark Centre for Entrepreneurship	2012		0.26674
723	Time to Innovate: Reflections and Recommendations on Time Management for Innovation Managers	2013		0.00417
103	Ensuring Software IP Cleanliness	2007		0.00026

604	Designing Viable Business Models for Living Labs	2012		4.84E-05
557	An Overview of Four Issues on Technology Entrepreneurship in the TIM Review	2012		4.45E-05
97	Software Licensing	2007		3.43E-05
102	Improving Application Development by Managing Licensing Issues	2007		3.27E-05
205	Mirth: Standards-Based Open Source Healthcare Interface Engine	2008		3.21E-05
ItemId	The most associated articles to topic 23: Entrepreneur-Academic Research (Entrepreneur)	Year	Bridge to topic	Prop
1063	Hybrid Entrepreneurship: How and Why Entrepreneurs Combine Employment with Self-Employment	2017		0.99978
986	Supporting Research-Inspired Entrepreneurial Activities in India	2016		0.96414
857	University Spinoffs: What, Why, and How?	2014		0.91613
549	The Role of Universities in Technology Entrepreneurship	2012		0.86545
158	Language Insecurity	2008		0.85048
818	The Government of India's Role in Promoting Innovation through Policy Initiatives for Entrepreneurship Development	2014		0.80185
156	Coverity Report	2008		0.70929
58	Ensuring the Quality of Open Source Software	2007		0.54445
723	Time to Innovate: Reflections and Recommendations on Time Management for Innovation Managers	2013		0.51183
1026	The Concept of the Entrepreneurial University Applied to Universities of Technology in Austria: Already Reality or a Vision of the Future?	2016		0.50107
237	Geospatial Primer: in Search of the Next Killer App\	2009		0.4302
1031	Empowering Local Tourism Providers to Innovate through a Living Lab Process: Does Scale Matter?	2016	13	0.42313
926	Innovation on the Open Sea: Examining Competence Transfer and Open Innovation in the Design of Offshore Vessels	2015		0.40619
485	Fostering Student Entrepreneurship and University Spinoff Companies	2011		0.36467
985	Creating Brand India: Strategies, Issues, and Challenges	2016		0.33469
763	Generative Innovation Practices, Customer Creativity, and the Adoption of New Technology Products	2014		0.27721
821	Reviewing the Knowledge Systems of Innovation and the Associated Roles of Major Stakeholders in the Indian Context	2014		0.17584
595	Creating Tomorrow's Global Entrepreneurs: A Case Study of the Stu Clark Centre for Entrepreneurship	2012		0.17472
987	Open Innovation in Indian Organizations: Types of Collaboration	2016		0.14572
656	Key Factors Affecting a Technology Entrepreneur's Choice of Incubator or Accelerator	2013		0.14002
ItemId	The most associated articles to topic 24: Living labs-Projects (Living labs)	Year	Bridge to topic	Prop
960	The Evolution of Intermediary Activities: Broadening the Concept of Facilitation in Living Labs	2016		0.9998
1048	Heading for a FALL: A Framework for Agile Living Lab Projects	2017		0.99961
749	How Do We Keep the Living Laboratory Alive? Learning and Conflicts in Living Lab Collaboration	2013		0.99721
1047	Taking Real-Life Seriously: An Approach to Decomposing Context Beyond "Environment" in Living Labs	2017		0.99329
1056	Action Research as a Framework to Evaluate the Operations of a Living Lab	2017		0.90351
606	Structuring User Involvement in Panel-Based Living Labs	2012		0.81831
636	Governance of Open Source Software Foundations: Who Holds the Power?	2012		0.77554
980	Weighing the Pros and Cons of Engaging in Open Innovation	2016	29	0.65394
1062	A Managerial Decision Tool for R&D Outsourcing and Partner Selection in High-Technology Industries	2017	29	0.57739
194	Open Source Software Foundations	2008		0.52779
1046	Categorization of Innovation Tools in Living Labs	2017	13	0.48274
744	A Living Lab as a Service: Creating Value for Micro-enterprises through Collaboration and Innovation	2013		0.36566
1054	Overcoming Barriers to Experimentation in Business-to-Business Living Labs	2017		0.14776
979	Insights from Stimulating Creative Behaviours in a Project-Based Organization Team	2016		0.14125
997	Outcomes from Applying Design-Led Innovation in an Australian Manufacturing Firm	2016		0.06834
593	Managing Innovation under Time Pressure: A Practical Perspective	2012		0.03145
1040	Integrating Open Innovation Platforms in Public Sector Decision Making: Empirical Results from Smart City Research	2016		0.01321
927	The Organization of Living Labs: Coordinating Activities for Regional Innovation	2015		0.00299
1049	The Design-Driven Living Lab: A New Approach to Exploring Solutions to Complex Societal Challenges	2017		0.00036
103	Ensuring Software IP Cleanliness	2007		0.00026
ItemId	The most associated articles to topic 25: Innovation-Public-Society (Innovation)	Year	Bridge to topic	Prop
913	Luxury and Creativity: Exploration, Exploitation, or Preservation?	2015		0.99978
562	From Business Administration to Business Creation: The Case of the Kalevala Global Business Creation School	2012		0.87577
877	The City as Living Laboratory: Empowering Citizens with the Citadel Toolkit	2015		0.82088
972	Governing Quintuple Helix Innovation: Urban Living Labs and Socio-Ecological Entrepreneurship	2016		0.76637
1041	Collaborative Innovation with External Actors: An Empirical Study on Open Innovation Platforms in Smart Cities	2016		0.76187
933	Cities as Collaborative Innovation Platforms	2015		0.67387
950	Leveraging Living Lab Innovation Processes through Crowdsourcing	2015		0.5701
1032	The Smart City Ecosystem as an Innovation Model: Lessons from Montreal	2016	42	0.55239
1040	Integrating Open Innovation Platforms in Public Sector Decision Making: Empirical Results from Smart City Research	2016		0.53288
932	Making Smart Regions Smarter: Smart Specialization and the Role of Universities in Regional Innovation Ecosystems	2015		0.25457
371	OpenOttawaLibre: An Interdisciplinary Approach to Building Creative Cities	2010		0.14995
607	Living Labbing the Rotterdam Way: Co-Creation as an Enabler for Urban Innovation	2012		0.12255
1033	A Process for Co-Creating Shared Value with the Crowd: Tourism Case Studies from a Regional Innovation System in Western Switzerland	2016		0.11319
278	Accelerating Successful Technical Entrepreneurship	2009		0.10196
393	Major Events: Good Economics and Exposure to the World	2010		0.09544
934	Sustainable Innovation: A Competitive Advantage for Innovation Ecosystems	2015		0.07613
742	Actor Roles in an Urban Living Lab: What Can We Learn from Suurpelto, Finland?	2013		0.06874
391	A New Engine of Economic Development	2010		0.06869
935	Governance Solutions for Wicked Problems: Metropolitan Innovation Ecosystems as Frontrunners to Sustainable Well-Being	2015		0.05867
793	Integrating Design for All in Living Labs	2014		0.05318
ItemId	The most associated articles to topic 26: Cybersecurity- design infrastructure (Cybersecurity)	Year	Bridge to topic	Prop
902	A Design Science Approach to Constructing Critical Infrastructure and Communicating Cybersecurity Risks	2015		0.99979
904	Secure by Design: Cybersecurity Extensions to Project Management Maturity Models for Critical Infrastructure Projects	2015		0.99969
837	Cybersecurity Capability Maturity Models for Providers of Critical Infrastructure	2014		0.99963
783	Electronic Word-of-Mouth Communication for Local Service Providers	2014		0.91259
889	Challenges in Maritime Cyber-Resilience	2015		0.79958
676	Strategic Partnerships and Open Innovation in the Biotechnology Industry in Belgium	2013	29	0.5496
424	A Network-Centric Snapshot of Value Co-Creation in Finnish Innovation Financing	2011	42	0.44009

252	Transparency in Government	2009		0.28013
554	Results-Based Organization Design for Technology Entrepreneurs	2012	2	0.2652
711	Developing an Innovation Engine to Make Canada a Global Leader in Cybersecurity	2013		0.21118
1008	A Digital Maturity Model for Telecommunications Service Providers	2016		0.19487
1001	Assessing Cooperation between Industry and Research Infrastructure in Hungary	2016		0.09702
704	Securing Canada's Information-Technology Infrastructure: Context, Principles, and Focus Areas of Cybersecurity Research	2013		0.08745
147	Open Source Software for Corporate IT	2008		0.07601
885	Supply Chain Cyber-Resilience: Creating an Agenda for Future Research	2015		0.075
845	Cybersecurity Startups: The Importance of Early and Rapid Globalization	2014		0.05911
943	Securing Cyberspace: Towards an Agenda for Research and Practice	2015		0.04151
219	Collaborative Software Development in the Enterprise	2009		0.03349
609	TIM Lecture Series - Born Global: A Pharmaceutical Startup Perspective	2012		0.02032
846	Cyber-Attack Attributes	2014		0.01592
ItemId	The most associated articles to topic 27: Technology-value IP (Tech. Innovation)	Year	Bridge to topic	Prop
799	A Citation-Based Patent Evaluation Framework to Reveal Hidden Value and Enable Strategic Business Decisions	2014		0.99978
830	Finding the Signal in the Noise of Patent Citations: How to Focus on Relevance for Strategic Advantage	2014		0.99971
505	Reasons for Patent Protection and Cost-effective Patent Filing Options for SMEs	2011		0.99961
693	Leveraging Old Intellectual Property to Accelerate Technology Entrepreneurship	2013		0.99732
501	Patent Value: A Business Perspective for Technology Startups	2011		0.96583
504	Intellectual Property Rights: Unlocking the Value of this New Asset Class	2011		0.92836
396	Why Intellectual Property Will Not Save the Canadian Economy	2010		0.72218
880	Do Actions Matter More than Resources? A Signalling Theory Perspective on the Technology Entrepreneurship Process	2015		0.45371
557	An Overview of Four Issues on Technology Entrepreneurship in the TIM Review	2012	40	0.44086
503	Software Patents: Current Challenges and Future Solutions	2011		0.40124
350	Communication Enabled Applications: What are the IP Considerations for Platform Providers?	2010		0.29656
502	Patents to Exclude vs. Include: Rethinking the Management of Intellectual Property Rights in a Knowledge-Based Economy	2011	29,47	0.26514
511	Open Invention Network: A Defensive Patent Pool for Open Source Projects and Businesses	2012	47	0.21244
856	Turning Technology into Business Using University Patents	2014	32	0.18153
629	TIM Lecture Series - 29 Lessons Learned in Entrepreneurship	2012		0.13718
790	Using Trademarks to Measure Innovation in Knowledge-Intensive Business Services	2014		0.12066
105	An Introduction to Rights Expression Languages	2007		0.06775
496	Innovation Policy Development and the Emergence of New Innovation Paradigms	2011		0.06133
894	Disrupting the Disrupter: Strategic Countermeasures to Attack the Business Model of a Coercive Patent-Holding Firm	2015		0.06057
864	Identifying the Challenges in Commercializing High Technology: A Case Study of Quantum Key Distribution Technology	2015		0.04876
ItemId	The most associated articles to topic 28: Open source-project community (Open source)	Year	Bridge to topic	Prop
256	An International Look at Women in Open Source	2009		0.99952
261	The GNOME Foundation Is All About People	2009		0.99943
317	Community 101	2010		0.99941
258	Lessons on Community Management from the Open Source World	2009		0.99937
260	Community-Built Software: What I Learned from Calagator	2009		0.99937
263	Offline: Where Tech Communities Succeed With Women	2009		0.99928
257	The Human Factor in Open Source	2009		0.99916
264	So Are You A Contributor?: Women's Contributions to Linux and Open Source Span Technology and Business	2009		0.99881
222	The Role of Consumers Within an Open Source Community	2009		0.99735
272	A Model for Sustainable Student Involvement in Community Open Source	2009		0.99539
316	Open Source User Assistance: Ensuring That Everybody Wins	2010		0.98367
210	Experiments, Expertise and Google Summer of Code (TM)	2008		0.9465
315	How the FreeBSD Project's Processes Help Companies Build Products	2010		0.90604
319	Developing a Successful Open Source Training Model	2010		0.7958
332	Low Cost Cellular Networks with OpenBTS	2010		0.71474
369	Open to Everyone: How Open Source Communities Can Benefit from Diversity Without Disunity	2010		0.71376
214	Creating Disruptive Value For Not-For-Profit Organizations Using Open Source	2008		0.70183
69	Free as in Adjective, Not as in Verb	2007		0.69117
223	So You Wanna be a Linus Torvalds? The Do's and Don'ts of Running a Small Open Source Project	2009		0.59382
195	Community Building: NetBSD in Hindsight	2008		0.5768
ItemId	The most associated articles to topic 29: Innovation-Firm-Open innovation (Innovation)	Year	Bridge to topic	Prop
673	Rethinking Open Innovation Beyond the Innovation Funnel	2013		0.99959
1024	Managing Innovation Ecosystems to Create and Capture Value in ICT Industries	2016		0.96177
812	Ambidextrous Strategies and Innovation Priorities: Adequately Priming the Pump for Continual Innovation	2014		0.93175
1061	Orchestrating Innovation Ecosystems: A Qualitative Analysis of Ecosystem Positioning Strategies	2017		0.93114
426	Renewal Through Co-Creation in Business Networks	2011		0.84745
987	Open Innovation in Indian Organizations: Types of Collaboration	2016		0.83905
675	Open Innovation at the Root of Entrepreneurial Strategy: A Case from the Norwegian Oil Industry	2013		0.789
919	Business, Innovation, and Knowledge Ecosystems: How They Differ and How to Survive and Thrive within Them	2015		0.69793
926	Innovation on the Open Sea: Examining Competence Transfer and Open Innovation in the Design of Offshore Vessels	2015		0.59339
510	How Open Source Has Changed the Software Industry: Perspectives from Open Source Entrepreneurs	2012		0.56264
751	Risk Management in Crowdsourcing-Based Business Ecosystems	2013		0.55127
463	Benefits of the Community for Partners of Open Source Vendors	2011		0.43633
722	Strategic Innovation for Business Performance: The Art and Science of Transformation	2013		0.42347
1062	A Managerial Decision Tool for R&D Outsourcing and Partner Selection in High-Technology Industries	2017	24	0.42223
731	A Firm-Level Innovation Management Framework and Assessment Tool for Increasing Competitiveness	2013	33	0.42068
311	Motivating Stakeholders for Co-created Innovation	2009		0.36701
410	How Firms Relate to Open Source Communities	2011		0.32245
676	Strategic Partnerships and Open Innovation in the Biotechnology Industry in Belgium	2013	26	0.31872
502	Patents to Exclude vs. Include: Rethinking the Management of Intellectual Property Rights in a Knowledge-Based Economy	2011	27,47	0.31776
980	Weighing the Pros and Cons of Engaging in Open Innovation	2016	24	0.3053
ItemId	The most associated articles to topic 30: Ecosystem-business platform (Ecosystem)	Year	Bridge to topic	Prop
355	Blueprint and Approach to Grow Revenue in Small Technology Companies	2010		0.99962

276	Enabling the Creative Entrepreneur: Business Ecosystems	2009		0.99953
377	Keystone Off-The-Shelf	2010		0.99952
308	Value Co-creation: Lessons from Lead to Win Ecosystem	2009		0.99228
433	Carleton Entrepreneurs: The First Keystone Off-The-Shelf Application	2011		0.96469
432	A Progress Report on the Keystone Off-The-Shelf Project	2011		0.95585
226	How Open Source Strengthens Business Models	2009		0.8507
86	Company Interactions with Open Platforms	2007		0.84091
85	Keystone Organization for Ontario's Open Source Ecosystem	2007		0.82888
278	Accelerating Successful Technical Entrepreneurship	2009		0.78217
95	TFN: Open Source and Innovation	2007		0.7479
227	The Emerging Promise of Business EcoSystems	2009		0.7324
488	Economics of Software Product Development Collectives	2011		0.6474
325	Technical Entrepreneurs Benefit From Business Ecosystems	2010		0.54241
658	An Ecosystem-Based Job-Creation Engine Fuelled by Technology Entrepreneurs	2013	15	0.53952
83	Putting Maps on the Web with Open Source Technologies	2007		0.51473
372	Implementing a Deal Development Platform for Business Ecosystems	2010	18	0.49988
436	Control and Diversity in Company-led Open Source Projects	2011		0.4816
356	Growing Revenue with Open Source	2010		0.47915
381	Migrating an Existing Business to a New Approach to Revenue Generation	2010		0.46985
ItemId	The most associated articles to topic 31: Technology-Health-Patient (Social Tech. Innovation)	Year	Bridge to topic	Prop
772	3D Printing: A Revolutionary Advance for the Field of Urology?	2014		0.99969
1019	Transferable Practices for Knowledge Mobilization: Lessons from a Community-Engaged Health Research Study	2016		0.99964
648	The Evolving Role of Open Source Software in Medicine and Health Services	2013		0.97743
864	Identifying the Challenges in Commercializing High Technology: A Case Study of Quantum Key Distribution Technology	2015		0.89296
911	Establishing New Codes for Creativity through Haute Cuisine: The Case of Ferran Adrià and elBulli	2015		0.8075
403	Emerging Open Source Health Information Business Ecosystems in Resource-Poor Environments: the OpenMRS Experience	2010		0.7664
873	Personal Health Systems Technologies: Critical Issues in Service Innovation and Diffusion	2015		0.76359
206	Open Health Tools: Tooling for Interoperable Healthcare	2008		0.75856
405	TriSano: Collaborating for the Good of Global Public Health	2010		0.73815
203	The Emerging Role of Open Source in Healthcare	2008		0.63079
887	Building Cyber-Resilience into Supply Chains	2015		0.60128
349	Inspired by Open Source and CEAs: The Future of Collaborative Healthcare Delivery in Canada	2010	15	0.40336
578	Accelerating a Network Model of Care: Taking a Social Innovation to Scale	2012	42	0.32926
579	Hacking Health: Bottom-up Innovation for Healthcare	2012		0.30755
565	Developmental Impact Analysis of an ICT-Enabled Scalable Healthcare Model in BRICS Economies	2012	2	0.30588
462	Beyond Technology: Enabling Communities Through Social Interoperability	2011		0.28767
581	TIM Lecture Series - TELUS in Health: Improving Health Outcomes for All Canadians	2012		0.28236
326	An Open Source Solution for Startups	2010		0.22264
204	Developing an Open Source Reference Implementation of the Canadian Electronic Health Records Solution	2008		0.16204
205	Mirth: Standards-Based Open Source Healthcare Interface Engine	2008		0.13639
ItemId	The most associated articles to topic 32: Innovation-Creative Idea (Innovation)	Year	Bridge to topic	Prop
910	Toward a New Understanding of Creative Dynamics: From One-Size-Fits-All Models to Multiple and Dynamic Forms of Creativity	2015		0.99977
970	Underground Innovation: How to Encourage Bootlegging Employees to Disclose Their Good Ideas	2016		0.99966
594	Creativity: Linking Theory and Practice for Entrepreneurs	2012		0.97291
909	Introduction to the Special Issue on Creativity in Innovation	2015		0.93558
853	Strengthening Innovation Capacity through Different Types of Innovation Cultures	2014		0.92385
735	Measuring Innovation Skills Acquired by College and Polytechnic Students through Applied Research	2013		0.90901
856	Turning Technology into Business Using University Patents	2014	27	0.72576
847	Crimeware Marketplaces and Their Facilitating Technologies	2014		0.62166
914	The Creativity Canvas: A Business Model for Knowledge and Idea Management	2015		0.573
979	Insights from Stimulating Creative Behaviours in a Project-Based Organization Team	2016		0.42161
1011	A Proposed Approach for Idea Selection in Front End of Innovation Activities	2016	3	0.32749
911	Establishing New Codes for Creativity through Haute Cuisine: The Case of Ferran Adrià and elBulli	2015		0.19172
722	Strategic Innovation for Business Performance: The Art and Science of Transformation	2013		0.17147
764	Collaborative Idea Management: A Driver of Continuous Innovation	2014		0.13452
763	Generative Innovation Practices, Customer Creativity, and the Adoption of New Technology Products	2014		0.05375
997	Outcomes from Applying Design-Led Innovation in an Australian Manufacturing Firm	2016		0.04696
371	OpenOttawaLibre: An Interdisciplinary Approach to Building Creative Cities	2010		0.04661
978	Why National Culture Should Be at the Heart of Innovation Management	2016		0.04011
657	How Can Entrepreneurs Motivate Crowdsourcing Participants?	2013		0.03363
765	Enhancing Innovation through Virtual Proximity	2014		0.01589
ItemId	The most associated articles to topic 33: Social innovation (Social Tech. Innovation)	Year	Bridge to topic	Prop
268	Applied Collaboration Studios: Transforming Complex Problems into Systems of Continuous Social Innovation	2009		0.99967
184	Open Source, Social Innovation and a New Economy of Engagement	2008		0.99958
185	Key Elements of Social Innovation	2008		0.99231
574	Renewing the Future: Social Innovation Systems, Sector Shift, and Innoveave	2012		0.98894
183	Open Sourcing Social Change: Inside the Constellation Model	2008		0.98815
576	Being Disruptive: How Open Growth is Delivering Effective Social Change at a Fast Pace	2012		0.93843
665	Problemsourcing: Local Open Innovation for R&D Organizations	2013		0.77005
122	Implementing Open Data: The Open Data Commons Project	2008		0.76331
724	How Service Innovation Boosts Bottom Lines	2013		0.74383
297	Social Media and Open Source: Worlds Apart?	2009		0.66743
764	Collaborative Idea Management: A Driver of Continuous Innovation	2014		0.66056
212	Power of Openness to Solve Textbook Access Problems	2008		0.61555
304	Co-creation: a New Way of Doing Business in an Age of Uncertainty	2009		0.60711
269	Social Actions: Making the Web More Philanthropic	2009		0.52408
731	A Firm-Level Innovation Management Framework and Assessment Tool for Increasing Competitiveness	2013	29	0.51208
364	Open Source Partner Strategy: Are Your Core Businesses Aligned?	2010		0.47354

580	Platformation: Cloud Computing Tools at the Service of Social Change	2012	35	0.42378
446	A Money-Making Platform for Entrepreneurs	2011		0.41943
189	The CUE Factor: Community-University Engagement for Social Innovation	2008	15	0.3487
577	Evergreen Brick Works: An Innovation and Sustainability Case Study	2012		0.319
ItemId	The most associated articles to topic 34: Technology-value network (Ecosystem)	Year	Bridge to topic	Prop
1003	Detecting White Spots in Innovation-Driven Intellectual Property Management	2016		0.96763
1002	Value Network Design for Innovations: Developing Alternative Value Network Drafts	2016		0.95906
943	Securing Cyberspace: Towards an Agenda for Research and Practice	2015		0.91887
885	Supply Chain Cyber-Resilience: Creating an Agenda for Future Research	2015		0.90808
373	Bloom: A Relationship Visualization Tool for Complex Networks	2010		0.83762
940	Reflecting on 100 Issues of the TIM Review	2015		0.69456
155	Open Source Vulnerability Database Project	2008		0.64677
244	Using JavaScript Toolkits to Create Rich Internet Applications	2009		0.62989
465	Reflecting on Fifty Issues of the OSBR	2011		0.59406
82	Open Source Telecommunication Companies	2007		0.58369
886	Cyber-Resilience: A Strategic Approach for Supply Chain Management	2015		0.42842
535	Minimum Viable Product and the Importance of Experimentation in Technology Startups	2012		0.3935
496	Innovation Policy Development and the Emergence of New Innovation Paradigms	2011		0.18717
887	Building Cyber-Resilience into Supply Chains	2015		0.1674
942	3D Printing and Its Disruptive Impacts on Supply Chains of the Future	2015		0.11494
356	Growing Revenue with Open Source	2010		0.05992
147	Open Source Software for Corporate IT	2008		0.0562
270	First Steps towards Mapping the Economy's Genome	2009		0.04077
889	Challenges in Maritime Cyber-Resilience	2015		0.03913
888	Cybersecurity and Cyber-Resilient Supply Chains	2015		0.0323
ItemId	The most associated articles to topic 35: Open source-Organizing (Open source)	Year	Bridge to topic	Prop
905	Representing Botnet-Enabled Cyber-Attacks and Botnet Takedowns Using Club Theory	2015		0.99973
637	Real-Time Mobile Communication of Power Requirements for Electric Vehicles	2012		0.99965
121	How is Copyright Relevant to Source Data and Source Code?	2008		0.89371
1057	Needsfinding in Living Labs: A Structured Research Approach	2017		0.88924
137	Uses of Creative Commons Licenses	2008		0.84271
295	Developing a Portal for Open Source Creation: A Brief Study	2009		0.76505
524	Chinese Entrepreneurs Go Global	2012		0.59388
580	Platformation: Cloud Computing Tools at the Service of Social Change	2012	33	0.52523
845	Cybersecurity Startups: The Importance of Early and Rapid Globalization	2014		0.4888
238	A RESTful Implementation of Geospatial Web Services	2009		0.43262
174	A Flat Network for the Unflat World: Open Educational Resources in Developing Countries	2008		0.36028
97	Software Licensing	2007		0.25024
616	Using Social Media to Accelerate the Internationalization of Startups from Inception	2012		0.24412
350	Communication Enabled Applications: What are the IP Considerations for Platform Providers?	2010		0.09008
198	Reducing Global Poverty and Disease with Community and Technology: An Open Source Perspective	2008		0.04802
128	The OpenTTT Approach	2008		0.01869
847	Crimeware Marketplaces and Their Facilitating Technologies	2014		0.00351
103	Ensuring Software IP Cleanliness	2007		0.00026
604	Designing Viable Business Models for Living Labs	2012		4.84E-05
557	An Overview of Four Issues on Technology Entrepreneurship in the TIM Review	2012		4.45E-05
ItemId	The most associated articles to topic 36: Open source-Data service provider (Open source)	Year	Bridge to topic	Prop
871	The Role of Self-Service Mobile Technologies in the Creation of Customer Travel Experiences	2015		0.99973
800	Mobile Convergence and Entrepreneurial Opportunities for Innovative Products and Services	2014		0.9997
428	Quality-Based Co-Value in SaaS Business Relationships	2011		0.99961
718	Servitization in a Security Business: Changing the Logic of Value Creation	2013		0.99475
773	Formulating an Executive Strategy for Big Data Analytics	2014		0.95614
352	Communication Enabled CRM	2010		0.7463
270	First Steps towards Mapping the Economy's Genome	2009		0.73949
388	Strategies for Selling Services	2010		0.72545
780	Innovation in Services: A Literature Review	2014		0.65717
419	Software-as-a-Service Offer Differentiation by Business Unit	2011		0.31295
782	Accessing Value-in-Use Information by Integrating Social Platforms into Service Offerings	2014		0.25822
791	Widening the Perspective on Industrial Innovation: A Service-Dominant-Logic Approach	2014		0.21256
757	The Businesses of Open Data and Open Source: Some Key Similarities and Differences	2014		0.18238
347	Communications Enabled Applications: Building Value, not Monetising APIs	2010		0.18188
340	Cloud Computing: What is it, and How Will it Affect Organizations?	2010		0.17467
1008	A Digital Maturity Model for Telecommunications Service Providers	2016		0.16387
581	TIM Lecture Series - TELUS in Health: Improving Health Outcomes for All Canadians	2012		0.15825
339	The Value of Cloud Computing	2010		0.15316
792	The Promoting Force of Technology for Service Innovation in High-Tech Industries	2014		0.13148
243	Licensing of Open APIs	2009		0.12757
ItemId	The most associated articles to topic 37: Accelerator-Project process (Ecosystem)	Year	Bridge to topic	Prop
1030	Rejuvenating the Cider Route in Quebec: An Action Design Research Approach to Stakeholder Collaboration and Innovation	2016		0.99007
878	A Method and Tool to Support the Management of Systems Engineering Projects	2015		0.96168
646	Sustainability of Open Collaborative Communities: Analyzing Recruitment Efficiency	2013		0.95066
1053	Methods for Supporting Older Users in Communicating Their Emotions at Different Phases of a Living Lab Project	2017		0.86375
296	Freely Licensed and Open Source Pipelines for Art Based Film and Media Production	2009		0.80875
123	The Personal Research Portal	2008	15	0.72066
343	Performance Testing From the Cloud	2010	45	0.65762
656	Key Factors Affecting a Technology Entrepreneur's Choice of Incubator or Accelerator	2013		0.60795
448	A Rapid Prototyping Environment for Student Entrepreneurs	2011		0.46857
198	Reducing Global Poverty and Disease with Community and Technology: An Open Source Perspective	2008		0.4683

223	So You Wanna be a Linus Torvalds? The Do's and Don'ts of Running a Small Open Source Project	2009		0.40542
1032	The Smart City Ecosystem as an Innovation Model: Lessons from Montreal	2016		0.08192
1033	A Process for Co-Creating Shared Value with the Crowd: Tourism Case Studies from a Regional Innovation System in Western Switzerland	2016		0.04399
395	Developing a Replicable and Sustainable Model of Business Incubation	2010		0.03014
78	Open Source as Community	2007		0.01596
286	Open Source: Shifting Buying and Evaluation Patterns of BI Users	2009		0.00908
204	Developing an Open Source Reference Implementation of the Canadian Electronic Health Records Solution	2008		0.00132
103	Ensuring Software IP Cleanliness	2007		0.00026
604	Designing Viable Business Models for Living Labs	2012		4.84E-05
557	An Overview of Four Issues on Technology Entrepreneurship in the TIM Review	2012		4.45E-05
ItemId	The most associated articles to topic 38: Entrepreneur-successful gamification (Entrepreneur)	Year	Bridge to topic	Prop
918	Level Up Your Strategy: Towards a Descriptive Framework for Meaningful Enterprise Gamification	2015		0.99981
454	Which Gender Differences Matter for High-Tech Entrepreneurship?	2011		0.9979
1009	Co-Creating User Stories: A Tool for Making Sense of Business Opportunities	2016		0.84812
348	How to Add Value to your Business with CEA: A Practical Approach	2010		0.81358
221	The Arrival of the Mobile Internet Thanks to the Economics of Open Source Software	2009		0.79
351	Integrating the Power of Open Source Telephony with Web 2.0 Technology	2010		0.61057
792	The Promoting Force of Technology for Service Innovation in High-Tech Industries	2014		0.58755
425	Using Value Co-Creation to Redefine Business Models	2011		0.54667
335	The Open Source Mobile Cloud: Delivering Next-Gen Mobile Apps and Systems	2010	44	0.33899
597	Predicting Ecosystem Alliances Using Landscape Theory	2012		0.28163
861	Cybersecurity Skills Training: An Attacker-Centric Gamified Approach	2015	6	0.2468
336	The State of Free Software in Mobile Devices	2010		0.21152
949	Exploring the Benefits of Integrating Business Model Research within Living Lab Projects	2015		0.18197
443	Proving the Expertise of Freelance Android Developers	2011		0.16471
330	Open is the New Closed: How the Mobile Industry uses Open Source to Further Commercial Agendas	2010		0.13665
464	Anystone Technologies: Lessons from the First Year of a Mobile Applications Startup	2011		0.11622
297	Social Media and Open Source: Worlds Apart?	2009		0.09835
333	CRC Mobile Broadcasting F/LOSS Projects	2010		0.08501
413	Nokia's Hybrid Business Model for Qt	2011		0.0803
808	Innovation Opportunities: An Overview of Standards and Platforms in the Video Game Industry	2014		0.0694
ItemId	The most associated articles to topic 39: Co-creation-Social value (Co-creation)	Year	Bridge to topic	Prop
834	The Online World of the Future: Safe, Productive, and Creative	2014		0.99966
849	Safety in the Online World of the Future	2014		0.97555
303	The Micro- and Macro-levels of Co-creation: How Transformations Change People's Preferences	2009		0.89223
434	Defining Good Deals in Business Collectives	2011		0.85796
811	Designing and Managing Value Co-Creation in KIBS Engagements	2014		0.84698
452	Redefining Women's Work: Tensions Between Technology"	2011		0.83961
187	Adaptive Co-management and the Learning that Leads to Social Innovation	2008		0.81398
427	The Strategic Impact of Corporate Responsibility and Criminal Networks on Value Co-Creation	2011		0.81097
310	A Social Vision for Value Co-creation in Design	2009		0.64452
581	TIM Lecture Series - TELUS in Health: Improving Health Outcomes for All Canadians	2012		0.45241
979	Insights from Stimulating Creative Behaviours in a Project-Based Organization Team	2016		0.36542
578	Accelerating a Network Model of Care: Taking a Social Innovation to Scale	2012		0.16925
782	Accessing Value-in-Use Information by Integrating Social Platforms into Service Offerings	2014		0.16555
763	Generative Innovation Practices, Customer Creativity, and the Adoption of New Technology Products	2014		0.12888
439	Shifting an Entrepreneur's World View	2011		0.11282
609	TIM Lecture Series - Born Global: A Pharmaceutical Startup Perspective	2012		0.04657
165	Sharing Information on the Semantic Web: The Reminiscence of an Old Legal Issue	2008		0.02781
556	Applying the Theory of the Firm to Examine a Technology Startup at the Investment Stage	2012		0.01989
873	Personal Health Systems Technologies: Critical Issues in Service Innovation and Diffusion	2015		0.01676
791	Widening the Perspective on Industrial Innovation: A Service-Dominant-Logic Approach	2014		0.01519
ItemId	The most associated articles to topic 40: Entrepreneur-Internal activities (Entrepreneur)	Year	Bridge to topic	Prop
766	Enabling Employee Entrepreneurship in Large Technology Firms	2014		0.99738
521	Entrepreneurial Effort in the Theory of the Firm	2012		0.99566
633	Managing Entrepreneurial Employees Who Bring Their Own IT to Work	2012		0.98333
520	Technology Entrepreneurship: Overview, Definition, and Distinctive Aspects	2012		0.98091
995	Employment Dynamics of Australian Entrepreneurship: A Management Perspective	2016		0.97925
996	Revealing Hidden Innovation: Patterns of External Innovation Investment in Australian Businesses	2016		0.96135
497	Entrepreneurial Orientation and Company Performance: Can the Academic Literature Guide Managers?	2011		0.88096
992	Innovation Rhetoric and Reality: An Introduction to the TIM Review's Special Issue on Innovation and Entrepreneurship in Australia	2016		0.75259
1075	Accelerating Research Innovation by Adopting the Lean Startup Paradigm	2017		0.71465
781	Radical Versus Incremental Innovation: The Importance of Key Competences in Service Firms	2014		0.6877
498	The Impact of External Relationships on the Growth of Young Technology Companies	2011	42	0.67367
925	Using Entrepreneurial Marketing to Foster Reseller Adoption of Smart Micro-Grid Technology	2015		0.6414
557	An Overview of Four Issues on Technology Entrepreneurship in the TIM Review	2012	27	0.51704
1076	Digital Technology Entrepreneurship: A Definition and Research Agenda	2017		0.48828
1000	A Framework for Sustainable Circular Business Model Innovation	2016		0.47015
556	Applying the Theory of the Firm to Examine a Technology Startup at the Investment Stage	2012		0.22917
801	Resolving Legitimacy Deficits in Technology Startups through Professional Services Practices	2014		0.20166
880	Do Actions Matter More than Resources? A Signalling Theory Perspective on the Technology Entrepreneurship Process	2015		0.18435
675	Open Innovation at the Root of Entrepreneurial Strategy: A Case from the Norwegian Oil Industry	2013		0.17933
780	Innovation in Services: A Literature Review	2014		0.16147
ItemId	The most associated articles to topic 41: Ecosystem-Native Actors (Ecosystem)	Year	Bridge to topic	Prop
993	All Australian Regions Are Not Born Equal: Understanding the Regional Innovation Management Sandpit	2016		0.99984
1038	Profiling Regional Innovation Ecosystems as Functional Collaborative Systems: The Case of Cambridge	2016		0.98152

978	Why National Culture Should Be at the Heart of Innovation Management	2016		0.92932
921	Women Entrepreneurs in Developing Nations: Growth and Replication Strategies and Their Impact on Poverty Alleviation	2015		0.7789
932	Making Smart Regions Smarter: Smart Specialization and the Role of Universities in Regional Innovation Ecosystems	2015		0.74032
624	Green, Innovative, and Profitable: A Case Study of Managerial Capabilities at Interface Inc.	2012		0.71405
937	Orchestrators of Innovation-Driven Regional Development: Experiences from the INNOFOKUS Project and Change2020 Programme	2015		0.56483
188	How Universities Can Enable Social Innovation	2008		0.48144
711	Developing an Innovation Engine to Make Canada a Global Leader in Cybersecurity	2013		0.43878
677	Incubation Programs from Public Research Organizations as Catalysts for Open Business Ecosystems	2013		0.3312
994	Developing a Startup and Innovation Ecosystem in Regional Australia	2016		0.28671
455	Building an Infrastructure to Support Women Founders: Lead to Win for Women	2011		0.26439
992	Innovation Rhetoric and Reality: An Introduction to the TIM Review's Special Issue on Innovation and Entrepreneurship in Australia	2016		0.23176
453	Creating an Environment That Encourages Women Entrepreneurs	2011		0.22079
604	Designing Viable Business Models for Living Labs	2012		0.21016
1040	Integrating Open Innovation Platforms in Public Sector Decision Making: Empirical Results from Smart City Research	2016		0.18135
395	Developing a Replicable and Sustainable Model of Business Incubation	2010		0.1632
934	Sustainable Innovation: A Competitive Advantage for Innovation Ecosystems	2015		0.1592
1033	A Process for Co-Creating Shared Value with the Crowd: Tourism Case Studies from a Regional Innovation System in Western Switzerland	2016		0.13102
197	A Panamanian Initiative to Embrace the Future	2008		0.12501
ItemId	The most associated articles to topic 42: Growth-network-venture (Growth)	Year	Bridge to topic	Prop
828	Down the Rabbit Hole: How Structural Holes in Entrepreneurs' Social Networks Impact Early Venture Growth	2014		0.98712
733	Corporate Lifecycles: Modelling the Dynamics of Innovation and Its Support Infrastructure	2013		0.9556
725	Addressing Canada's Commercialization Crisis and Shortage of Venture Capital: Will the Federal Government's Solution Work?	2013		0.92147
1007	Corporate Entrepreneurship: A Review and Future Research Agenda	2016		0.83334
553	Categorizing the Growth Strategies of Small Firms	2012		0.82518
920	Technological Public-Private Innovation Networks: A Conceptual Framework Describing Their Structure and Mechanism of Interaction	2015		0.78806
827	Developing a Social Network as a Means of Obtaining Entrepreneurial Knowledge Needed for Internationalization	2014		0.73403
1023	Entrepreneurial Growth Ambitions: The Case of Finnish Technology Startups	2016		0.6849
393	Major Events: Good Economics and Exposure to the World	2010		0.61288
994	Developing a Startup and Innovation Ecosystem in Regional Australia	2016		0.53431
424	A Network-Centric Snapshot of Value Co-Creation in Finnish Innovation Financing	2011	26	0.36761
1032	The Smart City Ecosystem as an Innovation Model: Lessons from Montreal	2016	25	0.34927
578	Accelerating a Network Model of Care: Taking a Social Innovation to Scale	2012	31	0.32954
357	Entrepreneurial Growth: An Entrepreneur's Choice	2010	5	0.25929
498	The Impact of External Relationships on the Growth of Young Technology Companies	2011	40	0.14118
395	Developing a Replicable and Sustainable Model of Business Incubation	2010		0.14101
485	Fostering Student Entrepreneurship and University Spinoff Companies	2011		0.12425
150	Blood on the Tracks: 6 Years of Technical Entrepreneurship in Ottawa	2008		0.10089
656	Key Factors Affecting a Technology Entrepreneur's Choice of Incubator or Accelerator	2013		0.08477
524	Chinese Entrepreneurs Go Global	2012		0.08438
ItemId	The most associated articles to topic 43: Entrepreneur-Global Startup (Entrepreneur)	Year	Bridge to topic	Prop
1072	Is There a Lean Future for Global Startups?	2017		0.9998
1073	Lean Internationalization: How to Globalize Early and Fast in a Small Economy	2017		0.99969
941	The Emergence of the Lean Global Startup as a New Type of Firm	2015		0.99968
1077	Initiating a New Research Phase in the Field of International Entrepreneurship: An Interview with Professor Nicole Coviello	2017		0.99956
532	Global from the Start: The Characteristics of Born-Global Firms in the Technology Sector	2012		0.99945
1074	Platforms for Innovation and Internationalization	2017		0.84359
609	TIM Lecture Series - Born Global: A Pharmaceutical Startup Perspective	2012		0.79404
826	Conceptualizing Innovation in Born-Global Firms	2014		0.76495
449	New Solutions to the Funding Dilemma of Technology Startups	2011		0.66057
535	Minimum Viable Product and the Importance of Experimentation in Technology Startups	2012		0.48813
677	Incubation Programs from Public Research Organizations as Catalysts for Open Business Ecosystems	2013		0.43472
378	Deals Without Borders: A Value Proposition for the Open Global Commerce Keystone	2010		0.41018
597	Predicting Ecosystem Alliances Using Landscape Theory	2012		0.39551
845	Cybersecurity Startups: The Importance of Early and Rapid Globalization	2014		0.32953
279	The Expanding Role of Entrepreneurs in the Creation and Development of Internet Ecosystems	2009		0.32373
324	The Business of Open: Common Pitfalls for Open Source Startups	2010		0.27845
827	Developing a Social Network as a Means of Obtaining Entrepreneurial Knowledge Needed for Internationalization	2014		0.24577
617	Global Mindset: An Entrepreneur's Perspective on the Born-Global Approach	2012		0.23585
801	Resolving Legitimacy Deficits in Technology Startups through Professional Services Practices	2014		0.19003
1075	Accelerating Research Innovation by Adopting the Lean Startup Paradigm	2017		0.18759
ItemId	The most associated articles to topic 44: Open source-Game software (Open source)	Year	Bridge to topic	Prop
211	Omeka: Open Source Web Publishing for Research, Collections and Exhibitions	2008		0.99961
178	Project Conifer	2008		0.97692
273	TellTable: Collaborative Work Using Single User Applications	2009		0.94369
808	Innovation Opportunities: An Overview of Standards and Platforms in the Video Game Industry	2014		0.87898
400	Developing a Service Industry to Support the Sahana Disaster Management System	2010		0.87824
789	Product and Service Interaction in the Chinese Online Game Industry	2014		0.86369
182	Child-Centric Laptop to Help Address Social Needs	2008		0.81273
404	The Humanitarian FOSS Project	2010		0.77466
197	A Panamanian Initiative to Embrace the Future	2008		0.75131
165	Sharing Information on the Semantic Web: The Reminiscence of an Old Legal Issue	2008		0.70192
577	Evergreen Brick Works: An Innovation and Sustainability Case Study	2012		0.62858
213	Social Innovation in Sub-Saharan Africa	2008	15	0.57211
846	Cyber-Attack Attributes	2014		0.56051
335	The Open Source Mobile Cloud: Delivering Next-Gen Mobile Apps and Systems	2010	38	0.51117

461	Introducing the Oregon State University Open Source Lab	2011		0.48521
262	BSD Advocacy and Breaking Through Market Barriers	2009		0.45952
195	Community Building: NetBSD in Hindsight	2008		0.42277
399	Humanitarian Free and Open Source Software	2010		0.24802
645	Sustainability in Open Source Software Commons: Lessons Learned from an Empirical Study of SourceForge Projects	2013		0.22386
176	Hybrid Software Boosts High Performance Computing Productivity	2008		0.12508
ItemId	The most associated articles to topic 45: Growth-Capability-Improvement (Growth)	Year	Bridge to topic	Prop
802	Using a Capability Perspective to Sustain IT Improvement	2014		0.99978
694	Enabling Sustainable Improvement in IT Entrepreneurship	2013		0.99975
626	Enabling Process Alignment for IT Entrepreneurship	2012		0.99974
596	Process Ambidexterity for IT Entrepreneurship	2012		0.99968
627	Process Adaptability in the IT Supply Chain	2012		0.99968
547	Process Ambidexterity for Entrepreneurial Firms	2012		0.95008
342	Private Clouds: Reality or Fog?	2010		0.79429
340	Cloud Computing: What is it, and How Will it Affect Organizations?	2010		0.6988
339	The Value of Cloud Computing	2010		0.67667
522	Organizational Ambidexterity: How Small Technology Firms Balance Innovation and Support	2012		0.22822
343	Performance Testing From the Cloud	2010	37	0.21437
285	Special Considerations for Business Intelligence Projects	2009		0.17506
215	Driving Innovation Through Interoperability	2008		0.15499
55	Special Considerations for Financial Services Firms	2007		0.13461
335	The Open Source Mobile Cloud: Delivering Next-Gen Mobile Apps and Systems	2010		0.13079
619	TIM Lecture Series - Growing a Global Company Anchored on Open Source Software	2012		0.12434
548	How Do Large Companies Manage Their Investments Across the Three Horizons?	2012		0.12397
279	The Expanding Role of Entrepreneurs in the Creation and Development of Internet Ecosystems	2009		0.1166
1060	Opening the Black Box of Ambidexterity: Three Product Development Stories	2017		0.11242
879	Optimizing Innovation with the Lean and Digitize Innovation Process	2015		0.09373
ItemId	The most associated articles to topic 46: Open Source-Development (Open source)	Year	Bridge to topic	Prop
115	Open Standards vs. Open Source: a Case of the OpenAccess Standard	2008		0.99961
75	Open Source Assets	2007		0.99931
136	Open Hardware Business Models	2008		0.99923
228	How Companies Make Money Through Involvement in Open Source Hardware Projects	2009		0.98319
442	Developing Silicon IP with Open Source Tools	2011		0.9582
512	A New Way of Measuring Openness: The Open Governance Index	2012		0.95026
76	Open Hardware	2007		0.91896
330	Open is the New Closed: How the Mobile Industry uses Open Source to Further Commercial Agendas	2010		0.85084
207	Open Source and Open Standards: Working Together for Effective Software Development and Distribution	2008		0.82299
192	Contrasting Proprietary and Free/Open Source Game Development	2008		0.81907
104	A Rallying Moment for Canadian Open Source Software	2007		0.81758
409	Best Practices in Multi-Vendor Open Source Communities	2011		0.71619
411	Private-Collective Innovation: Let There Be Knowledge	2011		0.63709
128	The OpenTTT Approach	2008		0.58679
277	Economic Free Software Perspectives	2009		0.56428
758	Overcoming Barriers to Collaboration in an Open Source Ecosystem	2014	7	0.5151
219	Collaborative Software Development in the Enterprise	2009		0.5097
412	Control in Open Source Software Development	2011		0.48933
757	The Businesses of Open Data and Open Source: Some Key Similarities and Differences	2014		0.3548
691	Introducing "Business Source": The Future of Corporate Open Source Licensing?	2013		0.35385
ItemId	The most associated articles to topic 47: Open Source-Licence (Open source)	Year	Bridge to topic	Prop
966	License Compliance in Open Source Cybersecurity Projects	2016		0.99963
246	Torcs Technology Law Speaker Series: Open Source Licenses and the Boundaries of Knowledge Production	2009		0.99912
106	Key Changes to the GNU General Public License	2007		0.97577
193	Free and Open Source Licenses in Community Life	2008		0.9497
66	Open Source on Trial	2007		0.90607
64	Five Stage Approach to Licensing	2007		0.90539
245	Measuring Modularity in Open Source Code Bases	2009		0.89619
145	Making Open Source Ready for the Enterprise: The Open Source Maturity Model	2008		0.84461
307	Ways of Engaging Consumers in Co-production	2009		0.77618
103	Ensuring Software IP Cleanliness	2007		0.71295
511	Open Invention Network: A Defensive Patent Pool for Open Source Projects and Businesses	2012	27	0.67216
379	Ottercall: A Language Learning Company	2010		0.58941
556	Applying the Theory of the Firm to Examine a Technology Startup at the Investment Stage	2012		0.45583
502	Patents to Exclude vs. Include: Rethinking the Management of Intellectual Property Rights in a Knowledge-Based Economy	2011	27,29	0.41674
341	Re-evaluating Open Source for Sustaining Competitive Advantage for Hosted Applications	2010		0.39891
271	Open Source Resources in Education: Opportunities and Challenges	2009	15	0.39081
416	Open Source License Selection in Relation to Business Models	2011		0.35598
318	What's the Value of an Eyeball? Passive Participation in Open Source Ecosystems	2010		0.33503
105	An Introduction to Rights Expression Languages	2007		0.32079
65	Open Source Licensing in the Enterprise	2007	16	0.30795

Appendix II: Top 20 articles per topic in DTM approach

Itemid	DTM_Topic:1 (Research – knowledge-Social) research researcher knowledge collaboration transfer study practice intermediary case publication tool health translation strategy academic mobilization smes planning support would	Year	Prop
1015	Building Scientist Capacity in Knowledge Translation: Development of the Knowledge Translation Planning Template	2016	0.5647
1016	Implementing Knowledge Translation Strategies in Funded Research in Canada and Australia: A Case Study	2016	0.555
668	University-SME Collaboration and Open Innovation: Intellectual-Property Management Tools and the Roles of Intermediaries	2013	0.2726
1020	Research on Fire: Lessons Learned in Knowledge Mobilization	2016	0.268
1014	Perspectives on Knowledge Mobilization: An Introduction to the Special Issue	2016	0.2386
533	Towards More Case Study Research in Entrepreneurship	2012	0.2205
809	Improvising Entrepreneurship	2014	0.2087
96	Ontario Research Commercialization Program	2007	0.1164
1019	Transferable Practices for Knowledge Mobilization: Lessons from a Community-Engaged Health Research Study	2016	0.0867
1018	Mobilizing Knowledge: The Evidence Gap for Assistive Devices	2016	0.0777
810	Commercialization and Public Good: Conflict, Complement, or Critical Component?	2014	0.0617
189	The CUE Factor: Community-University Engagement for Social Innovation	2008	0.0465
188	How Universities Can Enable Social Innovation	2008	0.0462
940	Reflecting on 100 Issues of the TIM Review	2015	0.0455
497	Entrepreneurial Orientation and Company Performance: Can the Academic Literature Guide Managers?	2011	0.0446
564	Ecosystem Under Construction: An Action Research Study on Entrepreneurship in a Business Ecosystem	2012	0.042
69	Free as in Adjective, Not as in Verb	2007	0.0356
465	Reflecting on Fifty Issues of the OSBR	2011	0.0356
1017	Developing Tacit Knowledge of Complex Systems: The Value of Early Empirical Inquiry in Healthcare Design	2016	0.0333
123	The Personal Research Portal	2008	0.0327
Itemid	DTM_Topic:2 (Innovation- firm-open innovation) open enterprise company innovation partner case development industry technology service firm process simulation model customer collaboration cooperation smes market external	Year	Prop
792	The Promoting Force of Technology for Service Innovation in High-Tech Industries	2014	0.4361
872	Agile New Service Development in an Interdisciplinary Context	2015	0.3715
926	Innovation on the Open Sea: Examining Competence Transfer and Open Innovation in the Design of Offshore Vessels	2015	0.358
674	Partner Selection for Open Innovation	2013	0.3519
987	Open Innovation in Indian Organizations: Types of Collaboration	2016	0.3037
625	Simulation of Supply-Chain Networks: A Source of Innovation and Competitive Advantage for Small and Medium-Sized Enterprises	2012	0.2676
980	Weighing the Pros and Cons of Engaging in Open Innovation	2016	0.2304
675	Open Innovation at the Root of Entrepreneurial Strategy: A Case from the Norwegian Oil Industry	2013	0.2082
673	Rethinking Open Innovation Beyond the Innovation Funnel	2013	0.1856
676	Strategic Partnerships and Open Innovation in the Biotechnology Industry in Belgium	2013	0.115
114	Open Carrier Grade Base Platform	2008	0.1126
1002	Value Network Design for Innovations: Developing Alternative Value Network Drafts	2016	0.1051
426	Renewal Through Co-Creation in Business Networks	2011	0.1031
948	The Grey Areas Between Open and Closed in Innovation Networks	2015	0.09
956	The Impact of Living Lab Methodology on Open Innovation Contributions and Outcomes	2016	0.0866
732	Reinventing the Wheel: Contextualizing Existing Innovations as a Path to Market Success	2013	0.0839
784	Finnish Knowledge-Intensive Business Services in China: Market Entry and Position in the Value Chain	2014	0.072
216	Open Innovation 2.0	2008	0.0695
489	Managing the Challenges of Becoming an Open Innovation Company: Experiences from Living Labs	2011	0.0683
463	Benefits of the Community for Partners of Open Source Vendors	2011	0.0632
Itemid	DTM_Topic:3 (Ecosystem-business-value community) ecosystem company business keystone member value niche lead player role provides organization supplier health compete model technology around world section	Year	Prop
86	Company Interactions with Open Platforms	2007	0.3625
1061	Orchestrating Innovation Ecosystems: A Qualitative Analysis of Ecosystem Positioning Strategies	2017	0.3312
355	Blueprint and Approach to Grow Revenue in Small Technology Companies	2010	0.3304
227	The Emerging Promise of Business Ecosystems	2009	0.267
276	Enabling the Creative Entrepreneur: Business Ecosystems	2009	0.265
278	Accelerating Successful Technical Entrepreneurship	2009	0.2586
325	Technical Entrepreneurs Benefit From Business Ecosystems	2010	0.254
711	Developing an Innovation Engine to Make Canada a Global Leader in Cybersecurity	2013	0.237
919	Business, Innovation, and Knowledge Ecosystems: How They Differ and How to Survive and Thrive within Them	2015	0.2354
308	Value Co-creation: Lessons from Lead to Win Ecosystem	2009	0.2238
85	Keystone Organization for Ontario's Open Source Ecosystem	2007	0.2002
726	A Heritage Economy: Business Model Innovation for Economic Wealth, Social Well-Being, and Environmental Health	2013	0.1983
564	Ecosystem Under Construction: An Action Research Study on Entrepreneurship in a Business Ecosystem	2012	0.1875
751	Risk Management in Crowdsourcing-Based Business Ecosystems	2013	0.1728
376	Keystone: Adjective or Noun?	2010	0.1521
113	Ladder of Participation: Business Models for Peer Production	2008	0.1493
279	The Expanding Role of Entrepreneurs in the Creation and Development of Internet Ecosystems	2009	0.1411
685	Navigating Risk When Entering and Participating in a Business Ecosystem	2013	0.1366
807	Designing Business Models for the Internet of Things	2014	0.1247
1024	Managing Innovation Ecosystems to Create and Capture Value in ICT Industries	2016	0.1189
Itemid	DTM_Topic:4 (Research - Test-Application) field trial factor test survey dimension participant technology culture user bias search figure component competitive application context national management correlation	Year	Prop
959	Factors Affecting the Attrition of Test Users During Living Lab Field Trials	2016	0.4662
1003	Detecting White Spots in Innovation-Driven Intellectual Property Management	2016	0.3818
978	Why National Culture Should Be at the Heart of Innovation Management	2016	0.3173
1047	Taking Real-Life Seriously: An Approach to Decomposing Context Beyond “Environment” in Living Labs	2017	0.1204
497	Entrepreneurial Orientation and Company Performance: Can the Academic Literature Guide Managers?	2011	0.1093
870	Implementation Prerequisites for Electronic Procurement of Services	2015	0.0516
1055	Reflecting on Actions in Living Lab Research	2017	0.0499
606	Structuring User Involvement in Panel-Based Living Labs	2012	0.0476

301	Components of Co-creation	2009	0.0457
452	Redefining Women's Work\ Tensions Between Technology"	2011	0.0413
645	Sustainability in Open Source Software Commons: Lessons Learned from an Empirical Study of SourceForge Projects	2013	0.0409
820	Perceived Environmental Uncertainty for Startups: A Note on Entrepreneurship Research from an Indian Perspective	2014	0.0401
370	Integrating Lessons from Other Disciplines into Open Source Practice	2010	0.0285
743	Open Innovation Processes in Living Lab Innovation Systems: Insights from the LeYLab	2013	0.0267
1054	Overcoming Barriers to Experimentation in Business-to-Business Living Labs	2017	0.0266
1001	Assessing Cooperation between Industry and Research Infrastructure in Hungary	2016	0.0248
872	Agile New Service Development in an Interdisciplinary Context	2015	0.0236
267	Collaborating Across Disciplines	2009	0.0228
656	Key Factors Affecting a Technology Entrepreneur's Choice of Incubator or Accelerator	2013	0.0207
533	Towards More Case Study Research in Entrepreneurship	2012	0.0194
ItemId	DTM_Topic:5 (Innovation-Creative Idea) creative idea world process team individual work thinking human online environment behaviour safety condition future think people knowledge time organizational	Year	Prop
834	The Online World of the Future: Safe, Productive, and Creative	2014	0.5778
911	Establishing New Codes for Creativity through Haute Cuisine: The Case of Ferran Adrià and elBulli	2015	0.5063
910	Toward a New Understanding of Creative Dynamics: From One-Size-Fits-All Models to Multiple and Dynamic Forms of Creativity	2015	0.4993
970	Underground Innovation: How to Encourage Bootlegging Employees to Disclose Their Good Ideas	2016	0.4367
849	Safety in the Online World of the Future	2014	0.3527
594	Creativity: Linking Theory and Practice for Entrepreneurs	2012	0.305
909	Introduction to the Special Issue on Creativity in Innovation	2015	0.2873
979	Insights from Stimulating Creative Behaviours in a Project-Based Organization Team	2016	0.2866
853	Strengthening Innovation Capacity through Different Types of Innovation Cultures	2014	0.1433
915	Setting the Stage for Collaborative Creative Leadership at Cirque du Soleil	2015	0.1432
267	Collaborating Across Disciplines	2009	0.1089
310	A Social Vision for Value Co-creation in Design	2009	0.0744
371	OpenOttawaLibre: An Interdisciplinary Approach to Building Creative Cities	2010	0.0699
1060	Opening the Black Box of Ambidexterity: Three Product Development Stories	2017	0.0664
809	Improvising Entrepreneurship	2014	0.0616
978	Why National Culture Should Be at the Heart of Innovation Management	2016	0.0465
912	Lessons in Creativity from the Innovative Design of the Swatch	2015	0.0453
763	Generative Innovation Practices, Customer Creativity, and the Adoption of New Technology Products	2014	0.0447
913	Luxury and Creativity: Exploration, Exploitation, or Preservation?	2015	0.0396
914	The Creativity Canvas: A Business Model for Knowledge and Idea Management	2015	0.037
ItemId	DTM_Topic:6 (Entrepreneur-Startup) company product customer market business offer solution cost model sale revenue strategy companies technology value benefit need money sell competitor	Year	Prop
362	Go-to-Market Targeting: Know the Market and Whether It Cares	2010	0.5884
226	How Open Source Strengthens Business Models	2009	0.486
388	Strategies for Selling Services	2010	0.4776
535	Minimum Viable Product and the Importance of Experimentation in Technology Startups	2012	0.4649
855	Disruptive Innovation vs Disruptive Technology: The Disruptive Potential of the Value Propositions of 3D Printing Technology Startups	2014	0.4498
324	The Business of Open: Common Pitfalls for Open Source Startups	2010	0.4272
280	Entrepreneurship in an Established Company	2009	0.3811
491	A Sales Execution Strategy Guide for Technology Startups	2011	0.3786
386	Building a Business-to-Business Sales Process	2010	0.372
356	Growing Revenue with Open Source	2010	0.3594
385	Differentiating Community from Customers in an F/LOSS Business	2010	0.3232
490	Acquisition Integration Models: How Large Companies Successfully Integrate Startups	2011	0.3068
942	3D Printing and Its Disruptive Impacts on Supply Chains of the Future	2015	0.3044
82	Open Source Telecommunication Companies	2007	0.304
629	TIM Lecture Series - 29 Lessons Learned in Entrepreneurship	2012	0.2986
216	Open Innovation 2.0	2008	0.2947
357	Entrepreneurial Growth: An Entrepreneur's Choice	2010	0.2822
548	How Do Large Companies Manage Their Investments Across the Three Horizons?	2012	0.2733
617	Global Mindset: An Entrepreneur's Perspective on the Born-Global Approach	2012	0.2705
355	Blueprint and Approach to Grow Revenue in Small Technology Companies	2010	0.2672
ItemId	DTM_Topic:7 (Adoption-Value customer) phase marketing customer test supplier action intention technology model resellers adoption subject behaviour user study process agent selling mode advertising	Year	Prop
634	Neuromarketing: Understanding Customers' Subconscious Responses to Marketing	2012	0.5959
965	Examining the Modes Malware Suppliers Use to Provide Goods and Services	2016	0.5782
1057	Needsfinding in Living Labs: A Structured Research Approach	2017	0.5025
925	Using Entrepreneurial Marketing to Foster Reseller Adoption of Smart Micro-Grid Technology	2015	0.4622
1053	Methods for Supporting Older Users in Communicating Their Emotions at Different Phases of a Living Lab Project	2017	0.3026
836	Effective Digital Channel Marketing for Cybersecurity Solutions	2014	0.2936
1010	Audience Commodification: A Source of Innovation in Business Models	2016	0.2478
300	Viable Business Models for Corporate Co-creation Communities	2009	0.0336
308	Value Co-creation: Lessons from Lead to Win Ecosystem	2009	0.0319
848	Assessing the Intentions and Timing of Malware	2014	0.031
115	Open Standards vs. Open Source: a Case of the OpenAccess Standard	2008	0.03
57	Competitive Actions of Open Source Firms	2007	0.0298
226	How Open Source Strengthens Business Models	2009	0.0295
635	An Enterprise Perspective on Customer Value Propositions for Open Source Software	2012	0.0283
763	Generative Innovation Practices, Customer Creativity, and the Adoption of New Technology Products	2014	0.0277
829	Challenging the Stage-Gate Model in Crowdsourcing: The Case of Fiat Mio in Brazil	2014	0.0275
718	Servitization in a Security Business: Changing the Logic of Value Creation	2013	0.0272
1034	Priority Systems at Theme Parks from the Perspective of Managers and Customers	2016	0.0258
135	Open Source Telecom	2008	0.0251
817	Entrepreneurship Education in India: A Critical Assessment and a Proposed Framework	2014	0.0244

Itemid	DTM_Topic:8 (Innovation-Public-Society) public citizen city innovation uncertainty collaborative environmental sector scale smart government environment organization stakeholder collaboration study decision intermediary pilot service	Year	Prop
820	Perceived Environmental Uncertainty for Startups: A Note on Entrepreneurship Research from an Indian Perspective	2014	0.3581
1032	The Smart City Ecosystem as an Innovation Model: Lessons from Montreal	2016	0.3107
1040	Integrating Open Innovation Platforms in Public Sector Decision Making: Empirical Results from Smart City Research	2016	0.2842
1041	Collaborative Innovation with External Actors: An Empirical Study on Open Innovation Platforms in Smart Cities	2016	0.2798
895	Viability Radar: A Practical Tool for Assessing the Viability of Transformative Service Innovations in a Healthcare Context	2015	0.1746
933	Cities as Collaborative Innovation Platforms	2015	0.1544
1045	Innovation in the Public Sector: Exploring the Characteristics and Potential of Living Labs and Innovation Labs	2017	0.1341
877	The City as Living Laboratory: Empowering Citizens with the Citadel Toolkit	2015	0.1198
1031	Empowering Local Tourism Providers to Innovate through a Living Lab Process: Does Scale Matter?	2016	0.1106
1049	The Design-Driven Living Lab: A New Approach to Exploring Solutions to Complex Societal Challenges	2017	0.085
252	Transparency in Government	2009	0.0739
607	Living Labbing the Rotterdam Way: Co-Creation as an Enabler for Urban Innovation	2012	0.0555
249	The Steady March of the European Penguins	2009	0.055
393	Major Events: Good Economics and Exposure to the World	2010	0.0479
120	Data Access in Canada: CivicAccess.ca	2008	0.0479
230	Government Transparency via Open Data and Open Source	2009	0.0432
935	Governance Solutions for Wicked Problems: Metropolitan Innovation Ecosystems as Frontrunners to Sustainable Well-Being	2015	0.0427
960	The Evolution of Intermediary Activities: Broadening the Concept of Facilitation in Living Labs	2016	0.0419
405	TriSano: Collaborating for the Good of Global Public Health	2010	0.0408
952	Contextuality and Co-Creation Matter: A Qualitative Case Study Comparison of Living Lab Concepts in Urban Research	2015	0.0332
Itemid	DTM_Topic:9 (Entrepreneur-Enterprise) network knowledge innovation actor social process change resource relationship role technological interaction sharing collaboration venture institution type organization organizational networked	Year	Prop
920	Technological Public-Private Innovation Networks: A Conceptual Framework Describing Their Structure and Mechanism of Interaction	2015	0.4888
1025	Boundary Objects as Part of Knowledge Integration for Networked Innovation	2016	0.4224
828	Down the Rabbit Hole: How Structural Holes in Entrepreneurs' Social Networks Impact Early Venture Growth	2014	0.3583
827	Developing a Social Network as a Means of Obtaining Entrepreneurial Knowledge Needed for Internationalization	2014	0.2555
1060	Opening the Black Box of Ambidexterity: Three Product Development Stories	2017	0.2022
536	A Guide for Entrepreneurs Who Lead and Manage Change	2012	0.1356
853	Strengthening Innovation Capacity through Different Types of Innovation Cultures	2014	0.122
426	Renewal Through Co-Creation in Business Networks	2011	0.1206
578	Accelerating a Network Model of Care: Taking a Social Innovation to Scale	2012	0.1035
919	Business, Innovation, and Knowledge Ecosystems: How They Differ and How to Survive and Thrive within Them	2015	0.0932
427	The Strategic Impact of Corporate Responsibility and Criminal Networks on Value Co-Creation	2011	0.0845
948	The Grey Areas Between Open and Closed in Innovation Networks	2015	0.0841
972	Governing Quintuple Helix Innovation: Urban Living Labs and Socio-Ecological Entrepreneurship	2016	0.0788
821	Reviewing the Knowledge Systems of Innovation and the Associated Roles of Major Stakeholders in the Indian Context	2014	0.0778
616	Using Social Media to Accelerate the Internationalization of Startups from Inception	2012	0.0691
602	Living Labs as Open-Innovation Networks	2012	0.066
605	Living Labs for Cross-Border Systemic Innovation	2012	0.0657
750	From Idea Crowdsourcing to Managing User Knowledge	2013	0.0642
743	Open Innovation Processes in Living Lab Innovation Systems: Insights from the LeYLab	2013	0.0627
1040	Integrating Open Innovation Platforms in Public Sector Decision Making: Empirical Results from Smart City Research	2016	0.061
Itemid	DTM_Topic:10 (Cybersecurity-OSS-Attack) information system domain network decision analysis data peer threat dynamic layer making device search dashboard attack architecture host detection example	Year	Prop
1068	Combining Exploratory Analysis and Automated Analysis for Anomaly Detection in Real-Time Data Streams	2017	0.5156
701	Peer-to-Peer Enclaves for Improving Network Defence	2013	0.4991
1018	Mobilizing Knowledge: The Evidence Gap for Assistive Devices	2016	0.387
717	On the Road to Holistic Decision Making in Adaptive Security	2013	0.3616
963	Crowdsourcing Literature Reviews in New Domains	2016	0.2865
771	IT Consumerization: A Case Study of BYOD in a Healthcare Setting	2014	0.1212
575	From Stories to Evidence: How Mining Data Can Promote Innovation in the Nonprofit Sector	2012	0.0831
358	Plumbing the Internet with PostgreSQL: An Open Source Case Study	2010	0.0823
964	Intrusion Learning: An Overview of an Emergent Discipline	2016	0.0628
165	Sharing Information on the Semantic Web: The Reminiscence of an Old Legal Issue	2008	0.053
861	Cybersecurity Skills Training: An Attacker-Centric Gamified Approach	2015	0.0522
344	Enterprise Mashups: Cloud-Based, Cloud-Driven and Cloud-Derived Applications	2010	0.0516
704	Securing Canada's Information-Technology Infrastructure: Context, Principles, and Focus Areas of Cybersecurity Research	2013	0.0484
878	A Method and Tool to Support the Management of Systems Engineering Projects	2015	0.0482
580	Platformation: Cloud Computing Tools at the Service of Social Change	2012	0.0463
166	Software Accessibility: Where Are We Today?	2008	0.0413
943	Securing Cyberspace: Towards an Agenda for Research and Practice	2015	0.0406
834	The Online World of the Future: Safe, Productive, and Creative	2014	0.04
230	Government Transparency via Open Data and Open Source	2009	0.0382
400	Developing a Service Industry to Support the Sahana Disaster Management System	2010	0.0347
Itemid	DTM_Topic:11 (Ecosystem-Native Actors) region local program development transformation innovation support university incubation national collaborative centre global collaboration partnership activity shared cluster networking around	Year	Prop
1038	Profiling Regional Innovation Ecosystems as Functional Collaborative Systems: The Case of Cambridge	2016	0.4941
932	Making Smart Regions Smarter: Smart Specialization and the Role of Universities in Regional Innovation Ecosystems	2015	0.3688
937	Orchestrators of Innovation-Driven Regional Development: Experiences from the INNOFOKUS Project and Change2020 Programme	2015	0.3106
677	Incubation Programs from Public Research Organizations as Catalysts for Open Business Ecosystems	2013	0.2883
993	All Australian Regions Are Not Born Equal: Understanding the Regional Innovation Management Sandpit	2016	0.224
1033	A Process for Co-Creating Shared Value with the Crowd: Tourism Case Studies from a Regional Innovation System in Western Switzerland	2016	0.1919
994	Developing a Startup and Innovation Ecosystem in Regional Australia	2016	0.1538
829	Challenging the Stage-Gate Model in Crowdsourcing: The Case of Fiat Mio in Brazil	2014	0.1314
604	Designing Viable Business Models for Living Labs	2012	0.1207
934	Sustainable Innovation: A Competitive Advantage for Innovation Ecosystems	2015	0.1174
667	Quebec Seeks Solutions: An Economic Development Agency's Role in Local Open Innovation	2013	0.0989
378	Deals Without Borders: A Value Proposition for the Open Global Commerce Keystone	2010	0.0913

455	Building an Infrastructure to Support Women Founders: Lead to Win for Women	2011	0.0805
605	Living Labs for Cross-Border Systemic Innovation	2012	0.0799
972	Governing Quintuple Helix Innovation: Urban Living Labs and Socio-Ecological Entrepreneurship	2016	0.0754
303	The Micro- and Macro-levels of Co-creation: How Transformations Change People's Preferences	2009	0.0735
395	Developing a Replicable and Sustainable Model of Business Incubation	2010	0.0659
656	Key Factors Affecting a Technology Entrepreneur's Choice of Incubator or Accelerator	2013	0.0649
821	Reviewing the Knowledge Systems of Innovation and the Associated Roles of Major Stakeholders in the Indian Context	2014	0.0636
189	The CUE Factor: Community-University Engagement for Social Innovation	2008	0.0615
ItemId	DTM_Topic:12 (Entrepreneur-Global Startup) entrepreneur startup technology firm founder opportunity venture global market business early capital successful international growth resource incubator theory support internationalization	Year	Prop
1073	Lean Internationalization: How to Globalize Early and Fast in a Small Economy	2017	0.7109
532	Global from the Start: The Characteristics of Born-Global Firms in the Technology Sector	2012	0.674
1072	Is There a Lean Future for Global Startups?	2017	0.6499
1077	Initiating a New Research Phase in the Field of International Entrepreneurship: An Interview with Professor Nicole Coviello	2017	0.6451
557	An Overview of Four Issues on Technology Entrepreneurship in the TIM Review	2012	0.6379
1063	Hybrid Entrepreneurship: How and Why Entrepreneurs Combine Employment with Self-Employment	2017	0.6327
521	Entrepreneurial Effort in the Theory of the Firm	2012	0.6196
941	The Emergence of the Lean Global Startup as a New Type of Firm	2015	0.6182
520	Technology Entrepreneurship: Overview, Definition, and Distinctive Aspects	2012	0.6144
845	Cybersecurity Startups: The Importance of Early and Rapid Globalization	2014	0.5952
454	Which Gender Differences Matter for High-Tech Entrepreneurship?	2011	0.562
1023	Entrepreneurial Growth Ambitions: The Case of Finnish Technology Startups	2016	0.5409
618	Market Channels of Technology Startups that Internationalize Rapidly from Inception	2012	0.525
614	What Technology Startups Must Get Right to Globalize Early and Rapidly	2012	0.5214
880	Do Actions Matter More than Resources? A Signalling Theory Perspective on the Technology Entrepreneurship Process	2015	0.5037
555	Making Money from Exploiting Schumpeterian Opportunities: John Sanguinetti and the Electronic Design Automation Industry	2012	0.4904
692	From Ideas to Opportunities: Exploring the Construction of Technology-Based Entrepreneurial Opportunities	2013	0.4795
656	Key Factors Affecting a Technology Entrepreneur's Choice of Incubator or Accelerator	2013	0.474
1007	Corporate Entrepreneurship: A Review and Future Research Agenda	2016	0.4595
826	Conceptualizing Innovation in Born-Global Firms	2014	0.4586
ItemId	DTM_Topic:13 (Entrepreneur-Startup) service provider customer experience electronic local proximity word-of-mouth communication small solution virtual legitimacy information pattern problem connection medium travel interaction	Year	Prop
783	Electronic Word-of-Mouth Communication for Local Service Providers	2014	0.626
871	The Role of Self-Service Mobile Technologies in the Creation of Customer Travel Experiences	2015	0.4083
971	A Pattern-Based Approach to the Development of Frugal Innovations	2016	0.3341
765	Enhancing Innovation through Virtual Proximity	2014	0.2822
801	Resolving Legitimacy Deficits in Technology Startups through Professional Services Practices	2014	0.2055
782	Accessing Value-in-Use Information by Integrating Social Platforms into Service Offerings	2014	0.1412
718	Servitization in a Security Business: Changing the Logic of Value Creation	2013	0.0778
388	Strategies for Selling Services	2010	0.0722
428	Quality-Based Co-Value in SaaS Business Relationships	2011	0.0636
243	Licensing of Open APIs	2009	0.0595
350	Communication Enabled Applications: What are the IP Considerations for Platform Providers?	2010	0.0353
440	Leveraging Collectives as a Technology Startup: A Case Study	2011	0.0273
1074	Platforms for Innovation and Internationalization	2017	0.0256
349	Inspired by Open Source and CEAs: The Future of Collaborative Healthcare Delivery in Canada	2010	0.0252
215	Driving Innovation Through Interoperability	2008	0.0251
105	An Introduction to Rights Expression Languages	2007	0.025
461	Introducing the Oregon State University Open Source Lab	2011	0.0229
238	A RESTful Implementation of Geospatial Web Services	2009	0.0222
608	""	2012	0.0221
356	Growing Revenue with Open Source	2010	0.0216
ItemId	DTM_Topic:14 (Ecosystem-business-value community) platform stakeholder model program development business opportunity technology group company lesson provide economic decision owner kots help revenue participant support	Year	Prop
381	Migrating an Existing Business to a New Approach to Revenue Generation	2010	0.4979
377	Keystone Off-The-Shelf	2010	0.4642
433	Carleton Entrepreneurs: The First Keystone Off-The-Shelf Application	2011	0.3869
432	A Progress Report on the Keystone Off-The-Shelf Project	2011	0.3443
440	Leveraging Collectives as a Technology Startup: A Case Study	2011	0.3099
446	A Money-Making Platform for Entrepreneurs	2011	0.2644
391	A New Engine of Economic Development	2010	0.2129
1019	Transferable Practices for Knowledge Mobilization: Lessons from a Community-Engaged Health Research Study	2016	0.2091
647	Going Open: Does it Mean Giving Away Control?	2013	0.1734
379	Ottercall: A Language Learning Company	2010	0.1248
355	Blueprint and Approach to Grow Revenue in Small Technology Companies	2010	0.1187
393	Major Events: Good Economics and Exposure to the World	2010	0.114
455	Building an Infrastructure to Support Women Founders: Lead to Win for Women	2011	0.0822
439	Shifting an Entrepreneur's World View	2011	0.0713
684	Rapid Prototyping Using a Configurable Platform	2013	0.0673
658	An Ecosystem-Based Job-Creation Engine Fuelled by Technology Entrepreneurs	2013	0.0659
1040	Integrating Open Innovation Platforms in Public Sector Decision Making: Empirical Results from Smart City Research	2016	0.0656
308	Value Co-creation: Lessons from Lead to Win Ecosystem	2009	0.064
782	Accessing Value-in-Use Information by Integrating Social Platforms into Service Offerings	2014	0.063
96	Ontario Research Commercialization Program	2007	0.0548
ItemId	DTM_Topic:15 (Accelerator-Project process) design service innovation logic employee problem methodology work sector sustainable organization manufacturing outcome result used study implementation procurement change observation	Year	Prop
870	Implementation Prerequisites for Electronic Procurement of Services	2015	0.5411
869	A Technology-Assisted Design Methodology for Employee-Driven Innovation in Services	2015	0.4885
780	Innovation in Services: A Literature Review	2014	0.452

1017	Developing Tacit Knowledge of Complex Systems: The Value of Early Empirical Inquiry in Healthcare Design	2016	0.3945
935	Governance Solutions for Wicked Problems: Metropolitan Innovation Ecosystems as Frontrunners to Sustainable Well-Being	2015	0.3038
997	Outcomes from Applying Design-Led Innovation in an Australian Manufacturing Firm	2016	0.257
554	Results-Based Organization Design for Technology Entrepreneurs	2012	0.2044
934	Sustainable Innovation: A Competitive Advantage for Innovation Ecosystems	2015	0.1579
724	How Service Innovation Boosts Bottom Lines	2013	0.1421
793	Integrating Design for All in Living Labs	2014	0.111
790	Using Trademarks to Measure Innovation in Knowledge-Intensive Business Services	2014	0.1083
781	Radical Versus Incremental Innovation: The Importance of Key Competences in Service Firms	2014	0.0769
792	The Promoting Force of Technology for Service Innovation in High-Tech Industries	2014	0.0655
811	Designing and Managing Value Co-Creation in KIBS Engagements	2014	0.0608
442	Developing Silicon IP with Open Source Tools	2011	0.0587
819	The Role of Managers as Agents in Successful Service Innovations: Evidence from India	2014	0.0571
603	Mapping Living Labs in the Landscape of Innovation Methodologies	2012	0.0484
228	How Companies Make Money Through Involvement in Open Source Hardware Projects	2009	0.0474
555	Making Money from Exploiting Schumpeterian Opportunities: John Sanguinetti and the Electronic Design Automation Industry	2012	0.0438
996	Revealing Hidden Innovation: Patterns of External Innovation Investment in Australian Businesses	2016	0.0411
ItemId	DTM_Topic:16 (Research-Collaboration) group competition participant workshop centre team business organization design building would health identity campus developed shopping service participatory individual facility	Year	Prop
1039	The Cuckoo's Nest Approach for Co-Creating Business Ecosystems in Smart Cities	2016	0.3286
665	Problemsourcing: Local Open Innovation for R&D Organizations	2013	0.1532
595	Creating Tomorrow's Global Entrepreneurs: A Case Study of the Stu Clark Centre for Entrepreneurship	2012	0.0965
856	Turning Technology into Business Using University Patents	2014	0.0854
994	Developing a Startup and Innovation Ecosystem in Regional Australia	2016	0.0675
957	Enhancing Early Innovation in an Urban Living Lab: Lessons from Espoo, Finland	2016	0.0463
371	OpenOttawaLibre: An Interdisciplinary Approach to Building Creative Cities	2010	0.0404
183	Open Sourcing Social Change: Inside the Constellation Model	2008	0.0315
263	Offline: Where Tech Communities Succeed With Women	2009	0.0303
401	IEEE Humanitarian Projects: Open Hardware for the Benefit of the Poorest Nations	2010	0.028
269	Social Actions: Making the Web More Philanthropic	2009	0.0208
86	Company Interactions with Open Platforms	2007	0.0193
267	Collaborating Across Disciplines	2009	0.0192
1009	Co-Creating User Stories: A Tool for Making Sense of Business Opportunities	2016	0.0188
567	Building Trust in High-Performing Teams	2012	0.0181
577	Evergreen Brick Works: An Innovation and Sustainability Case Study	2012	0.0174
937	Orchestrators of Innovation-Driven Regional Development: Experiences from the INNOFOKUS Project and Change2020 Programme	2015	0.0172
793	Integrating Design for All in Living Labs	2014	0.017
393	Major Events: Good Economics and Exposure to the World	2010	0.0164
259	The 100-Mile Client Roster	2009	0.016
ItemId	DTM_Topic:17 (Cybersecurity-Threat-Risk) security vulnerability defect code system information risk program control threat analysis problem osvdb error access report result attack language would	Year	Prop
713	An Enterprise Security Program and Architecture to Support Business Drivers	2013	0.5554
712	Quantitative Metrics and Risk Assessment: The Three Tenets Model of Cybersecurity	2013	0.5449
715	A Research Agenda for Security Engineering	2013	0.507
157	Security Hardening of Open Source Software	2008	0.4869
158	Language Insecurity	2008	0.4373
889	Challenges in Maritime Cyber-Resilience	2015	0.3501
156	Coverity Report	2008	0.316
155	Open Source Vulnerability Database Project	2008	0.3004
888	Cybersecurity and Cyber-Resilient Supply Chains	2015	0.2268
863	Securing the Car: How Intrusive Manufacturer-Supplier Approaches Can Reduce Cybersecurity Vulnerabilities	2015	0.1626
58	Ensuring the Quality of Open Source Software	2007	0.1593
717	On the Road to Holistic Decision Making in Adaptive Security	2013	0.1484
887	Building Cyber-Resilience into Supply Chains	2015	0.1423
1069	A Cybersecurity Risk Assessment Framework that Integrates Value-Sensitive Design	2017	0.1336
846	Cyber-Attack Attributes	2014	0.1288
885	Supply Chain Cyber-Resilience: Creating an Agenda for Future Research	2015	0.121
700	Cybersecurity Futures: How Can We Regulate Emergent Risks?	2013	0.1087
702	Security Challenges in Smart-Grid Metering and Control Systems	2013	0.1027
718	Servitization in a Security Business: Changing the Logic of Value Creation	2013	0.0983
943	Securing Cyberspace: Towards an Agenda for Research and Practice	2015	0.0957
ItemId	DTM_Topic:18 (Technology-Healthcare) data information health system healthcare access technology device power care patient solution record challenge provide mobile medical management application also	Year	Prop
637	Real-Time Mobile Communication of Power Requirements for Electric Vehicles	2012	0.798
1067	Big Data and Individual Privacy in the Age of the Internet of Things	2017	0.6102
702	Security Challenges in Smart-Grid Metering and Control Systems	2013	0.5799
581	TIM Lecture Series - TELUS in Health: Improving Health Outcomes for All Canadians	2012	0.4379
205	Mirth: Standards-Based Open Source Healthcare Interface Engine	2008	0.346
349	Inspired by Open Source and CEAs: The Future of Collaborative Healthcare Delivery in Canada	2010	0.3036
648	The Evolving Role of Open Source Software in Medicine and Health Services	2013	0.2993
771	IT Consumerization: A Case Study of BYOD in a Healthcare Setting	2014	0.285
773	Formulating an Executive Strategy for Big Data Analytics	2014	0.2663
873	Personal Health Systems Technologies: Critical Issues in Service Innovation and Diffusion	2015	0.2171
335	The Open Source Mobile Cloud: Delivering Next-Gen Mobile Apps and Systems	2010	0.2123
120	Data Access in Canada: CivicAccess.ca	2008	0.1986
565	Developmental Impact Analysis of an ICT-Enabled Scalable Healthcare Model in BRICS Economies	2012	0.1948
579	Hacking Health: Bottom-up Innovation for Healthcare	2012	0.1897
403	Emerging Open Source Health Information Business Ecosystems in Resource-Poor Environments: the OpenMRS Experience	2010	0.163
757	The Businesses of Open Data and Open Source: Some Key Similarities and Differences	2014	0.1613

886	Cyber-Resilience: A Strategic Approach for Supply Chain Management	2015	0.1349
284	Business Intelligence: A Primer	2009	0.1347
287	Open Source BI: A Market Overview	2009	0.1339
700	Cybersecurity Futures: How Can We Regulate Emergent Risks?	2013	0.1306
ItemId	DTM_Topic:19 (Open source-content community) student content university education learning course educational institution project resource open technology program access initiative developing development country world school	Year	Prop
197	A Panamanian Initiative to Embrace the Future	2008	0.4753
175	Why Give Knowledge Away for Free? The Case for Open Educational Resources	2008	0.443
174	A Flat Network for the Unflat World: Open Educational Resources in Developing Countries	2008	0.4302
213	Social Innovation in Sub-Saharan Africa	2008	0.4141
271	Open Source Resources in Education: Opportunities and Challenges	2009	0.3789
182	Child-Centric Laptop to Help Address Social Needs	2008	0.3217
59	Conference Report: Open Education 2007	2007	0.3113
334	Experiences From the OSSIE Open Source Software Defined Radio Project	2010	0.2918
253	Use of Moodle for Single Entry Portal at Riga Technical University	2009	0.2821
77	Open Educational Resources	2007	0.2695
210	Experiments, Expertise and Google Summer of Code (TM)	2008	0.2685
461	Introducing the Oregon State University Open Source Lab	2011	0.2565
595	Creating Tomorrow's Global Entrepreneurs: A Case Study of the Stu Clark Centre for Entrepreneurship	2012	0.2528
212	Power of Openness to Solve Textbook Access Problems	2008	0.2523
189	The CUE Factor: Community-University Engagement for Social Innovation	2008	0.2357
204	Developing an Open Source Reference Implementation of the Canadian Electronic Health Records Solution	2008	0.2329
1026	The Concept of the Entrepreneurial University Applied to Universities of Technology in Austria: Already Reality or a Vision of the Future?	2016	0.2195
485	Fostering Student Entrepreneurship and University Spinoff Companies	2011	0.2089
319	Developing a Successful Open Source Training Model	2010	0.1781
404	The Humanitarian FOSS Project	2010	0.1681
ItemId	DTM_Topic:20 (Cybersecurity-Crowdsourcing) crowd crowdsourcing actor risk value business resource firm relationship process kibs biotechnology pharmaceutical task strategic category engagement type different client	Year	Prop
685	Navigating Risk When Entering and Participating in a Business Ecosystem	2013	0.4906
615	To Internationalize Rapidly from Inception: Crowdsourcing	2012	0.2997
811	Designing and Managing Value Co-Creation in KIBS Engagements	2014	0.2993
751	Risk Management in Crowdsourcing-Based Business Ecosystems	2013	0.2958
427	The Strategic Impact of Corporate Responsibility and Criminal Networks on Value Co-Creation	2011	0.2821
676	Strategic Partnerships and Open Innovation in the Biotechnology Industry in Belgium	2013	0.2653
950	Leveraging Living Lab Innovation Processes through Crowdsourcing	2015	0.1685
657	How Can Entrepreneurs Motivate Crowdsourcing Participants?	2013	0.1616
995	Employment Dynamics of Australian Entrepreneurship: A Management Perspective	2016	0.1556
784	Finnish Knowledge-Intensive Business Services in China: Market Entry and Position in the Value Chain	2014	0.1054
963	Crowdsourcing Literature Reviews in New Domains	2016	0.0803
665	Problemsourcing: Local Open Innovation for R&D Organizations	2013	0.0774
829	Challenging the Stage-Gate Model in Crowdsourcing: The Case of Fiat Mio in Brazil	2014	0.0579
1033	A Process for Co-Creating Shared Value with the Crowd: Tourism Case Studies from a Regional Innovation System in Western Switzerland	2016	0.0496
770	HarassMap: Using Crowdsourced Data to Map Sexual Harassment in Egypt	2014	0.0421
609	TIM Lecture Series - Born Global: A Pharmaceutical Startup Perspective	2012	0.0409
750	From Idea Crowdsourcing to Managing User Knowledge	2013	0.0378
449	New Solutions to the Funding Dilemma of Technology Startups	2011	0.0291
757	The Businesses of Open Data and Open Source: Some Key Similarities and Differences	2014	0.0195
82	Open Source Telecommunication Companies	2007	0.0181
ItemId	DTM_Topic:21 (Growth-Capability-Improvement) organization business process management technology need maturity capability change product function must level solution requirement team required improvement firm within	Year	Prop
627	Process Adaptability in the IT Supply Chain	2012	0.7471
626	Enabling Process Alignment for IT Entrepreneurship	2012	0.7148
596	Process Ambidexterity for IT Entrepreneurship	2012	0.6838
694	Enabling Sustainable Improvement in IT Entrepreneurship	2013	0.6705
802	Using a Capability Perspective to Sustain IT Improvement	2014	0.5519
547	Process Ambidexterity for Entrepreneurial Firms	2012	0.5449
879	Optimizing Innovation with the Lean and Digitize Innovation Process	2015	0.2343
145	Making Open Source Ready for the Enterprise: The Open Source Maturity Model	2008	0.1736
548	How Do Large Companies Manage Their Investments Across the Three Horizons?	2012	0.156
536	A Guide for Entrepreneurs Who Lead and Manage Change	2012	0.1529
215	Driving Innovation Through Interoperability	2008	0.1353
206	Open Health Tools: Tooling for Interoperable Healthcare	2008	0.13
285	Special Considerations for Business Intelligence Projects	2009	0.126
64	Five Stage Approach to Licensing	2007	0.1185
734	Using Boundary Management for More Effective Product Development	2013	0.1175
554	Results-Based Organization Design for Technology Entrepreneurs	2012	0.1157
764	Collaborative Idea Management: A Driver of Continuous Innovation	2014	0.1133
878	A Method and Tool to Support the Management of Systems Engineering Projects	2015	0.1129
522	Organizational Ambidexterity: How Small Technology Firms Balance Innovation and Support	2012	0.1123
713	An Enterprise Security Program and Architecture to Support Business Drivers	2013	0.1122
ItemId	DTM_Topic:22 (Ecosystem-business-value community) eclipse platform deal ecosystem collective member common business system foundation individual asset resource modularity base architecture participation technology player research	Year	Prop
896	Who Inhabits a Business Ecosystem? The Technospecies as a Unifying Concept	2015	0.5485
495	Business Ecosystems as Institutions of Participation: A Systems Perspective on Community-Developed Platforms	2011	0.4501
434	Defining Good Deals in Business Collectives	2011	0.3966
376	Keystone: Adjective or Noun?	2010	0.3839
488	Economics of Software Product Development Collectives	2011	0.365
655	Platforms, Communities, and Business Ecosystems: Lessons Learned about Technology Entrepreneurship in an Interconnected World	2013	0.2857
245	Measuring Modularity in Open Source Code Bases	2009	0.2537

556	Applying the Theory of the Firm to Examine a Technology Startup at the Investment Stage	2012	0.2396
94	Eclipse: A Premier Open Source Community	2007	0.225
372	Implementing a Deal Development Platform for Business Ecosystems	2010	0.2237
436	Control and Diversity in Company-led Open Source Projects	2011	0.2145
647	Going Open: Does it Mean Giving Away Control?	2013	0.1773
919	Business, Innovation, and Knowledge Ecosystems: How They Differ and How to Survive and Thrive within Them	2015	0.1455
378	Deals Without Borders: A Value Proposition for the Open Global Commerce Keystone	2010	0.1308
276	Enabling the Creative Entrepreneur: Business Ecosystems	2009	0.1022
219	Collaborative Software Development in the Enterprise	2009	0.0902
683	Niche Formation in the Mashup Ecosystem	2013	0.0801
751	Risk Management in Crowdsourcing-Based Business Ecosystems	2013	0.0715
203	The Emerging Role of Open Source in Healthcare	2008	0.0711
807	Designing Business Models for the Internet of Things	2014	0.0687
ItemId	DTM_Topic:23 (Living_Lab-Innovation-project) risk value device cybersecurity botnet stakeholder action club medical step takedown route cider type blueprint legal sourcing dimension design group	Year	Prop
905	Representing Botnet-Enabled Cyber-Attacks and Botnet Takedowns Using Club Theory	2015	0.6676
1069	A Cybersecurity Risk Assessment Framework that Integrates Value-Sensitive Design	2017	0.5275
862	Botnet Takedown Initiatives: A Taxonomy and Performance Model	2015	0.5109
903	A Value Blueprint Approach to Cybersecurity in Networked Medical Devices	2015	0.4688
1030	Rejuvenating the Cider Route in Quebec: An Action Design Research Approach to Stakeholder Collaboration and Innovation	2016	0.369
196	Treasury of the iCommons: Reflections of a Commons Sourcing Lawyer	2008	0.1599
435	The Social Management of Risk	2011	0.1134
55	Special Considerations for Financial Services Firms	2007	0.0564
357	Entrepreneurial Growth: An Entrepreneur's Choice	2010	0.037
845	Cybersecurity Startups: The Importance of Early and Rapid Globalization	2014	0.0338
146	Method for Qualification and Selection of Open Source Software	2008	0.0267
700	Cybersecurity Futures: How Can We Regulate Emergent Risks?	2013	0.0259
846	Cyber-Attack Attributes	2014	0.0258
386	Building a Business-to-Business Sales Process	2010	0.0242
847	Crimeware Marketplaces and Their Facilitating Technologies	2014	0.023
980	Weighing the Pros and Cons of Engaging in Open Innovation	2016	0.0215
1020	Research on Fire: Lessons Learned in Knowledge Mobilization	2016	0.0194
355	Blueprint and Approach to Grow Revenue in Small Technology Companies	2010	0.0185
863	Securing the Car: How Intrusive Manufacturer-Supplier Approaches Can Reduce Cybersecurity Vulnerabilities	2015	0.0167
848	Assessing the Intentions and Timing of Malware	2014	0.0151
ItemId	DTM_Topic:24 (Innovation-Local innovation) event problem idea innovation solution company open solutions world solve people international quebec first knowledge collaboration session adaptive local process	Year	Prop
664	The Seeking Solutions Approach: Solving Challenging Business Problems with Local Open Innovation	2013	0.4562
667	Quebec Seeks Solutions: An Economic Development Agency's Role in Local Open Innovation	2013	0.4031
912	Lessons in Creativity from the Innovative Design of the Swatch	2015	0.3502
1011	A Proposed Approach for Idea Selection in Front End of Innovation Activities	2016	0.3486
666	Local Open Innovation: How to Go from Ideas to Solutions	2013	0.2329
764	Collaborative Idea Management: A Driver of Continuous Innovation	2014	0.1873
914	The Creativity Canvas: A Business Model for Knowledge and Idea Management	2015	0.1639
393	Major Events: Good Economics and Exposure to the World	2010	0.1442
187	Adaptive Co-management and the Learning that Leads to Social Innovation	2008	0.0967
371	OpenOttawaLibre: An Interdisciplinary Approach to Building Creative Cities	2010	0.0907
665	Problemsourcing: Local Open Innovation for R&D Organizations	2013	0.0826
411	Private-Collective Innovation: Let There Be Knowledge	2011	0.0737
546	User Frustrations as Opportunities	2012	0.067
576	Being Disruptive: How Open Growth is Delivering Effective Social Change at a Fast Pace	2012	0.0667
267	Collaborating Across Disciplines	2009	0.0665
829	Challenging the Stage-Gate Model in Crowdsourcing: The Case of Fiat Mio in Brazil	2014	0.0534
1033	A Process for Co-Creating Shared Value with the Crowd: Tourism Case Studies from a Regional Innovation System in Western Switzerland	2016	0.0444
186	Social Innovation: Access and Leadership	2008	0.0419
615	To Internationalize Rapidly from Inception: Crowdsourcing	2012	0.0397
909	Introduction to the Special Issue on Creativity in Innovation	2015	0.0387
ItemId	DTM_Topic:25 (Growth-Legitimacy process) process need development also open technology different project important work tool first many within organization level time people well result	Year	Prop
1046	Categorization of Innovation Tools in Living Labs	2017	0.9538
951	Places and Spaces within Living Labs	2015	0.9089
1055	Reflecting on Actions in Living Lab Research	2017	0.8945
1056	Action Research as a Framework to Evaluate the Operations of a Living Lab	2017	0.8858
740	Coordination and Participation in Living Lab Networks	2013	0.8663
748	Linking Living Lab Characteristics and Their Outcomes: Towards a Conceptual Framework	2013	0.8545
952	Contextuality and Co-Creation Matter: A Qualitative Case Study Comparison of Living Lab Concepts in Urban Research	2015	0.8533
958	Urban Living Labs for Sustainability in Suburbs in Need of Modernization and Social Uplift	2016	0.8493
1048	Heading for a FALL: A Framework for Agile Living Lab Projects	2017	0.8265
957	Enhancing Early Innovation in an Urban Living Lab: Lessons from Espoo, Finland	2016	0.8114
603	Mapping Living Labs in the Landscape of Innovation Methodologies	2012	0.8113
1054	Overcoming Barriers to Experimentation in Business-to-Business Living Labs	2017	0.8105
960	The Evolution of Intermediary Activities: Broadening the Concept of Facilitation in Living Labs	2016	0.8049
749	How Do We Keep the Living Laboratory Alive? Learning and Conflicts in Living Lab Collaboration	2013	0.8045
741	The Habitation Lab: Using a Design Approach to Foster Innovation for Sustainable Living	2013	0.8035
744	A Living Lab as a Service: Creating Value for Micro-enterprises through Collaboration and Innovation	2013	0.7912
956	The Impact of Living Lab Methodology on Open Innovation Contributions and Outcomes	2016	0.7908
1047	Taking Real-Life Seriously: An Approach to Decomposing Context Beyond "Environment" in Living Labs	2017	0.7907
1049	The Design-Driven Living Lab: A New Approach to Exploring Solutions to Complex Societal Challenges	2017	0.7653
607	Living Labbing the Rotterdam Way: Co-Creation as an Enabler for Urban Innovation	2012	0.7636

			0
ItemId	DTM_Topic:26 (Open Source-Development) hardware device software project technology netbsd code design free humanitarian could documentation tool component volunteer developer first book problem radio	Year	Prop
684	Rapid Prototyping Using a Configurable Platform	2013	0.3798
404	The Humanitarian FOSS Project	2010	0.3369
863	Securing the Car: How Intrusive Manufacturer-Supplier Approaches Can Reduce Cybersecurity Vulnerabilities	2015	0.3248
442	Developing Silicon IP with Open Source Tools	2011	0.3041
333	CRC Mobile Broadcasting F/LOSS Projects	2010	0.2827
400	Developing a Service Industry to Support the Sahana Disaster Management System	2010	0.2648
198	Reducing Global Poverty and Disease with Community and Technology: An Open Source Perspective	2008	0.2534
703	Keystone Business Models for Network Security Processors	2013	0.2439
399	Humanitarian Free and Open Source Software	2010	0.2343
331	Establishing and Engaging an Active Open Source Ecosystem with the BeagleBoard	2010	0.2254
259	The 100-Mile Client Roster	2009	0.2253
316	Open Source User Assistance: Ensuring That Everybody Wins	2010	0.2134
441	Lessons from an Open Source Business	2011	0.2032
619	TIM Lecture Series - Growing a Global Company Anchored on Open Source Software	2012	0.1942
76	Open Hardware	2007	0.1794
260	Community-Built Software: What I Learned from Calagator	2009	0.1746
214	Creating Disruptive Value For Not-For-Profit Organizations Using Open Source	2008	0.1731
365	Improving Product-Market Fit by Engaging an Open Source Community	2010	0.1724
195	Community Building: NetBSD in Hindsight	2008	0.1655
263	Offline: Where Tech Communities Succeed With Women	2009	0.1519
ItemId	DTM_Topic:27 (Open Source-License) software license f/loss open_source source code open copyright free right work commercial proprietary program licensing used legal public term project	Year	Prop
106	Key Changes to the GNU General Public License	2007	0.8325
966	License Compliance in Open Source Cybersecurity Projects	2016	0.735
229	F/LOSS is Commercial Software	2009	0.6506
137	Uses of Creative Commons Licenses	2008	0.6409
105	An Introduction to Rights Expression Languages	2007	0.64
416	Open Source License Selection in Relation to Business Models	2011	0.6323
122	Implementing Open Data: The Open Data Commons Project	2008	0.6136
193	Free and Open Source Licenses in Community Life	2008	0.6036
756	The Business of Open Source Software: A Primer	2014	0.5822
121	How is Copyright Relevant to Source Data and Source Code?	2008	0.5817
66	Open Source on Trial	2007	0.5702
74	Defining Open Source	2007	0.5649
691	Introducing "Business Source": The Future of Corporate Open Source Licensing?	2013	0.5578
65	Open Source Licensing in the Enterprise	2007	0.5543
644	Code Forking, Governance, and Sustainability in Open Source Software	2013	0.4927
97	Software Licensing	2007	0.4925
104	A Rallying Moment for Canadian Open Source Software	2007	0.4827
67	Comparing the BSD and GPL Licenses	2007	0.4674
75	Open Source Assets	2007	0.4541
102	Improving Application Development by Managing Licensing Issues	2007	0.4491
ItemId	DTM_Topic:28 (Open source-Data service provider) service application computing cloud communication provider customer infrastructure vendor value model channel business capability digital quality saas cost market relationship	Year	Prop
347	Communications Enabled Applications: Building Value, not Monetising APIs	2010	0.5502
340	Cloud Computing: What is it, and How Will it Affect Organizations?	2010	0.5163
428	Quality-Based Co-Value in SaaS Business Relationships	2011	0.5006
339	The Value of Cloud Computing	2010	0.4864
342	Private Clouds: Reality or Fog?	2010	0.4749
352	Communication Enabled CRM	2010	0.4568
425	Using Value Co-Creation to Redefine Business Models	2011	0.4549
343	Performance Testing From the Cloud	2010	0.4546
348	How to Add Value to your Business with CEA: A Practical Approach	2010	0.4196
363	Fundamentals of a Volume Market Engine	2010	0.3469
419	Software-as-a-Service Offer Differentiation by Business Unit	2011	0.3035
836	Effective Digital Channel Marketing for Cybersecurity Solutions	2014	0.272
490	Acquisition Integration Models: How Large Companies Successfully Integrate Startups	2011	0.2642
279	The Expanding Role of Entrepreneurs in the Creation and Development of Internet Ecosystems	2009	0.1994
618	Market Channels of Technology Startups that Internationalize Rapidly from Inception	2012	0.1749
1008	A Digital Maturity Model for Telecommunications Service Providers	2016	0.1689
335	The Open Source Mobile Cloud: Delivering Next-Gen Mobile Apps and Systems	2010	0.1645
800	Mobile Convergence and Entrepreneurial Opportunities for Innovative Products and Services	2014	0.1343
341	Re-evaluating Open Source for Sustaining Competitive Advantage for Hosted Applications	2010	0.1192
491	A Sales Execution Strategy Guide for Technology Startups	2011	0.1115
ItemId	DTM_Topic:29 () model score good impact economy economic global public private direct entity benefit high path example marketplace society figure analysis infrastructure	Year	Prop
714	Protecting Critical Infrastructure by Identifying Pathways of Exposure to Risk	2013	0.6579
847	Crimeware Marketplaces and Their Facilitating Technologies	2014	0.4189
810	Commercialization and Public Good: Conflict, Complement, or Critical Component?	2014	0.3112
565	Developmental Impact Analysis of an ICT-Enabled Scalable Healthcare Model in BRICS Economies	2012	0.1715
113	Ladder of Participation: Business Models for Peer Production	2008	0.0784
943	Securing Cyberspace: Towards an Agenda for Research and Practice	2015	0.0717
97	Software Licensing	2007	0.0591
395	Developing a Replicable and Sustainable Model of Business Incubation	2010	0.0563
837	Cybersecurity Capability Maturity Models for Providers of Critical Infrastructure	2014	0.0557
411	Private-Collective Innovation: Let There Be Knowledge	2011	0.055

556	Applying the Theory of the Firm to Examine a Technology Startup at the Investment Stage	2012	0.0548
942	3D Printing and Its Disruptive Impacts on Supply Chains of the Future	2015	0.0435
920	Technological Public-Private Innovation Networks: A Conceptual Framework Describing Their Structure and Mechanism of Interaction	2015	0.0433
175	Why Give Knowledge Away for Free? The Case for Open Educational Resources	2008	0.0426
145	Making Open Source Ready for the Enterprise: The Open Source Maturity Model	2008	0.0407
388	Strategies for Selling Services	2010	0.0406
848	Assessing the Intentions and Timing of Malware	2014	0.0404
277	Economic Free Software Perspectives	2009	0.039
862	Botnet Takedown Initiatives: A Taxonomy and Performance Model	2015	0.0389
399	Humanitarian Free and Open Source Software	2010	0.0376
ItemId	DTM_Topic:30 (Co-creation-value customer) value co-creation customer business model creation research product firm chain company framework component service resource proposition point offering relationship practice	Year	Prop
534	A Customer Value Creation Framework for Businesses That Generate Revenue with Open Source Software	2012	0.6032
635	An Enterprise Perspective on Customer Value Propositions for Open Source Software	2012	0.5442
309	Value Co-creation as Part of an Integrative Vision of Innovation Management	2009	0.4455
423	The Future of Co-Creation	2011	0.3862
301	Components of Co-creation	2009	0.3835
545	Business Model Discovery by Technology Entrepreneurs	2012	0.3633
791	Widening the Perspective on Industrial Innovation: A Service-Dominant-Logic Approach	2014	0.3319
807	Designing Business Models for the Internet of Things	2014	0.3052
1000	A Framework for Sustainable Circular Business Model Innovation	2016	0.2709
949	Exploring the Benefits of Integrating Business Model Research within Living Lab Projects	2015	0.2614
1002	Value Network Design for Innovations: Developing Alternative Value Network Drafts	2016	0.2352
1010	Audience Commodification: A Source of Innovation in Business Models	2016	0.2079
310	A Social Vision for Value Co-creation in Design	2009	0.1858
496	Innovation Policy Development and the Emergence of New Innovation Paradigms	2011	0.1815
566	The Physical Internet and Business Model Innovation	2012	0.1657
427	The Strategic Impact of Corporate Responsibility and Criminal Networks on Value Co-Creation	2011	0.1598
782	Accessing Value-in-Use Information by Integrating Social Platforms into Service Offerings	2014	0.1556
1008	A Digital Maturity Model for Telecommunications Service Providers	2016	0.1548
425	Using Value Co-Creation to Redefine Business Models	2011	0.1503
718	Servitization in a Security Business: Changing the Logic of Value Creation	2013	0.1502
ItemId	DTM_Topic:31 (Cybersecurity-Data service system) user data computer internet network authentication device used system text server online voice consumer mobile access password however card using	Year	Prop
716	Multifactor Authentication: Its Time Has Come	2013	0.5113
964	Intrusion Learning: An Overview of an Emergent Discipline	2016	0.4903
846	Cyber-Attack Attributes	2014	0.4568
1066	The Internet of (Vulnerable) Things: On Hypponen's Law, Security Engineering, and IoT Legislation	2017	0.3743
800	Mobile Convergence and Entrepreneurial Opportunities for Innovative Products and Services	2014	0.3273
848	Assessing the Intentions and Timing of Malware	2014	0.1332
270	First Steps towards Mapping the Economy's Genome	2009	0.1307
546	User Frustrations as Opportunities	2012	0.1112
273	TellTable: Collaborative Work Using Single User Applications	2009	0.1009
606	Structuring User Involvement in Panel-Based Living Labs	2012	0.0855
750	From Idea Crowdsourcing to Managing User Knowledge	2013	0.0825
222	The Role of Consumers Within an Open Source Community	2009	0.077
847	Crimeware Marketplaces and Their Facilitating Technologies	2014	0.0729
241	An Introduction to Open APIs	2009	0.0603
943	Securing Cyberspace: Towards an Agenda for Research and Practice	2015	0.0557
262	BSD Advocacy and Breaking Through Market Barriers	2009	0.0556
316	Open Source User Assistance: Ensuring That Everybody Wins	2010	0.0447
166	Software Accessibility: Where Are We Today?	2008	0.0433
575	From Stories to Evidence: How Mining Data Can Promote Innovation in the Nonprofit Sector	2012	0.0419
318	What's the Value of an Eyeball? Passive Participation in Open Source Ecosystems	2010	0.0415
ItemId	DTM_Topic:32 (Ecosystem-Social innovation) social people woman organization change work business sector world entrepreneur impact support success opportunity family need poverty population client among	Year	Prop
452	Redefining Women's Work\': Tensions Between Technology"	2011	0.4651
921	Women Entrepreneurs in Developing Nations: Growth and Replication Strategies and Their Impact on Poverty Alleviation	2015	0.4515
854	Does Social Innovation Require Social Entrepreneurship?	2014	0.4038
453	Creating an Environment That Encourages Women Entrepreneurs	2011	0.4025
269	Social Actions: Making the Web More Philanthropic	2009	0.3792
578	Accelerating a Network Model of Care: Taking a Social Innovation to Scale	2012	0.3147
185	Key Elements of Social Innovation	2008	0.3033
577	Evergreen Brick Works: An Innovation and Sustainability Case Study	2012	0.3027
387	Open Source Contributions as a Complement to Your Sales Strategy	2010	0.2989
523	Social Entrepreneurship: Definition and Boundaries	2012	0.2754
184	Open Source, Social Innovation and a New Economy of Engagement	2008	0.2726
574	Renewing the Future: Social Innovation Systems, Sector Shift, and Innoveave	2012	0.2702
580	Platformation: Cloud Computing Tools at the Service of Social Change	2012	0.2689
402	Mifos: Ending Poverty with Software	2010	0.2655
268	Applied Collaboration Studios: Transforming Complex Problems into Systems of Continuous Social Innovation	2009	0.2319
454	Which Gender Differences Matter for High-Tech Entrepreneurship?	2011	0.2213
392	When Small is Big: Microcredit and Economic Development	2010	0.2185
455	Building an Infrastructure to Support Women Founders: Lead to Win for Women	2011	0.2171
576	Being Disruptive: How Open Growth is Delivering Effective Social Change at a Fast Pace	2012	0.1928
186	Social Innovation: Access and Leadership	2008	0.1746
ItemId	DTM_Topic:33 (Technology-value network) model digital partnership partner constellation research cgbp adoption omeka applied library funders collection skill evergreen platform college blog work crowdfunding	Year	Prop
973	Crowdfunding: Finding the Optimal Platform for Funders and Entrepreneurs	2016	0.5488

211	Omeka: Open Source Web Publishing for Research, Collections and Exhibitions	2008	0.3473
735	Measuring Innovation Skills Acquired by College and Polytechnic Students through Applied Research	2013	0.3248
183	Open Sourcing Social Change: Inside the Constellation Model	2008	0.2241
114	Open Carrier Grade Base Platform	2008	0.2057
178	Project Conifer	2008	0.159
364	Open Source Partner Strategy: Are Your Core Businesses Aligned?	2010	0.0672
575	From Stories to Evidence: How Mining Data Can Promote Innovation in the Nonprofit Sector	2012	0.0549
123	The Personal Research Portal	2008	0.0436
577	Evergreen Brick Works: An Innovation and Sustainability Case Study	2012	0.0387
137	Uses of Creative Commons Licenses	2008	0.0257
1020	Research on Fire: Lessons Learned in Knowledge Mobilization	2016	0.0183
576	Being Disruptive: How Open Growth is Delivering Effective Social Change at a Fast Pace	2012	0.018
371	OpenOttawaLibre: An Interdisciplinary Approach to Building Creative Cities	2010	0.0158
323	Building Canada's Culture of Entrepreneurship: Sure-bet to Startup Survival	2010	0.0157
857	University Spinoffs: What, Why, and How?	2014	0.0151
1015	Building Scientist Capacity in Knowledge Translation: Development of the Knowledge Translation Planning Template	2016	0.0147
549	The Role of Universities in Technology Entrepreneurship	2012	0.014
230	Government Transparency via Open Data and Open Source	2009	0.0124
68	Evolution of an Open Source Strategy	2007	0.0122
ItemId	DTM_Topic:34 (Open source-Game software) development industry internet game standard market china online product computer chinese developer company service partner design video growth hardware physical	Year	Prop
789	Product and Service Interaction in the Chinese Online Game Industry	2014	0.614
808	Innovation Opportunities: An Overview of Standards and Platforms in the Video Game Industry	2014	0.3615
734	Using Boundary Management for More Effective Product Development	2013	0.2513
524	Chinese Entrepreneurs Go Global	2012	0.2488
566	The Physical Internet and Business Model Innovation	2012	0.1862
192	Contrasting Proprietary and Free/Open Source Game Development	2008	0.1681
784	Finnish Knowledge-Intensive Business Services in China: Market Entry and Position in the Value Chain	2014	0.0911
221	The Arrival of the Mobile Internet Thanks to the Economics of Open Source Software	2009	0.0854
102	Improving Application Development by Managing Licensing Issues	2007	0.0748
279	The Expanding Role of Entrepreneurs in the Creation and Development of Internet Ecosystems	2009	0.0686
356	Growing Revenue with Open Source	2010	0.0643
114	Open Carrier Grade Base Platform	2008	0.0605
115	Open Standards vs. Open Source: a Case of the OpenAccess Standard	2008	0.0501
682	Evolution of Wireless Sensor Networks for Industrial Control	2013	0.0469
204	Developing an Open Source Reference Implementation of the Canadian Electronic Health Records Solution	2008	0.0446
717	On the Road to Holistic Decision Making in Adaptive Security	2013	0.0443
425	Using Value Co-Creation to Redefine Business Models	2011	0.041
330	Open is the New Closed: How the Mobile Industry uses Open Source to Further Commercial Agendas	2010	0.041
700	Cybersecurity Futures: How Can We Regulate Emergent Risks?	2013	0.0388
370	Integrating Lessons from Other Disciplines into Open Source Practice	2010	0.0386
ItemId	DTM_Topic:35 (Open source-project community) open_source project developer member work code people foundation community software system team governance release gnome contributor contribute linux contribution google	Year	Prop
261	The GNOME Foundation Is All About People	2009	0.5844
636	Governance of Open Source Software Foundations: Who Holds the Power?	2012	0.4074
194	Open Source Software Foundations	2008	0.4023
222	The Role of Consumers Within an Open Source Community	2009	0.3928
264	So Are You A Contributor?: Women's Contributions to Linux and Open Source Span Technology and Business	2009	0.3754
256	An International Look at Women in Open Source	2009	0.3713
512	A New Way of Measuring Openness: The Open Governance Index	2012	0.3521
645	Sustainability in Open Source Software Commons: Lessons Learned from an Empirical Study of SourceForge Projects	2013	0.3447
330	Open is the New Closed: How the Mobile Industry uses Open Source to Further Commercial Agendas	2010	0.3419
258	Lessons on Community Management from the Open Source World	2009	0.3058
223	So You Wanna be a Linux Torvalds? The Do's and Don'ts of Running a Small Open Source Project	2009	0.2929
317	Community 101	2010	0.2688
68	Evolution of an Open Source Strategy	2007	0.2621
221	The Arrival of the Mobile Internet Thanks to the Economics of Open Source Software	2009	0.2578
257	The Human Factor in Open Source	2009	0.2453
649	Sustainability and Governance in Developing Open Source Projects as Processes of In-Becoming	2013	0.2333
315	How the FreeBSD Project's Processes Help Companies Build Products	2010	0.218
260	Community-Built Software: What I Learned from Calagator	2009	0.2151
436	Control and Diversity in Company-led Open Source Projects	2011	0.2073
297	Social Media and Open Source: Worlds Apart?	2009	0.2048
ItemId	DTM_Topic:36 (Entrepreneur-successful gamification) mobile device platform phone android network alliance symbian manufacturer space firm area theory decision supplier outsourcing industry work landscape governance	Year	Prop
1062	A Managerial Decision Tool for R&D Outsourcing and Partner Selection in High-Technology Industries	2017	0.422
597	Predicting Ecosystem Alliances Using Landscape Theory	2012	0.3463
936	Scaling Spatial Transformation: Smart Specialization of Urban Capabilities in the Helsinki Region	2015	0.2462
335	The Open Source Mobile Cloud: Delivering Next-Gen Mobile Apps and Systems	2010	0.1252
443	Proving the Expertise of Freelance Android Developers	2011	0.124
221	The Arrival of the Mobile Internet Thanks to the Economics of Open Source Software	2009	0.1235
336	The State of Free Software in Mobile Devices	2010	0.0909
863	Securing the Car: How Intrusive Manufacturer-Supplier Approaches Can Reduce Cybersecurity Vulnerabilities	2015	0.085
333	CRC Mobile Broadcasting F/LOSS Projects	2010	0.0577
512	A New Way of Measuring Openness: The Open Governance Index	2012	0.0463
297	Social Media and Open Source: Worlds Apart?	2009	0.0414
413	Nokia's Hybrid Business Model for Qt	2011	0.039
330	Open is the New Closed: How the Mobile Industry uses Open Source to Further Commercial Agendas	2010	0.0379
425	Using Value Co-Creation to Redefine Business Models	2011	0.0359

933	Cities as Collaborative Innovation Platforms	2015	0.0298
951	Places and Spaces within Living Labs	2015	0.0284
464	AnyStone Technologies: Lessons from the First Year of a Mobile Applications Startup	2011	0.0283
426	Renewal Through Co-Creation in Business Networks	2011	0.0271
351	Integrating the Power of Open Source Telephony with Web 2.0 Technology	2010	0.0236
808	Innovation Opportunities: An Overview of Standards and Platforms in the Video Game Industry	2014	0.0233
ItemId	DTM_Topic:37 (Open source-project community) community member user communities open_source contribution online participant collaboration group value participate forum active share barrier idea lesson brand leader	Year	Prop
563	Collective Value Creation and Empowerment in an Online Brand Community: A Netnographic Study on LEGO Builders	2012	0.5164
758	Overcoming Barriers to Collaboration in an Open Source Ecosystem	2014	0.5161
616	Using Social Media to Accelerate the Internationalization of Startups from Inception	2012	0.2769
1009	Co-Creating User Stories: A Tool for Making Sense of Business Opportunities	2016	0.2465
300	Viable Business Models for Corporate Co-creation Communities	2009	0.1549
409	Best Practices in Multi-Vendor Open Source Communities	2011	0.1339
317	Community 101	2010	0.1323
410	How Firms Relate to Open Source Communities	2011	0.1254
370	Integrating Lessons from Other Disciplines into Open Source Practice	2010	0.1217
78	Open Source as Community	2007	0.1144
385	Differentiating Community from Customers in an F/LOSS Business	2010	0.1113
655	Platforms, Communities, and Business Ecosystems: Lessons Learned about Technology Entrepreneurship in an Interconnected World	2013	0.0932
316	Open Source User Assistance: Ensuring That Everybody Wins	2010	0.0793
750	From Idea Crowdsourcing to Managing User Knowledge	2013	0.069
1056	Action Research as a Framework to Evaluate the Operations of a Living Lab	2017	0.0682
365	Improving Product-Market Fit by Engaging an Open Source Community	2010	0.0647
272	A Model for Sustainable Student Involvement in Community Open Source	2009	0.0605
258	Lessons on Community Management from the Open Source World	2009	0.0575
914	The Creativity Canvas: A Business Model for Knowledge and Idea Management	2015	0.0571
263	Offline: Where Tech Communities Succeed With Women	2009	0.0567
ItemId	DTM_Topic:38 (Open source-data solution) language measure trademark learner indicator would kibs innovation frugal instructor protection need ottercall sustainability collective group corporate learning solution even	Year	Prop
977	Corporate and Grassroot Frugal Innovation: A Comparison of Top-Down and Bottom-Up Strategies	2016	0.3042
790	Using Trademarks to Measure Innovation in Knowledge-Intensive Business Services	2014	0.2699
915	Setting the Stage for Collaborative Creative Leadership at Cirque du Soleil	2015	0.2676
379	Ottercall: A Language Learning Company	2010	0.1805
646	Sustainability of Open Collaborative Communities: Analyzing Recruitment Efficiency	2013	0.0353
107	Protecting Information Technology Property Rights	2007	0.0329
370	Integrating Lessons from Other Disciplines into Open Source Practice	2010	0.032
909	Introduction to the Special Issue on Creativity in Innovation	2015	0.0181
105	An Introduction to Rights Expression Languages	2007	0.0166
187	Adaptive Co-management and the Learning that Leads to Social Innovation	2008	0.0164
555	Making Money from Exploiting Schumpeterian Opportunities: John Sanguinetti and the Electronic Design Automation Industry	2012	0.0158
74	Defining Open Source	2007	0.0157
253	Use of Moodle for Single Entry Portal at Riga Technical University	2009	0.014
409	Best Practices in Multi-Vendor Open Source Communities	2011	0.013
535	Minimum Viable Product and the Importance of Experimentation in Technology Startups	2012	0.0128
267	Collaborating Across Disciplines	2009	0.0124
958	Urban Living Labs for Sustainability in Suburbs in Need of Modernization and Social Uplift	2016	0.0109
55	Special Considerations for Financial Services Firms	2007	0.0108
363	Fundamentals of a Volume Market Engine	2010	0.0088
442	Developing Silicon IP with Open Source Tools	2011	0.0083
ItemId	DTM_Topic:39 (Growth-network-venture) government canada canadian policy capital investment venture funding innovation business industry economic organization country federal fund sector ottawa technology global	Year	Prop
725	Addressing Canada's Commercialization Crisis and Shortage of Venture Capital: Will the Federal Government's Solution Work?	2013	0.6603
818	The Government of India's Role in Promoting Innovation through Policy Initiatives for Entrepreneurship Development	2014	0.4743
985	Creating Brand India: Strategies, Issues, and Challenges	2016	0.4552
996	Revealing Hidden Innovation: Patterns of External Innovation Investment in Australian Businesses	2016	0.4181
986	Supporting Research-Inspired Entrepreneurial Activities in India	2016	0.4007
992	Innovation Rhetoric and Reality: An Introduction to the TIM Review's Special Issue on Innovation and Entrepreneurship in Australia	2016	0.3725
819	The Role of Managers as Agents in Successful Service Innovations: Evidence from India	2014	0.3636
821	Reviewing the Knowledge Systems of Innovation and the Associated Roles of Major Stakeholders in the Indian Context	2014	0.3331
323	Building Canada's Culture of Entrepreneurship: Sure-bet to Startup Survival	2010	0.257
252	Transparency in Government	2009	0.2568
251	The Feds are Ready for a Change	2009	0.2361
995	Employment Dynamics of Australian Entrepreneurship: A Management Perspective	2016	0.234
562	From Business Administration to Business Creation: The Case of the Kalevala Global Business Creation School	2012	0.2303
576	Being Disruptive: How Open Growth is Delivering Effective Social Change at a Fast Pace	2012	0.2149
449	New Solutions to the Funding Dilemma of Technology Startups	2011	0.2128
724	How Service Innovation Boosts Bottom Lines	2013	0.208
424	A Network-Centric Snapshot of Value Co-Creation in Finnish Innovation Financing	2011	0.206
392	When Small is Big: Microcredit and Economic Development	2010	0.176
130	Open Source in Canada's Public Sector	2008	0.1712
230	Government Transparency via Open Data and Open Source	2009	0.1637
ItemId	DTM_Topic:40 (Cybersecurity- design infrastructure) research science critical infrastructure cybersecurity system management standard model scientific design principle engineering challenge definition section specific domain capability information	Year	Prop
705	Managing Cybersecurity Research and Experimental Development: The REVO Approach	2013	0.5768
837	Cybersecurity Capability Maturity Models for Providers of Critical Infrastructure	2014	0.5436
835	Defining Cybersecurity	2014	0.5361
904	Secure by Design: Cybersecurity Extensions to Project Management Maturity Models for Critical Infrastructure Projects	2015	0.5191
704	Securing Canada's Information-Technology Infrastructure: Context, Principles, and Focus Areas of Cybersecurity Research	2013	0.5146

902	A Design Science Approach to Constructing Critical Infrastructure and Communicating Cybersecurity Risks	2015	0.4855
1001	Assessing Cooperation between Industry and Research Infrastructure in Hungary	2016	0.3169
878	A Method and Tool to Support the Management of Systems Engineering Projects	2015	0.2282
711	Developing an Innovation Engine to Make Canada a Global Leader in Cybersecurity	2013	0.2008
943	Securing Cyberspace: Towards an Agenda for Research and Practice	2015	0.1763
646	Sustainability of Open Collaborative Communities: Analyzing Recruitment Efficiency	2013	0.1519
849	Safety in the Online World of the Future	2014	0.1358
844	Assessing Scientific Contributions: A Proposed Framework and Its Application to Cybersecurity	2014	0.131
715	A Research Agenda for Security Engineering	2013	0.1129
554	Results-Based Organization Design for Technology Entrepreneurs	2012	0.0927
845	Cybersecurity Startups: The Importance of Early and Rapid Globalization	2014	0.0846
700	Cybersecurity Futures: How Can We Regulate Emergent Risks?	2013	0.0739
885	Supply Chain Cyber-Resilience: Creating an Agenda for Future Research	2015	0.0724
249	The Steady March of the European Penguins	2009	0.0703
648	The Evolving Role of Open Source Software in Medicine and Health Services	2013	0.0647
Itemid	DTM_Topic:41 (Ecosystem-Platform-network provider) mashup apis trust data ontario relationship ecosystem network provider analysis research google leader visualization show member finnish team maps growth	Year	Prop
417	Key Player Identification in the Mashup Ecosystem	2011	0.5143
418	Competition in the Mashup Ecosystem	2011	0.484
683	Niche Formation in the Mashup Ecosystem	2013	0.472
380	Assessing Trust Between Members of a Marketplace	2010	0.4681
242	Mapping Mashup Ecosystems	2009	0.4673
429	Trusted to Lead: Trustworthiness and its Impact on Leadership	2011	0.3697
373	Bloom: A Relationship Visualization Tool for Complex Networks	2010	0.3283
567	Building Trust in High-Performing Teams	2012	0.3174
424	A Network-Centric Snapshot of Value Co-Creation in Finnish Innovation Financing	2011	0.245
498	The Impact of External Relationships on the Growth of Young Technology Companies	2011	0.1825
344	Enterprise Mashups: Cloud-Based, Cloud-Driven and Cloud-Derived Applications	2010	0.1726
243	Licensing of Open APIs	2009	0.1477
241	An Introduction to Open APIs	2009	0.146
96	Ontario Research Commercialization Program	2007	0.0693
95	TFN: Open Source and Innovation	2007	0.0541
85	Keystone Organization for Ontario's Open Source Ecosystem	2007	0.0537
252	Transparency in Government	2009	0.0495
682	Evolution of Wireless Sensor Networks for Industrial Control	2013	0.0425
597	Predicting Ecosystem Alliances Using Landscape Theory	2012	0.0421
379	Ottercall: A Language Learning Company	2010	0.0404
Itemid	DTM_Topic:42 (Living labs-Projects) study motivation table theory variable decision adopter system time survey factor contribution commercialization driver adoption science word-of-mouth identified attitude waiting	Year	Prop
568	A Business Application of the System Dynamics Approach: Word-of-Mouth and Its Effect in an Online Environment	2012	0.4819
1034	Priority Systems at Theme Parks from the Perspective of Managers and Customers	2016	0.4647
844	Assessing Scientific Contributions: A Proposed Framework and Its Application to Cybersecurity	2014	0.3903
864	Identifying the Challenges in Commercializing High Technology: A Case Study of Quantum Key Distribution Technology	2015	0.2352
657	How Can Entrepreneurs Motivate Crowdsourcing Participants?	2013	0.2321
1000	A Framework for Sustainable Circular Business Model Innovation	2016	0.0921
533	Towards More Case Study Research in Entrepreneurship	2012	0.0583
645	Sustainability in Open Source Software Commons: Lessons Learned from an Empirical Study of SourceForge Projects	2013	0.0562
497	Entrepreneurial Orientation and Company Performance: Can the Academic Literature Guide Managers?	2011	0.0481
454	Which Gender Differences Matter for High-Tech Entrepreneurship?	2011	0.0412
428	Quality-Based Co-Value in SaaS Business Relationships	2011	0.0405
498	The Impact of External Relationships on the Growth of Young Technology Companies	2011	0.0382
287	Open Source BI: A Market Overview	2009	0.038
301	Components of Co-creation	2009	0.0328
488	Economics of Software Product Development Collectives	2011	0.0268
137	Uses of Creative Commons Licenses	2008	0.0256
288	Open Source BI Reporting Tool Review	2009	0.023
594	Creativity: Linking Theory and Practice for Entrepreneurs	2012	0.0214
722	Strategic Innovation for Business Performance: The Art and Science of Transformation	2013	0.0212
870	Implementation Prerequisites for Electronic Procurement of Services	2015	0.021
Itemid	DTM_Topic:43 (Ecosystem-business platform) evaluation supply_chain strategic information patent business technology value printing relevant prior based supplier firm methodology knowledge cyber-resilience resilience identify cited	Year	Prop
799	A Citation-Based Patent Evaluation Framework to Reveal Hidden Value and Enable Strategic Business Decisions	2014	0.7873
830	Finding the Signal in the Noise of Patent Citations: How to Focus on Relevance for Strategic Advantage	2014	0.7557
887	Building Cyber-Resilience into Supply Chains	2015	0.3826
848	Assessing the Intentions and Timing of Malware	2014	0.3014
772	3D Printing: A Revolutionary Advance for the Field of Urology?	2014	0.2941
885	Supply Chain Cyber-Resilience: Creating an Agenda for Future Research	2015	0.2068
888	Cybersecurity and Cyber-Resilient Supply Chains	2015	0.1383
886	Cyber-Resilience: A Strategic Approach for Supply Chain Management	2015	0.1236
942	3D Printing and Its Disruptive Impacts on Supply Chains of the Future	2015	0.0822
146	Method for Qualification and Selection of Open Source Software	2008	0.0805
855	Disruptive Innovation vs Disruptive Technology: The Disruptive Potential of the Value Propositions of 3D Printing Technology Startups	2014	0.0463
1002	Value Network Design for Innovations: Developing Alternative Value Network Drafts	2016	0.0366
1003	Detecting White Spots in Innovation-Driven Intellectual Property Management	2016	0.0362
286	Open Source: Shifting Buying and Evaluation Patterns of BI Users	2009	0.036
356	Growing Revenue with Open Source	2010	0.0333
428	Quality-Based Co-Value in SaaS Business Relationships	2011	0.029
270	First Steps towards Mapping the Economy's Genome	2009	0.0265
980	Weighing the Pros and Cons of Engaging in Open Innovation	2016	0.0244

1011	A Proposed Approach for Idea Selection in Front End of Innovation Activities	2016	0.0237
127	Free and Open Source Software: Overview and Preliminary Guidelines for the Government of Canada	2008	0.0228
ItemId	DTM_Topic:44 (Technology-value IP) patent technology property business intellectual court right invention licensing protection infringement firm asset application cost potential also patenting portfolio year	Year	Prop
894	Disrupting the Disrupter: Strategic Countermeasures to Attack the Business Model of a Coercive Patent-Holding Firm	2015	0.6824
505	Reasons for Patent Protection and Cost-effective Patent Filing Options for SMEs	2011	0.4717
693	Leveraging Old Intellectual Property to Accelerate Technology Entrepreneurship	2013	0.4436
503	Software Patents: Current Challenges and Future Solutions	2011	0.3464
501	Patent Value: A Business Perspective for Technology Startups	2011	0.3419
511	Open Invention Network: A Defensive Patent Pool for Open Source Projects and Businesses	2012	0.3001
504	Intellectual Property Rights: Unlocking the Value of this New Asset Class	2011	0.2487
502	Patents to Exclude vs. Include: Rethinking the Management of Intellectual Property Rights in a Knowledge-Based Economy	2011	0.2256
770	HarassMap: Using Crowdsourced Data to Map Sexual Harassment in Egypt	2014	0.1953
246	Toryst Technology Law Speaker Series: Open Source Licenses and the Boundaries of Knowledge Production	2009	0.1928
396	Why Intellectual Property Will Not Save the Canadian Economy	2010	0.1771
392	When Small is Big: Microcredit and Economic Development	2010	0.1441
103	Ensuring Software IP Cleanliness	2007	0.0956
856	Turning Technology into Business Using University Patents	2014	0.0944
66	Open Source on Trial	2007	0.0853
593	Managing Innovation under Time Pressure: A Practical Perspective	2012	0.0827
106	Key Changes to the GNU General Public License	2007	0.071
295	Developing a Portal for Open Source Creation: A Brief Study	2009	0.0604
857	University Spinoffs: What, Why, and How?	2014	0.0486
416	Open Source License Selection in Relation to Business Models	2011	0.0484
ItemId	DTM_Topic:45 (Entrepreneur-internal activities) software open_source support source application project system many available vendor code tool proprietary solution commercial using product developer standard need	Year	Prop
244	Using JavaScript Toolkits to Create Rich Internet Applications	2009	0.8858
288	Open Source BI Reporting Tool Review	2009	0.7922
176	Hybrid Software Boosts High Performance Computing Productivity	2008	0.7911
296	Freely Licensed and Open Source Pipelines for Art Based Film and Media Production	2009	0.7855
408	Cost Optimization Through Open Source Software	2011	0.7821
207	Open Source and Open Standards: Working Together for Effective Software Development and Distribution	2008	0.6909
54	Enterprise Open Source Support	2007	0.6804
290	BIRT: Building Next Generation BI Using Open Source	2009	0.6766
129	Open Source e-Procurement Software	2008	0.6746
273	TellTable: Collaborative Work Using Single User Applications	2009	0.6733
289	Enabling Geospatial Business Intelligence	2009	0.6718
234	Geospatial: An Open Source Microcosm	2009	0.663
236	Open Source Web Based Geospatial Processing with OMAR	2009	0.6552
84	Building an Open Source Company One Penguin at a Time	2007	0.6401
286	Open Source: Shifting Buying and Evaluation Patterns of BI Users	2009	0.6292
56	Supporting Not-for-Profits: an Opportunity for the Commons	2007	0.5934
287	Open Source BI: A Market Overview	2009	0.5877
177	Is Open Source Right for your Library?	2008	0.5821
237	Geospatial Primer: in Search of the Next Killer App\\"	2009	0.5816
147	Open Source Software for Corporate IT	2008	0.5815
ItemId	DTM_Topic:46 (Co-creation-Social value) consumer employee production activity co-production apple engage iphone creative good personal service luxury consumption experience individual gamification knowledge game also	Year	Prop
913	Luxury and Creativity: Exploration, Exploitation, or Preservation?	2015	0.517
918	Level Up Your Strategy: Towards a Descriptive Framework for Meaningful Enterprise Gamification	2015	0.4766
307	Ways of Engaging Consumers in Co-production	2009	0.4664
861	Cybersecurity Skills Training: An Attacker-Centric Gamified Approach	2015	0.2506
302	Value Co-Creation and New Marketing	2009	0.2464
97	Software Licensing	2007	0.1291
303	The Micro- and Macro-levels of Co-creation: How Transformations Change People's Preferences	2009	0.1111
633	Managing Entrepreneurial Employees Who Bring Their Own IT to Work	2012	0.1075
113	Ladder of Participation: Business Models for Peer Production	2008	0.0926
766	Enabling Employee Entrepreneurship in Large Technology Firms	2014	0.0738
521	Entrepreneurial Effort in the Theory of the Firm	2012	0.063
764	Collaborative Idea Management: A Driver of Continuous Innovation	2014	0.0558
536	A Guide for Entrepreneurs Who Lead and Manage Change	2012	0.0531
429	Trusted to Lead: Trustworthiness and its Impact on Leadership	2011	0.0513
722	Strategic Innovation for Business Performance: The Art and Science of Transformation	2013	0.0483
311	Motivating Stakeholders for Co-created Innovation	2009	0.042
771	IT Consumerization: A Case Study of BYOD in a Healthcare Setting	2014	0.0408
221	The Arrival of the Mobile Internet Thanks to the Economics of Open Source Software	2009	0.0308
276	Enabling the Creative Entrepreneur: Business Ecosystems	2009	0.0297
222	The Role of Consumers Within an Open Source Community	2009	0.0271
ItemId	DTM_Topic:47 (Open source-software product) innovation firm strategy competitive market management growth resource leadership product strategic corporate business company culture capability performance external change radical	Year	Prop
812	Ambidextrous Strategies and Innovation Priorities: Adequately Priming the Pump for Continual Innovation	2014	0.6383
624	Green, Innovative, and Profitable: A Case Study of Managerial Capabilities at Interface Inc.	2012	0.4821
733	Corporate Lifecycles: Modelling the Dynamics of Innovation and Its Support Infrastructure	2013	0.433
553	Categorizing the Growth Strategies of Small Firms	2012	0.3846
781	Radical Versus Incremental Innovation: The Importance of Key Competences in Service Firms	2014	0.3626
731	A Firm-Level Innovation Management Framework and Assessment Tool for Increasing Competitiveness	2013	0.3236
993	All Australian Regions Are Not Born Equal: Understanding the Regional Innovation Management Sandpit	2016	0.2567
522	Organizational Ambidexterity: How Small Technology Firms Balance Innovation and Support	2012	0.2481
673	Rethinking Open Innovation Beyond the Innovation Funnel	2013	0.2253

1007	Corporate Entrepreneurship: A Review and Future Research Agenda	2016	0.1933
826	Conceptualizing Innovation in Born-Global Firms	2014	0.1706
722	Strategic Innovation for Business Performance: The Art and Science of Transformation	2013	0.1527
853	Strengthening Innovation Capacity through Different Types of Innovation Cultures	2014	0.1517
410	How Firms Relate to Open Source Communities	2011	0.1311
997	Outcomes from Applying Design-Led Innovation in an Australian Manufacturing Firm	2016	0.1255
502	Patents to Exclude vs. Include: Rethinking the Management of Intellectual Property Rights in a Knowledge-Based Economy	2011	0.1245
995	Employment Dynamics of Australian Entrepreneurship: A Management Perspective	2016	0.1143
1024	Managing Innovation Ecosystems to Create and Capture Value in ICT Industries	2016	0.1101
764	Collaborative Idea Management: A Driver of Continuous Innovation	2014	0.101
489	Managing the Challenges of Becoming an Open Innovation Company: Experiences from Living Labs	2011	0.0953

Appendix III: Topic trends in LDA

Appendix IV: Topic trends in DTM

Appendix V: Word clouds of collection of topic words in LDA

Topic 9

Topic 10

Topic 11

Topic 12

Topic 13

Topic 14

Topic 15

Topic 16

Topic 17

Topic 18

Topic 19

Topic 20

Topic 21

Topic 22

Topic 23

Topic 24

Topic 25

Topic 26

Topic 27

Topic 28

Topic 29

Topic 30

Topic 31

Topic 32

Topic 33

Topic 34

Topic 35

Topic 36

Topic 37

Topic 38

Topic 39

Topic 40

Topic 41

Topic 42

Topic 43

Topic 44

Topic 45

Topic 46

Topic 47

Appendix VI: Top 20 topic words in different slices in DTM approach

2007	2008	2009	2010	2011	Topic1 2012	2013	2014	2015	2016	2017
research researcher knowledge	research researcher knowledge	research researcher knowledge	research researcher knowledge	research knowledge researcher	research knowledge study	research knowledge collaboration	research knowledge researcher	knowledge research translation	knowledge research translation	knowledge research translation
collaboration	collaboration	collaboratio n	collaboration	study	researcher	researcher	collaboration	researcher	researcher	researcher
transfer study practice	study transfer intermediary	study transfer practice	study transfer case	collaboration case practice	collaboration case practice	study practice intermediary	translation study practice	health collaboration study	health mobilization practice	health mobilization practice
intermediary case	practice case	case intermediary	practice intermediary	transfer intermediary	intermediary publication	translation case	health intermediary	practice mobilization	study collaboration	study collaboration
publication tool health translation strategy	publication tool health translation strategy	publication tool health translation strategy	publication tool health translation strategy	translation tool health strategy	translation transfer tool smes	health tool publication smes transfer university- enterprise mobilization strategy	intermediary case publication tool strategy	strategy planning intermediary publication case	strategy planning plan mental would	strategy planning plan mental would
academic mobilization	academic mobilization	academic mobilization	academic mobilization	academic mobilization	academic mobilization	academic mobilization	academic mobilization	academic mobilization	academic mobilization	academic mobilization
smes	smes	smes	academic	academic	university- enterprise	strategy	smes	would	canada	canada

planning support would	planning support would	planning support would	planning support would	university- enterprise planning support	planning support would	support planning would	support would plan	support transfer program	canada tool funding	implementati on funding tool
Words 2007 open enterprise company innovation partner case	Words 2008 open enterprise company innovation partner case	Words 2009 open enterprise company partner innovation case	Words 2010 open enterprise company partner innovation case	Words 2011 open company partner innovation enterprise case	Topic2 Words 2012 open innovation company partner case enterprise service	Words 2013 open innovation company case partner service industry	Words 2014 innovation open case company service industry partner	Words 2015 innovation open case company industry service partner	Words 2016 innovation open company industry case partner firm	Words 2017 innovation open company case industry partner firm
development industry technology service firm process simulation model	development industry technology service firm simulation process model	developmen t industry service technology firm simulation process model collaboratio n	development industry service technology firm simulation process model	development service industry technology simulation firm process model	development simulation industry firm technology process model	firm development technology enterprise process simulation model open- innovation	firm technology development enterprise cooperation process model	firm cooperation development technology enterprise process model	service cooperation development technology enterprise collaboration process	service cooperation development technology enterprise collaboration process
customer collaboration cooperation smes	collaboration customer cooperation smes	customer cooperation smes	cooperation customer smes	cooperation smes collaboration customer open- innovation	smes open- innovation cooperation customer collaboration	cooperation smes collaboration customer	customer market engineering smes	collaboration competence market customer	smes engineering market model	smes engineering market model
market external	market external	market open- innovation	market open- innovation	market	market	market	competence	smes	customer	customer
Words 2007 ecosystem company business keystone member value niche lead player role provides organization supplier health compete model technology around world section	Words 2008 ecosystem business company keystone member value lead niche player role provides organization supplier health model compete technology world section around	Words 2009 ecosystem business company keystone member value lead niche player role provides organization supplier model health technology compete section world around	Words 2010 ecosystem business company keystone member value lead player niche role organization provides supplier model section health technology grow actor community	Words 2011 ecosystem business company keystone member value lead role niche player organization provides actor model health section supplier technology grow community	Topic3 Words 2012 ecosystem business company keystone member lead value role actor niche player organization provides model health engine community section technology global	Words 2013 ecosystem business company keystone actor lead role member value niche engine player organization model provides health community global technology section	Words 2014 ecosystem business company actor role keystone lead value member niche player organization engine model global community provides health strategy strategic	Words 2015 ecosystem business company actor role keystone value lead member player niche organization global engine model strategy community health provides strategic	Words 2016 ecosystem business company actor role keystone value lead strategy player global niche member organization engine model network strategic community founder	Words 2017 ecosystem company business actor role strategy keystone value global lead player niche organization member founder network strategic engine model community
Words 2007 field trial factor test survey dimension participant technology culture user bias search figure component competitive application context national management correlation	Words 2008 field factor trial test survey dimension participant technology culture user bias search figure component application competitive context national management correlation	Words 2009 field factor trial test survey dimension participant technology culture user bias component search figure competitive application national context managemen t correlation	Words 2010 field trial factor test survey dimension participant technology culture user bias figure component search competitive application national context management relevant	Words 2011 field trial factor test survey dimension participant technology culture user bias figure component competitive search national application context management attrition	Topic4 Words 2012 field test trial factor survey dimension participant technology culture user figure bias national competitive search component application context attrition management attrition	Words 2013 field test survey factor trial dimension participant technology culture user figure national competitive search bias application context attrition component management	Words 2014 field test trial factor survey participant dimension culture technology user national figure attrition competitive context search application component bias management	Words 2015 field trial test factor participant survey culture dimension user technology attrition national figure competitive context search application management component relevant	Words 2016 field trial test participant culture factor user survey attrition dimension technology national figure competitive context search application assignment innovation example	Words 2017 field trial test participant culture dimension user factor survey attrition technology national figure competitive context assignment application search innovation example
Words 2007 creative idea world process team individual	Words 2008 creative idea world process team individual	Words 2009 creative idea world process team individual	Words 2010 creative idea world process team individual	Words 2011 creative idea world process team individual	Topic5 Words 2012 creative idea world process team individual	Words 2013 creative idea world process team individual	Words 2014 creative idea world process team individual	Words 2015 creative idea team process individual world	Words 2016 creative idea team behaviour process individual	Words 2017 creative idea team behaviour process individual

work thinking human online	work human thinking online	work human thinking online	work human thinking online	work human thinking environment	work behaviour thinking human	work safety behaviour online	safety behaviour online work	behaviour work environment safety	world work environment manager organizationa 	world work environment manager organizationa
environment behaviour safety condition future	environment behaviour safety condition future	environment behaviour safety condition future	environment behaviour safety future condition	behaviour online safety future condition organizationa 	safety environment online future condition organizationa 	human thinking environment future condition organizationa 	future human environment thinking condition organizationa 	thinking elbuli online future human adri organizationa 	employee safety thinking bootlegging future human online	employee thinking safety bootlegging future human online
think	think	think	think	knowledge	knowledge	knowledge	knowledge	adri	future	future
people	people	people	knowledge organizationa 	knowledge	knowledge	knowledge	knowledge	organizationa 	human	human
knowledge	knowledge	knowledge	people	time	time	time	time	restaurant	online	online
time organizationa 	time organizationa 	organizationa l time	time	think people	organization people	organization manager	elbuli manager	manager time	elbuli adri	elbuli adri
Topic6										
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
company product customer market business offer solution cost model sale revenue strategy companies technology value benefit need money sell competitor	company product customer market business offer solution cost model sale revenue strategy value technology need money companies benefit sell develop	company product customer market business offer solution cost model revenue sale strategy value technology need money benefit startup companies growth	company customer product market business solution sale cost revenue offer strategy model startup technology value need money growth develop must	company customer product market business sale solution cost revenue strategy technology startup offer model value need success must opportunity growth	company customer product market business technology solution cost sale revenue startup offer strategy need value model opportunity success must growth	company product customer market technology business solution cost offer sale opportunity revenue success value startup strategy need value model development develop	company product customer market technology business solution offer cost opportunity sale success value strategy startup need revenue potential development develop	company product market customer technology business solution offer cost opportunity sale strategy success value potential development need develop revenue startup	product company customer market technology business solution offer cost sale opportunity strategy potential value develop development success need revenue startup	product company customer market technology solution business offer cost sale opportunity strategy potential value develop development success need revenue startup
Topic7										
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
phase marketing customer test supplier action intention technology model resellers adoption subject behaviour user study process agent selling mode advertising	phase marketing customer test supplier action intention technology model resellers subject adoption behaviour user study process agent selling mode advertising	phase marketing customer test supplier action intention technology model resellers subject adoption behaviour user study process agent selling mode brain	phase marketing customer supplier test action intention technology resellers model subject adoption behaviour user study process agent selling mode brain	customer marketing phase supplier test intention resellers technology action model subject behaviour adoption user study process selling agent mode brain	customer marketing phase supplier test intention resellers technology model subject action behaviour user adoption study process selling agent brain mode	marketing customer supplier phase intention resellers test technology model user adoption action behaviour subject study mode agent process selling malware	marketing customer supplier resellers intention phase technology model user adoption test action behaviour mode study malware agent subject perceived process	marketing customer supplier technology intention resellers model phase user adoption action behaviour test mode malware agent study perceived variable advertising	customer supplier user marketing intention model technology phase user mode resellers malware action behaviour agent adoption test bicycle variable study advertising	user intention model customer supplier technology phase marketing behaviour mode resellers bicycle action malware adoption agent test variable personal behavioural
Topic8										
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
public citizen city innovation uncertainty collaborative environmenta l sector scale smart government environment organization stakeholder	public citizen city innovation uncertainty collaborative environmenta l sector scale smart government environment organization stakeholder	public city citizen innovation uncertainty collaborativ e environmenta l sector scale smart government environment organization stakeholder	public city citizen innovation uncertainty collaborative sector environmenta l scale smart environment government stakeholder organization	public city citizen innovation uncertainty collaborative sector environmenta l smart scale environment government stakeholder organization	public city citizen innovation uncertainty collaborative sector environmenta l smart scale environment government stakeholder organization	city public citizen innovation uncertainty collaborative smart sector environmenta l scale environment stakeholder government organization	city innovation public citizen uncertainty smart collaborative sector environmenta l scale environment stakeholder government organization	city innovation citizen public smart collaborative uncertainty sector stakeholder organization scale environmenta l environment government	innovation city public citizen smart collaborative sector intermediary stakeholder uncertainty organization tourism government scale	innovation city public citizen sector smart collaborative stakeholder intermediary organization uncertainty tourism government scale

collaboration study decision	collaboration study decision	collaboratio n study decision	collaboration study intermediary	collaboration study intermediary	intermediary collaboration study	intermediary study collaboration	intermediary study collaboration	intermediary tourism collaboration	collaboration environment service environmen tal actor study	collaboration environment service study actor environmen tal
intermediary pilot	intermediary pilot	pilot intermediary	decision pilot	decision service pilot	service decision tourism	service tourism decision	service tourism viability	study service viability		
service	service	service	service	service	Topic9					
Words 2007 network knowledge innovation actor social process change	Words 2008 network knowledge innovation actor social process change	Words 2009 network knowledge innovation actor social process change	Words 2010 network knowledge innovation actor social process change	Words 2011 network knowledge innovation actor social process change	Words 2012 network knowledge innovation actor social change process	Words 2013 network knowledge innovation actor social process change	Words 2014 knowledge network innovation actor social process change	Words 2015 network knowledge innovation actor social process technological	Words 2016 knowledge network innovation actor process social integration	Words 2017 knowledge network innovation actor process social integration organiza tiona change boundary
resource relationship role	resource relationship role	resource role relationship technologica interaction	resource role relationship technological interaction	resource role relationship technological interaction	resource role relationship technological interaction	resource role technological relationship interaction	resource technological role interaction relationship	change interaction integration	boundary technological networked	change boundary technological role networked
technological interaction	technological interaction	interaction	interaction	interaction	interaction	interaction	interaction	resource role boundary	change role organiza tiona interaction	technological role networked
sharing	sharing	sharing	sharing	sharing	type	type	type	boundary	interaction resource organization	networked
collaboration venture	collaboration venture	collaboratio n institution	collaboration type institution	collaboration type institution	institution sharing collaboration	institution structural integration	structural institution integration	type relationship organiza tiona networked	interaction resource organization	organization resource interaction
institution	institution	type venture	type venture	type organization	organization	organization	organizationa venture	venture organiza tiona organization	type relationship	type relationship
type	type	organization	organization	venture	venture	venture	sharing	boundary	collaboration	collaboration
organization organizationa networked	organization organizationa networked	organization organizationa l integration	organization organizationa l integration	organizationa l structural	organizationa l structural	collaboration	collaboration	structural	production	production
Topic10										
Words 2007 information system domain network decision analysis data peer threat dynamic layer making device search dashboard attack architecture host detection example	Words 2008 information system domain network decision analysis data peer threat dynamic layer making device search dashboard attack architecture host detection example	Words 2009 information system domain network decision analysis data peer threat dynamic layer device making search dashboard architecture host detection example	Words 2010 information system domain network decision data analysis threat peer device dynamic making layer attack search dashboard host architecture detection timely	Words 2011 information system domain network decision data analysis threat device peer dynamic making attack layer search host architecture dashboard detection timely	Words 2012 information system network domain decision data analysis threat device attack peer making dynamic layer host search architecture detection timely example	Words 2013 information system network domain decision threat data analysis device attack peer dynamic making layer host detection search timely architecture example	Words 2014 information system domain network decision analysis data threat device attack making dynamic peer detection search host timely example evidence	Words 2015 information system domain analysis network device decision data threat attack search making detection evidence dynamic indicator peer example timely layer	Words 2016 information domain system analysis device data network decision attack threat evidence search indicator dynamic analyst peer	Words 2017 information system domain analysis device attack data network decision threat indicator evidence search detection analyst assistive making dynamic analyst example alert
Topic11										
Words 2007 region local program	Words 2008 region local program	Words 2009 region program local	Words 2010 region program local	Words 2011 region program local	Words 2012 region program local	Words 2013 region program local	Words 2014 region local development	Words 2015 region local development	Words 2016 region local innovation	Words 2017 region local innovation
development transformatio n	development transformatio n	developmen t transformati on	development support	development innovation	development innovation	development innovation	program innovation	innovation program	development program	development program
innovation support	innovation support	support innovation	innovation incubation transformatio n	support incubation	support incubation	support incubation	support fiat	support university	support university	support university
university incubation national	university incubation national	incubation university national	university national	university national	university national	university national	university national	university national	university national	university national
collaborative centre global	collaborative centre global	collaborativ e centre global	collaborative centre global	collaborative centre global	collaborative centre global	collaborative centre global	collaborative fiat	collaborative incubation global	collaborative global cambridge	collaborative global cambridge
collaboration	collaboration	collaboratio n	collaboration	collaboration	activity	activity	global	cluster	cluster	cluster
partnership activity	partnership activity	partnership shared	activity shared	activity cluster	transformatio n systemic	global cluster	centre cluster	smart	incubation	incubation

shared cluster networking around	shared cluster networking around	activity cluster networking around	cluster partnership networking systemic	shared systemic partnership networking	fiat cluster shared policy	systemic shared policy around	policy systemic shared around	policy helix actor centre	network actor around service	network actor around service
					Topic12: Entrepreneur -Global Startup					
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
entrepreneur startup technology firm founder opportunity venture global market business early capital successful international growth resource incubator theory support internationalization	entrepreneur startup technology firm founder opportunity venture global market business early capital successful international growth resource incubator theory internationalization individual	entrepreneur startup technology firm founder opportunity venture global market business early capital successful international growth resource incubator theory support born-global	entrepreneur startup technology firm founder opportunity venture global market business early capital successful international growth resource incubator born-global theory internationalization	entrepreneur startup technology firm founder opportunity venture global market business early capital successful growth resource born-global theory internationalization support	entrepreneur startup technology firm global opportunity global market venture founder early business international born-global internationalization growth resource incubator born-global research development foreign	entrepreneur technology startup firm opportunity global market venture business early international founder growth internationalization resource research born-global development founder lean foreign	entrepreneur startup technology firm market global venture opportunity business early internationalization research internationalization lean early resource born-global development foreign focus	entrepreneur startup technology firm market global business growth international venture opportunity research venture internationalization early resource born-global development focus	entrepreneur startup firm technology global market growth international business research lean venture opportunity internationalization early resource born-global hybrid development foreign	entrepreneur startup firm global market technology international lean business research growth hybrid internationalization venture opportunity early born-global resource development foreign
					Topic13					
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
service provider customer experience electronic local proximity word-of-mouth communication small solution virtual legitimacy information pattern problem connection medium travel interaction	service provider customer experience electronic local proximity word-of-mouth communication small solution virtual legitimacy information pattern problem connection medium travel interaction	service provider customer experience electronic local word-of-mouth proximity communication small virtual solution legitimacy pattern information problem connection medium travel frugal	service provider customer experience local electronic word-of-mouth proximity communication small virtual solution legitimacy pattern information problem connection medium frugal travel	service provider customer experience local word-of-mouth electronic proximity communication small virtual solution pattern information problem connection medium frugal travel	service provider customer experience word-of-mouth local proximity electronic communication small virtual solution pattern information problem connection frugal medium travel	service provider customer word-of-mouth experience proximity local electronic communication small virtual solution pattern information problem connection medium travel	service provider customer word-of-mouth proximity experience local legitimacy electronic communication small virtual solution frugal information problem connection medium travel	service provider customer experience pattern word-of-mouth solution proximity local legitimacy problem electronic small virtual information travel interaction connection	service provider pattern frugal customer experience solution problem word-of-mouth local proximity communication legitimacy electronic virtual small information travel interaction connection	service provider pattern frugal customer solution experience problem local word-of-mouth proximity communication legitimacy electronic virtual small information travel interaction connection
					Topic14					
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
platform stakeholder model program development business opportunity technology group company lesson provide economic decision owner kots	platform stakeholder model program development business opportunity technology group company lesson provide economic decision owner kots	platform stakeholder model program development business opportunity technology group company lesson provide economic decision owner kots	platform model stakeholder program development business opportunity technology group company provide lesson kots economic owner decision	platform model program stakeholder business opportunity development technology provide kots group owner company lesson help decision	platform model program stakeholder business opportunity development owner technology provide lesson help group company kots support	platform model program stakeholder owner business opportunity development provide technology help lesson group company kots support	platform model program stakeholder owner business opportunity development provide technology help lesson group company support problem	platform model program stakeholder owner business opportunity development provide technology lesson group company support learned	platform model program stakeholder owner opportunity business development help provide technology group company support learned	platform model program stakeholder owner opportunity business development help provide technology group company support learned

help revenue participant support	help revenue participant support	revenue help participant support	revenue help participant support	economic revenue support participant	support revenue economic problem	decision revenue problem learned	learned kots revenue decision	problem revenue participant access	problem participant revenue music	problem revenue participant music
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Topic15 Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
design service innovation logic employee problem	design service innovation logic employee problem	design service innovation logic employee problem	design service innovation logic employee methodology	design service innovation logic employee methodology	design service innovation employee logic methodology	service design innovation employee problem methodology	service design innovation employee problem work	service design innovation employee problem sustainable	design service innovation employee work problem	design service innovation employee work problem
methodology work sector	methodology work sector	methodology work sector	problem work sector	problem work sector	problem work sector	work sector sustainable	methodology sustainable sector	work methodology procurement	sustainable design-led methodology	sustainable design-led methodology
sustainable organization manufacturin g	sustainable organization manufacturin g	sustainable organization manufacturin g	sustainable organization manufacturin g	sustainable organization manufacturin g	sustainable organization outcome	logic organization manufacturin g	result organization	sector result well-being	study result sector	study result sector
outcome result used study implementati on	outcome result used study implementati on	outcome result used study implementati on	outcome result used study implementati on	outcome result used study implementati on	outcome result used study implementati on	result used study outcome implementati on	logic study used procurement well-being	study wicked used organization design-led	procurement well-being used wicked organization	procurement well-being used wicked organization
procurement change observation	procurement change observation	procurement change observation	procurement well-being change	procurement well-being important	procurement well-being important	procurement well-being wicked	procurement well-being important	implementati on manufacturin g important	infection implementati on manufacturin g	infection implementati on manufacturin g
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Topic16 Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
group competition participant workshop centre team business organization design building would health identity campus developed shopping service participatory individual facility	group competition participant workshop centre team business organization design building would health identity campus developed shopping service participatory individual facility	group competition participant workshop centre business team organization design building would health campus developed identity shopping service participatory individual facility	group competition participant workshop centre business team organization design building would health campus developed shopping identity participatory service facility individual	group competition workshop participant centre business team organization design building would campus health developed shopping identity participatory service individual facility	group workshop competition centre participant business team organization design building campus would developed shopping health service participatory identity individual facility	group workshop competition participant centre business team organization design building campus would developed shopping health service participatory identity individual facility	group workshop participant business centre competition team organization design campus shopping building would health service developed participatory individual identity facility	workshop group participant centre business organization team competition design campus shopping building would health service developed participatory individual identity facility	workshop group participant centre business organization team design campus competition shopping building health service would developed participatory individual cuckoos identity	workshop group participant centre business organization team design campus competition shopping building health service would developed participatory individual cuckoos identity
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Topic17 Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
security vulnerability defect code system information risk program control threat analysis problem osvdb error access report result attack language would	security vulnerability defect system code information risk program control threat analysis osvdb problem error access report attack result language would	security vulnerability system information risk control defect code threat program analysis access problem attack osvdb error report result report would protection	security vulnerability system risk information control threat code defect program attack access analysis problem would error report result osvdb organization	security system vulnerability risk control information threat attack code access program defect access analysis would problem organization cybersecurity result protection attacker	security risk system information threat vulnerability control attack access would cybersecurity program code analysis organization attacker protection analysis program level result defect	security risk system threat information control vulnerability attack access would cybersecurity organization attacker protection analysis program level framework availability result	security risk system control information vulnerability threat attack cybersecurity access would organization attacker protection framework level availability analysis integrity program	security risk system control vulnerability information threat cybersecurity attack access would organization protection attacker framework integrity level availability analysis confidentialit y	security risk control system vulnerability information threat cybersecurity attack access would protection organization attacker framework level availability analysis confidentialit y	security risk control vulnerability system information threat cybersecurity attack access would protection organization framework attacker integrity level availability analysis confidentialit y
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Topic18 Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
data information health	data information health	data information health	data health information	data health system	data health system	data system health	data system health	data system health	data information system	data information system

system healthcare access technology device power care patient solution record challenge provide mobile medical management application also	system healthcare access technology device power care patient solution challenge record provide medical mobile management application also	system healthcare device technology power patient care solution challenge mobile provide medical record managemen t application also	system healthcare access device technology power patient care solution mobile challenge medical provide management record also application	information healthcare device access power patient technology care solution mobile challenge management provide medical vehicle also smart	healthcare information device power patient technology care mobile access solution challenge smart vehicle management electric provide also	healthcare information device patient technology care smart solution mobile access power challenge grid communicati on individual application also	device information healthcare patient technology care solution access mobile challenge individual smart application privacy also power provide	information healthcare device patient care technology individual solution access privacy challenge mobile application also smart provide personal	device health healthcare patient care individual technology privacy access challenge solution application personal also mobile provide smart	device privacy individual health healthcare care technology privacy access challenge solution personal application also provide smart mobile
Words 2007 student content university education learning course educational institution project resource open technology program access initiative developing development country world school	Words 2008 student university content education learning course institution project educational resource open technology program access initiative development school country world developing	Words 2009 student university course content education learning educational project institution resource open program developmen t school technology access initiative developing country material	Words 2010 student university course education learning content educational project program institution development school resource open technology faculty developing access initiative material	Words 2011 student university course education learning educational content school program faculty development project institution resource technology academic open initiative developing access	Words 2012 university student course education educational learning school faculty program content development academic project institution technology resource open developing initiative access	Words 2013 university student course education school educational learning faculty program academic development content technology institution project resource developing initiative open access	Words 2014 university student course education school faculty educational learning academic program development technology content institution project resource developing initiative open access	Words 2015 university student course education school faculty educational academic learning program development technology institution content project developing resource initiative access open	Words 2016 university student education course faculty school academic educational learning program technology development institution content project developing initiative resource access austria	Words 2017 university student education course faculty school academic educational learning program technology development institution content project developing initiative resource access austria
Words 2007 crowd crowdsourcin g actor risk value business resource firm relationship process kibs biotechnolog y pharmaceutic al task strategic category engagement type different client	Words 2008 crowd crowdsourcin g actor risk value business resource firm relationship process kibs biotechnolog y pharmaceutic al task strategic category engagement type different client	Words 2009 crowd crowdsourci ng actor risk value business resource firm relationship process kibs biotechnolog y pharmaceutic al task strategic category engagement type different client	Words 2010 crowd crowdsourcin g actor risk value business resource firm kibs process relationship biotechnolog y pharmaceutic al task strategic category engagement type different client	Words 2011 crowd crowdsourcin g actor risk value business resource firm kibs process relationship biotechnolog y pharmaceutic al task strategic category engagement type different client	Words 2012 crowdsourcin g crowd actor risk business value resource kibs process relationship biotechnolog y task category pharmaceutic al strategic engagement type strategic pharmaceutic al type different client	Words 2013 crowdsourcin g crowd risk actor business value resource kibs firm biotechnolog y relationship category process task engagement type strategic pharmaceutic al different client	Words 2014 crowdsourcin g crowd actor risk kibs value business resource firm engagement process relationship category biotechnolog y task type client strategic management	Words 2015 crowdsourcin g crowd actor value risk kibs business resource firm engagement process task category relationship type biotechnolog y strategic initiative client different	Words 2016 crowdsourcin g crowd actor value risk kibs business resource firm engagement process task category relationship type biotechnolog y strategic initiative client micro-startup	Words 2017 crowdsourcin g crowd actor value risk kibs business resource firm engagement process task category relationship type biotechnolog y strategic initiative client micro-startup
Words 2007 organization business process management technology need maturity capability change	Words 2008 organization business process management technology need maturity capability change	Words 2009 business organization process managemen t technology need capability function	Words 2010 business process organization management technology need capability function change	Words 2011 business process organization management technology need capability function change	Words 2012 process business management organization capability function technology need firm	Words 2013 process capability organization management business technology function change need	Words 2014 process organization capability management business technology function change improvement	Words 2015 process organization management capability business technology function change lean	Words 2016 process organization management capability business technology function change lean	Words 2017 organization process management capability business technology function change lean

product function must level solution requirement team required improvement firm within	function product level must solution requirement team improvement required firm within	change must level product solution team requirement improvement t firm demand within	maturity must level product solution firm improvement team demand performance within	firm must level improvement maturity product performance solution demand within team	change must improvement level performance demand product maturity solution within team	improvement firm maturity level must performance within product demand team solution	need firm maturity level must performance within lean team product demand	need improvement firm maturity level must performance team within product demand	need improvement maturity level firm performance team within product alignment	need improvement maturity level firm performance team within product alignment
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Topic22 Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
eclipse platform deal ecosystem collective member common business system foundation individual asset resource modularity base architecture participation technology player research	eclipse platform deal ecosystem collective member business common system foundation individual asset resource modularity base architecture participation player technology research	eclipse platform deal ecosystem collective member business system common individual modularity foundation asset resource base participation player architecture research relationship	platform eclipse deal ecosystem collective member business system common asset resource individual foundation player relationship participation keystone technology research modularity	platform eclipse deal ecosystem collective business member system asset resource common individual foundation technology participation research governance relationship architecture modularity	platform ecosystem deal eclipse business collective system member technology asset resource individual common research governance architecture relationship foundation participation architecture organization	platform ecosystem business system eclipse deal collective technology member resource asset individual research governance architecture relationship common organization foundation keystone	ecosystem platform business system technology deal eclipse collective member resource specie research individual relationship asset organization technospecie s governance architecture common	ecosystem platform business system technology deal technospecie s collective eclipse specie member resource relationship research individual different organization asset keystone governance	ecosystem platform business system technology deal technospecie s collective eclipse specie member resource relationship research different asset individual organization keystone governance	
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Topic23 = Topic 1, Cybersecurity -Threat-Risk Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
risk value device cybersecurity botnet stakeholder action club medical step takedown route cider type blueprint legal sourcing dimension design group	risk value device cybersecurity botnet stakeholder action club medical step takedown route cider type blueprint sourcing legal dimension design group	risk value device cybersecurity botnet stakeholder action medical club takedown step route cider type blueprint dimension legal design group manufacur r	risk value device cybersecurity botnet stakeholder action medical club takedown step route cider type blueprint dimension design group legal manufacturer	risk value device cybersecurity botnet stakeholder action medical takedown club route step cider type blueprint dimension design group manufacturer framework	risk device cybersecurity value botnet stakeholder medical takedown club action route cider step type blueprint dimension design manufacturer group framework	risk device botnet cybersecurity value stakeholder medical takedown club action route cider step type blueprint dimension design manufacturer group framework	risk device botnet cybersecurity value stakeholder medical takedown club action route cider type step blueprint dimension design manufacturer group security	risk device botnet cybersecurity value stakeholder takedown medical club route cider action type step blueprint dimension manufacturer group cyber-attacks	risk device stakeholder cybersecurity value route medical cider botnet takedown action club step design type framework manufacturer pump insulin type group	
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Topic24 Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
event problem idea innovation solution company open solutions world solve people international quebec first knowledge collaboration session adaptive local	event problem idea innovation solution company open solutions world people international solve quebec first knowledge collaboration session adaptive local	event idea problem innovation solution company open solutions world international people quebec solve first knowledge collaboratio n session local process	event problem idea innovation solution company open solutions quebec international world people solve first knowledge session collaboration local process	event problem idea innovation solution company open solutions quebec international world people solve knowledge first session people solve local collaboration process	problem idea event innovation solution company open solutions quebec open international world knowledge first solve people session local collaboration process	problem idea event innovation solution company solutions quebec open international world knowledge first session people solve local collaboration process	idea problem innovation event solution company world knowledge open quebec international first session solve swatch process local	idea innovation problem event solution company world knowledge solutions open quebec swatch international first people process solve session	idea innovation problem world event solution company knowledge solutions open quebec utility swatch international first people watch process solve	idea innovation problem world event solution company solutions knowledge open quebec utility swatch international first people watch process solve

process	process	collaborative	major	collaborative	seeking	seeking	collaborative	utility	session	session
					Topic25: Living Labs - Development Process					
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
process need	process need	need process	need development	also development	living_lab also	innovation living_lab	innovation process	innovation process	innovation process	living_lab innovation
development	development	development	process	need	process	process	also	research	research	research
also	also	also	also	process	need	also	research	also	living_lab	process
open	open	different	different	different	innovation	research	different	different	also	user
technology	technology	work	time	time	development	development	development	living_lab	different	also
different	different	open	work	innovation	research	need	living_lab	need	study	context
project	project	within	within	work	different	different	case	case	development	case
important	important	technology	important	activity	time	case	however	study	activity	study
work	work	time	activity	research	case	however	result	user	need	different
tool	tool	many	first	important	however	result	user	however	context	activity
first	many	tool	example	living_lab	work	within	result	concept	however	need
many	within	first	result	environment	within	study	based	role	level	development
within	level	project	technology	example	user	based	concept	based	within	however
organization	time	people	tool	result	result	time	user	within	concept	system
level	people	result	open	however	based	work	level	result	system	used
time	activity	example	based	well	well	well	role	system	stakeholder	concept
people	well	well	environment		environment	example	context		based	design
well										based
result										researcher
					Topic26					
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
hardware	hardware	hardware	hardware	hardware	hardware	component	design	design	design	design
device	device	software	software	software	component	design	component	component	component	component
software	software	device	humanitarian	design	software	hardware	code	code	code	code
project	project	project	code	code	design	code	hardware	software	software	software
technology	technology	technology	code	technology	code	technology	software	application	hardware	hardware
netbsd	netbsd	code	technology	tool	technology	application	technology	technology	application	application
code	code	humanitarian	design	humanitarian	tool	model	model	manufacterer	manufacterer	manufacterer
design	design	design	device	project	model	model	model	technology	technology	technology
free	free	free	documentati	bigbluebutto	application	processor	processor	model	model	model
humanitarian	humanitarian	documentati	component	n	project	tool	tool	processor	tool	tool
could	could	tool	tool	device	bigbluebutto	device	device	tool	processor	processor
documentati	tool	component	foss	could	n	could	integrated	integrated	device	device
on	documentati	could	free	first	device	integrated	first	device	could	could
tool	component	first	could	model	first	could	could	could	integrated	integrated
component	volunteer	developer	developer	developer	processor	developer	developer	first	first	first
volunteer	developer	foss	bigbluebutto	application	humanitarian	project	manufacterer	problem	problem	problem
developer	first	netbsd	n	documentati	developer	business	project	developer	developer	developer
first	book	problem	radio	free	integrated	bigbluebutto	problem	project	project	module
book	problem	support	model	processor	business	n	business	module	module	project
problem	foss	radio	application	foss	problem	humanitarian	glue	glue	glue	glue
radio					Topic27					
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
software	software	software	software	software	software	open_source	open_source	open_source	license	license
license	license	license	open_source	open_source	open_source	software	license	license	open_source	code
f/loss	f/loss	open_sourc	license	license	license	license	software	code	code	open_source
open_source	open_source	e	source	source	source	source	code	software	software	software
source	source	f/loss	f/loss	open	code	code	source	source	source	source
code	code	open	open	f/loss	open	open	open	open	open	open
open	open	code	code	code	f/loss	f/loss	program	program	program	program
copyright	copyright	free	free	commercial	program	program	business	business	business	licensing
free	free	commercial	commercial	free	business	business	licensing	licensing	licensing	licensed
right	right	proprietary	proprietary	proprietary	commercial	licensing	f/loss	f/loss	copyright	business
work	work	right	right	right	right	right	right	right	copyright	copyright
commercial	commercial	copyright	copyright	copyright	licensing	development	development	commercial	commercial	commercial
proprietary	proprietary	work	work	work	proprietary	development	copyright	copyright	right	right
program	program	licensing	development	development	development	copyright	copyright	development	f/loss	f/loss
licensing	licensing	program	program	program	free	proprietary	proprietary	licensed	development	development
used	public	development	work	business	copyright	free	free	proprietary	proprietary	package
legal	project	used	public	public	public	model	developer	developer	package	proprietary
public	used	project	used	used	model	developer	licensed	free	developer	developer
term	development	public	project	work	used	public	model	public	used	used
project	term	term	business	model	developer	used	public	used	public	public
					Topic28					
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017

service application computing	service application computing	service application cloud	service application cloud	service application cloud	service application provider	service provider digital	service digital provider	service digital provider	service digital provider	service digital provider
cloud communicati on	cloud communicati on	computing communicati on	computing communicati on	customer communicati on	cloud channel	application communicati on	communicati on	applicati on	communicati on	communicati on
provider customer	customer provider	customer provider	customer provider	provider computing	communicati on customer	channel cloud	application cloud	channel customer	channel customer	channel customer
infrastructure	infrastructure	infrastructure	infrastructure	channel	digital	customer	customer	cloud	cloud	cloud
vendor value model channel business capability digital quality saas cost market relationship	vendor value model channel business capability digital quality cost saas market relationship	vendor value model channel business capability digital quality cost saas market relationship	value vendor model channel business capability digital quality saas cost market sale	value infrastructure model digital quality saas business vendor capability market sale relationship	computing infrastructure quality value model business saas sale market relationship tool capability	computing quality infrastructure value model business sale tool relationship market capability saas	quality value computing infrastructure model business sale tool relationship market capability delivery	quality value infrastructure computing model business tool relationship sale market capability delivery	quality value infrastructure computing model business tool relationship sale market capability delivery	quality value infrastructure computing model business tool relationship sale market capability delivery
Topic29										
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
model score good impact economy economic global public private direct entity benefit high path example marketplace	model score good impact economy economic global public private direct entity benefit high path example marketplace	model score impact good economy economic global public private direct entity benefit high path example marketplace	model impact score good economy global public economic private economic entity benefit direct high path example society	model impact good score global public economy private economic entity benefit direct high path example society	model impact good global public score private economic economy entity benefit high path direct society example	model impact good public global score private economic entity path benefit high economy direct society marketplace	model impact good public global private economic benefit society score economy high marketplace entity path direct	model impact public good global private economic society benefit economy score high entity marketplace path direct	model impact public good global economic private society benefit economy score high entity marketplace path example	impact model public good global economic private society benefit economy score high entity marketplace path example
society	society	society	marketplace	marketplace	analysis	example	commercializ ation	example	direct	commercializ ation
figure	figure	analysis	analysis	analysis	marketplace	analysis	example	commercializ ation	commercializ ation	direct
analysis	analysis	figure	figure	figure	figure	commercializ ation	analysis	analysis	analysis	analysis
infrastructure	infrastructure	infrastructure	relationship	relationship	relationship	figure	network	network	network	network
Topic30										
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
value co-creation customer business model creation research product firm chain company framework component service resource proposition point offering relationship practice	value co-creation customer business model creation research product firm chain company framework component service resource proposition point offering relationship practice	value co-creation customer business model creation research product firm company chain framework component service proposition resource point offering relationship practice	value co-creation customer business model creation research product firm framework company proposition service resource component chain point offering relationship practice	value business customer co-creation model creation research firm product framework proposition resource service company point offering relationship component practice chain	value business customer model co-creation creation firm research framework product proposition resource service offering point practice relationship company component logic	value business model customer co-creation creation research firm proposition framework resource product service offering practice logic point company relationship perspective	value business model customer co-creation creation research proposition practice firm framework offering resource logic service product point company perspective view	business model value customer co-creation research creation proposition practice framework firm service resource logic offering point product company figure perspective	business model value customer research co-creation creation proposition framework service practice resource firm economy point logic figure product company offering	model business value customer research creation co-creation proposition service framework practice resource economy firm point logic figure product chain company
Topic31										
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
user data	user data	user data	user data	user data	user data	user data	user data	user data	user data	device data
computer internet	computer internet	computer internet	computer network	computer network	authentication computer	authentication device	network computer	network device	network device	network user
network authentication device	network authentication device	network authentication device	network authentication device	network authentication device	device network	device network	device mobile	device internet	device internet	internet computer

used system	used system	used system	used system	used online	used mobile	mobile used	authentication consumer	learning consumer	intrusion mobile	intrusion consumer
text server online	text server online	text online server	online consumer text	system mobile consumer	online system consumer	consumer password online	used system online	consumer authentication used intrusion	consumer used system authentication	mobile system used attack
voice	voice	consumer	mobile	password	password	system	attack	system	attack	authentication
consumer mobile access password however card using	consumer mobile access password however card using	voice mobile password access however using card	server voice password access however card using	text voice however server attack card access	attack text however voice card access using	attack card however text voice learning factor	cyber-attacks learning password voice text however intrusion	attack online cyber-attacks password however voice text	attack online password cyber-attacks however voice connected	authentication password online however cyber-attacks connected vulnerability
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Topic32 Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
social people woman organization change work business sector	social people woman organization change work business sector	social woman people organization business change work sector entrepreneur	social woman people business organization work entrepreneur change sector	woman social people business entrepreneur organization work change sector impact support world family success enterprise population need poverty care program	social woman entrepreneur people business organization change work sector enterprise impact care support family need program world success population opportunity	social woman entrepreneur people business enterprise change organization impact work sector support care family need program world opportunity population success	social entrepreneur woman people enterprise business change organization impact work sector program need family care among world opportunity human	social entrepreneur woman people enterprise business change organization support impact program sector need family care among world opportunity poverty	social entrepreneur woman people enterprise business change work organization support impact program sector family need care among world income opportunity	social entrepreneur woman people business enterprise work change support organization impact program family sector need income care among world opportunity
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Topic33 Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
model	model	model	model	model	model	applied	model	model	model	model
digital	digital	partnership	partnership	applied	applied	model	applied	crowdfundin g	crowdfundin g	crowdfundin g
partnership	partnership	partner	partner	research	research	research	crowdfundin g	fundors	fundors	fundors
partner constellation	partner constellation	digital research	applied research	partnership partner	fundors college	fundors college	research fundors	applied research	entrepreneur platform	entrepreneur platform
research	research	applied	digital	fundors	partner	partner	college	entrepreneur	research	research
cgbp	cgbp	constellation	fundors	digital	partnership	crowdfundin g	skill	platform	applied	applied
adoption	adoption	fundors	college	college	crowdfundin g	partner	platform	college	college	college
omeka	omeka	cgbp	skill	college	skill	partnership	skill	skill	payout	payout
applied	applied	adoption	constellation	crowdfundin g	digital	platform	partner	partner	partner	partner
library	library	skill	crowdfundin g	platform	platform	digital	partnership	partnership	skill	skill
fundors	fundors	omeka	platform	constellation	entrepreneur	entrepreneur	digital	payout	funding	funding
collection	collection	library	adoption	crowdfundin g	entrepreneur	funding	funding	funding	partnership	partnership
skill	skill	college	cgbp	evergreen	entrepreneur	constellation	constellation	digital	equity	equity
evergreen	evergreen	platform	evergreen	entrepreneur	evergreen	activity	activity	equity	combination	combination
platform	platform	crowdfundin g	omeka	adoption	adoption	evergreen	activity	constellation	constellation	constellation
college	college	evergreen	library	cgbp	activity	activity	equity	activity	constellation	constellation
blog	blog	collection	funding	library	cgbp	payout	evergreen	combination	interest	interest
work	work	blog	collection	omeka	work	adoption	adoption	interest	table	table
crowdfundin g	crowdfundin g	work	work	collection	library	outcome	work	evergreen	activity	activity
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Topic34 Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
development	development	developmen t	development	development	game	game	game	game	game	game
industry	internet	internet	internet	game	development	development	industry	industry	industry	industry
internet	industry	industry	industry	internet	internet	industry	development	online	online	online
game	game	game	game	industry	china	china	online	development	development	development
standard	standard	market	market	market	market	market	china	china	china	china
market	market	standard	standard	china	standard	china	internet	internet	internet	internet
china	online	china	online	online	online	chinese	market	market	market	market
online	product	online	chinese	chinese	standard	standard	chinese	company	chinese	chinese
product	computer	product	product	product	product	company	company	company	company	company
computer	chinese	computer	company	company	service	service	service	service	service	service
chinese	developer	company	service	service	service	product	standard	standard	standard	standard
developer	developer	company	service	service	service	product	product	product	product	product

company service partner design video growth hardware physical	company service design partner video growth hardware physical	service design partner developer video growth hardware physical	computer design partner video developer growth hardware physical	partner design computer video developer physical growth hardware	partner design computer video physical growth developer creative	partner design computer video creative games growth physical	design video creative computer partner games growth hardware	design video creative computer games partner growth hardware	design video creative computer games partner growth hardware	design video creative games computer partner growth hardware
Words 2007 open_source	Words 2008 open_source	Words 2009 project open_source	Words 2010 project open_source	Words 2011 project open_source	Words 2012 project open_source	Words 2013 project open_source	Words 2014 project open_source	Words 2015 project open_source	Words 2016 project developer	Words 2017 project developer
project developer member work code people foundation community software system team governance release gnome contributor contribute linux contribution google	project developer member work people foundation code community software system team gnome governance contributor release linux contribute contribution google	developer work people member foundation community code software system team system contributor linux contribution google contribute governance release	open_source developer work people member foundation community governance member code team system governance contributor contribution contribute linux release gnome google	open_source developer work software foundation community governance member people team code system contributor contribute contribution linux release google working	open_source developer governance work software foundation community member team people code system contributor contribute contribution release linux time successful	open_source developer governance work software team community foundation member people code system contributor contribute contribution release time linux working	open_source developer work governance team software member community foundation people system code contributor contribution contribute release time working successful	open_source developer work governance team software member community foundation people system code contributor contribution contribute release time working successful	work open_source governance team member software community foundation people system code contributor contribution contribute release time working successful	work open_source governance team member software community foundation people system code contributor contribution contribute release time working successful
Words 2007 mobile device platform phone android network alliance	Words 2008 mobile device platform phone android network alliance	Words 2009 mobile device platform phone android network alliance manufacturer	Words 2010 mobile device platform android phone network alliance manufacturer	Words 2011 mobile device platform android phone network alliance firm	Words 2012 mobile platform device android network alliance phone firm	Words 2013 mobile platform device android network alliance decision area	Words 2014 mobile platform device decision area network android space	Words 2015 mobile decision area platform supplier device space network	Words 2016 mobile decision supplier area platform device space network	Words 2017 decision mobile supplier area platform outsourcing device space
sybian manufacturer space firm area theory decision supplier outsourcing industry work landscape governance	sybian manufacturer space firm area theory decision supplier outsourcing industry work landscape governance	sybian space firm area theory decision supplier outsourcing industry work landscape governance	sybian firm space area theory decision supplier outsourcing industry work landscape governance	firm manufacturer space area sybian decision supplier outsourcing industry landscape work governance	theory decision area space manufacturer sybian supplier outsourcing landscape industry work espoo	phone firm space theory supplier manufacturer sybian outsourcing work espoo campus industry	supplier phone alliance firm theory manufacturer outsourcing campus espoo aalto work sybian	android firm phone alliance theory campus outsourcing manufacturer espoo aalto work governance	firm outsourcing phone android alliance theory espoo campus manufacturer aalto work governance	network firm phone android alliance theory espoo campus manufacturer aalto work governance
Words 2007 community member user	Words 2008 community member user	Words 2009 community user member communities	Words 2010 community member user	Words 2011 community member user	Words 2012 community member user	Words 2013 community user member	Words 2014 community user member	Words 2015 community user member	Words 2016 community user member	Words 2017 community user member
communities open_source contribution online participant collaboration	communities open_source contribution online participant collaboration	contribution open_source online participant collaboration	contribution open_source online participant collaboration	communities open_source contribution online collaboration participant	communities open_source contribution open_source value	collaboration communities online barrier open_source group	collaboration barrier co-creation group open_source	co-creation collaboration barrier actor group participant	co-creation collaboration barrier actor participant story	co-creation collaboration barrier story actor group
group value participate forum active share barrier idea lesson brand leader	group value participate share forum barrier active idea lesson brand leader	group value barrier share participate forum active idea brand lesson create	group value barrier share participate forum brand active idea lesson create	value group barrier share brand participate forum idea create social active	brand barrier group participate share participate forum social co-creation create actor	contribution value participate co-creation share brand actor participate social create forum	communities online participate contribution value share story participate brand create different social	communities online open_source contribution value share story participate brand social create	group online communities open_source contribution value share participate create brand	participant online communities contribution open_source share value participate social create brand
Words 2007 language measure trademark	Words 2008 language measure trademark	Words 2009 language measure trademark	Words 2010 language measure trademark	Words 2011 language trademark measure	Words 2012 trademark language measure	Words 2013 trademark language measure	Words 2014 trademark measure indicator	Words 2015 trademark measure	Words 2016 frugal trademark measure	Words 2017 frugal trademark measure

learner indicator would kibs innovation frugal instructor protection need ottercall sustainability collective group corporate learning solution even	learner indicator would kibs innovation frugal instructor protection need ottercall sustainability collective group corporate learning solution even	learner indicator would kibs innovation frugal protection instructor ottercall need sustainabilit y collective group corporate solution learning even	indicator learner would kibs innovation frugal protection instructor ottercall need sustainability collective group corporate solution learning even	indicator kibs would frugal innovation learner protection instructor sustainability need collective group corporate ottercall solution even registration	indicator kibs frugal would innovation protection learner sustainability need collective instructor group corporate ottercall solution even registration	indicator kibs frugal innovation would protection sustainability need collective corporate group instructor solution even registration ottercall	language kibs frugal innovation would protection sustainability need collective learner corporate group solution even instructor registration target	indicator language kibs innovation would sustainability protection need collective corporate group learner solution even target offering people	indicator innovation language kibs sustainability would protection corporate need group collective solution target even learner offering line	indicator innovation language kibs sustainability would protection corporate need group collective solution target even learner offering line
Words 2007 government canada canadian policy capital investment venture funding innovation business industry economic organization country federal fund sector ottawa technology global	Words 2008 government canada canadian policy capital investment funding venture innovation business industry organization economic federal country fund sector ottawa global technology	Words 2009 government canada canadian investment capital policy funding venture innovation business organization industry economic federal country fund sector ottawa global growth	Words 2010 government investment canada canadian capital funding policy venture innovation business organization industry fund economic country global sector growth ottawa investor	Words 2011 government investment canada funding capital canada venture canadian innovation policy business organization industry fund global sector investor country economic technology	Words 2012 government investment venture capital innovation funding canada canadian organization policy business industry fund global sector growth country economic india investor	Words 2013 innovation government venture capital investment organization industry capital canadian funding policy business fund business india global sector country growth system technology	Words 2014 innovation government organization india investment industry capital venture policy funding country global business fund system sector canadian indian growth canada	Words 2015 innovation india government investment organization industry country policy capital venture business sector indian system growth technology science national	Words 2016 innovation india government investment industry country organization policy business indian sector global venture national capital funding science australian growth technology	Words 2017 innovation india government investment country organization policy business indian sector venture global funding national science australian capital growth technology
Words 2007 research science critical infrastructure cybersecurity system management standard model scientific design principle engineering challenge definition section specific domain capability information	Words 2008 research science critical infrastructure cybersecurity system management standard model scientific design engineering challenge definition section specific capability domain information	Words 2009 research critical cybersecurit y science infrastructure system management standard model design scientific principle definition challenge engineering section specific capability information domain	Words 2010 research cybersecurity critical infrastructure science system management model design scientific standard principle definition challenge engineering specific information problem	Words 2011 research cybersecurity critical infrastructure system science management model design definition scientific section engineering challenge capability specific information problem	Words 2012 research cybersecurity infrastructure critical system science model design management definition scientific section engineering challenge capability specific standard information problem	Words 2013 cybersecurity research infrastructure critical system science design model definition management challenge capability engineering section scientific principle specific information problem maturity	Words 2014 cybersecurity infrastructure research critical system design model definition science management engineering maturity principle scientific challenge cyberspace information specific section	Words 2015 cybersecurity infrastructure design critical research system model management science engineering definition maturity principle capability scientific cyberspace challenge standard information perspective	Words 2016 infrastructure cybersecurity research design critical system model management science engineering scientific definition maturity principle capability cyberspace challenge standard information perspective	Words 2017 infrastructure cybersecurity research design critical system model science management engineering scientific definition maturity principle capability cyberspace challenge standard information perspective
Words 2007 mashup apis trust data ontario relationship ecosystem network provider analysis research google leader visualization show member finnish team	Words 2008 mashup apis trust data relationship ecosystem network provider analysis research google visualization leader show member finnish team	Words 2009 mashup apis trust data relationship ecosystem network provider analysis research ontario google visualization leader show member finnish team	Words 2010 mashup trust apis data relationship ecosystem network provider research analysis leader finnish visualization show ontario member google team	Words 2011 mashup trust relationship apis data ecosystem network provider research analysis finnish leader team show growth company visualization google	Words 2012 mashup trust apis relationship data ecosystem network provider research team analysis finnish leader show growth google figure niche	Words 2013 mashup trust apis data relationship ecosystem network finnish provider research analysis team leader growth show google figure niche	Words 2014 mashup trust data apis relationship ecosystem finnish provider network research analysis team leader growth show google figure niche	Words 2015 mashup trust data apis relationship ecosystem finnish provider network research analysis team growth leader show google figure niche	Words 2016 mashup trust data relationship apis finnish ecosystem network provider research analysis team growth leader show google figure niche	Words 2017 mashup trust data relationship apis finnish ecosystem network provider research analysis team growth leader show google figure niche

maps growth	maps growth	growth maps	growth company	member figure	member visualization	company member	company member	company communicati on	company communicati on	company communicati on
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Topic42 Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
study	study	study	study	study	study	study	study	study	time	time
motivation	table	motivation	motivation	motivation	motivation	motivation	theory	commercializ ation	study	study
table	motivation	table	table	table	theory	theory	motivation	time	waiting	waiting
theory	theory	theory	theory	theory	table	table	commercializ ation	system	commercializ ation	system
variable	variable	variable	variable	variable	decision	time	time	theory	system	commercializ ation
decision	decision	decision	decision	decision	variable	commercializ ation	contribution	motivation	circular	circular
adopter	adopter	system	system	system	system	variable	system	waiting	attitude	attitude
system	system	adopter	adopter	time	time	system	table	table	theory	theory
time	time	time	time	adopter	commercializ ation	contribution	variable	contribution	motivation	motivation
survey	survey	survey	contribution	commercializ ation	adopter	decision	waiting	variable	variable	variable
factor	factor	contribution	commercializ ation	contribution	contribution	driver	decision	attitude	table	table
contribution	contribution	factor	factor	factor	driver	science	science	circular	park	contribution
commercializ ation	commercializ ation	commerciali zation	survey	survey	factor	motivational	driver	decision	contribution	park
driver	driver	driver	driver	driver	survey	adopter	attitude	driver	decision	decision
adoption	adoption	adoption	adoption	adoption	word-of- mouth	survey	survey	science	driver	driver
science	science	science	science	science	adoption	factor	circular	survey	survey	survey
word-of- mouth	word-of- mouth	word-of- mouth	word-of- mouth	word-of- mouth	science	waiting	adopter	park	science	science
identified	identified	attitude	motivational	motivational	motivational	attitude	factor	factor	factor	factor
attitude	attitude	identified	attitude	waiting	waiting	adoption	motivational	adopter	priority	priority
waiting	waiting	motivational	waiting	attitude	attitude	circular	identified	motivational	express	express
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Topic43 Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
evaluation	evaluation	evaluation	evaluation	evaluation	evaluation	patent	patent	supply_chain	supply_chain	supply_chain
supply_chain	supply_chain	supply_chai n	supply_chain	supply_chain	patent	evaluation	information	information	information	information
strategic	strategic	strategic	strategic	strategic	supply_chain	information	evaluation	patent	patent	patent
information	information	information	patent	patent	information	supply_chain	supply_chain	evaluation	evaluation	evaluation
patent	patent	patent	information	information	strategic	strategic	strategic	strategic	strategic	strategic
business	business	business	business	business	business	business	technology	supplier	supplier	supplier
technology	technology	technology	technology	technology	technology	technology	business	cyber- resilience	technology	technology
value	value	value	value	value	value	prior	prior	technology	cyber- resilience	cyber- resilience
printing	printing	printing	printing	prior	prior	value	value	resilience	resilience	resilience
relevant	relevant	prior	prior	printing	printing	relevant	relevant	business	business	business
prior	prior	relevant	relevant	relevant	relevant	printing	printing	prior	prior	prior
based	based	based	based	supplier	supplier	firm	firm	value	relevant	relevant
supplier	supplier	supplier	supplier	firm	firm	supplier	supplier	relevant	value	value
firm	firm	firm	firm	based	based	based	cyber- resilience	printing	printing	printing
methodology	methodology	knowledge	knowledge	knowledge	cyber- resilience	cyber- resilience	knowledge	firm	firm	firm
knowledge	knowledge	methodolog y	cyber- resilience	cyber- resilience	knowledge	knowledge	resilience	knowledge	knowledge	knowledge
cyber- resilience	cyber- resilience	cyber- resilience	resilience	resilience	resilience	resilience	based	based	based	based
resilience	resilience	resilience	methodology	methodology	methodology	methodology	methodology	acquirer	acquirer	acquirer
identify	identify	identify	identify	identify	identify	identify	organ	methodology	methodology	methodology
cited	cited	cited	cited	cited	cited	organ	identify	identify	identify	identify
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Topic44 Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
patent	patent	patent	patent	patent	patent	patent	patent	patent	technology	technology
technology	technology	technology	technology	technology	technology	technology	technology	technology	patent	patent
property	property	property	property	property	property	property	firm	firm	business	business
business	business	business	business	business	business	business	business	business	coercive	business
intellectual	intellectual	intellectual	intellectual	intellectual	intellectual	intellectual	property	property	coercive	property
court	court	court	court	invention	invention	firm	intellectual	intellectual	property	coercive
right	right	right	right	invention	invention	right	coercive	patent- holding	patent- holding	intellectual
invention	invention	invention	court	licensing	firm	invention	right	holding	holding	patent- holding
licensing	licensing	licensing	licensing	application	licensing	licensing	licensing	licensing	licensing	licensing
protection	protection	protection	application	firm	asset	asset	patent- holding	right	right	right
infringement	firm	application	asset	asset	application	coercive	invention	invention	invention	invention
firm	application	asset	protection	court	court	application	potential	litigation	litigation	litigation
asset	asset	firm	firm	protection	potential	potential	harassmap	potential	potential	potential
application	infringement	infringemen t	cost	cost	protection	patent- holding	application	risk	risk	risk
cost	cost	cost	potential	portfolio	infringement	also	asset	application	asset	asset
potential	potential	potential	patenting	potential	cost	infringement	risk	asset	application	application

also patenting portfolio year	patenting also portfolio year	patenting portfolio also year	portfolio infringement also inventor	patenting also infringement inventor	also coercive inventor portfolio	risk inventor litigation time	litigation also inventor harassment	harassmap also infringement time	also harassmap infringement time	also harassmap infringement time
					Topic45					
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
software open_source support source application project system many available vendor code tool proprietary solution commercial using product developer standard need	open_source software support application system source project many tool vendor available solution code proprietary using product standard need commercial cost	open_sourc e software application system support source tool many project vendor available solution using product need time proprietary cost developmen t code	software open_source application system support source many tool time available vendor product vendor using cost project need development cost proprietary also	software open_source system support time tool many available source product vendor using cost solution need development project also proprietary	software application system time open_source support many tool many available open_source using need cost product source also development solution vendor also project would	software application system time support many tool available open_source using need cost product source also development solution vendor provide	software application time system many tool available support need using also product open_source cost development source solution would vendor significant	software time application system many tool available need support using also product cost would development open_source source solution significant vendor example	time software system application many need tool available support using also product would development cost source open_source solution significant example	
					Topic46					
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
consumer employee production activity co- production apple engage iphone creative good personal service luxury consumption experience individual gamification knowledge game also	consumer employee production activity co- production apple iphone engage creative good personal service luxury experience individual gamification knowledge game also	consumer employee production activity co- production apple iphone engage creative personal good service luxury experience gamification individual knowledge game skill also	consumer employee production activity apple co- production creative engage iphone good personal luxury gamification service experience individual knowledge game skill also	employee consumer production activity apple creative luxury gamification co- production engage good personal iphone service game knowledge individual skill system	employee consumer production luxury creative activity gamification apple good game service personal knowledge co- production individual experience iphone skill system	employee consumer production luxury gamification creative activity apple game good service knowledge apple personal engagement individual experience system personal skill training also	employee consumer luxury gamification consumer production creative game good knowledge service knowledge apple system experience individual training skill engagement application personal	employee luxury gamification consumer creative production game good knowledge activity service system training skill individual user enterprise application apple	employee luxury gamification consumer creative production game good knowledge service activity system training skill individual experience user application enterprise apple	employee luxury gamification consumer creative production game good knowledge service activity system training skill individual experience user application enterprise apple
					Topic47					
Words 2007	Words 2008	Words 2009	Words 2010	Words 2011	Words 2012	Words 2013	Words 2014	Words 2015	Words 2016	Words 2017
innovation firm strategy competitive market management growth resource leadership product strategic corporate business company culture capability performance external change radical	innovation firm strategy competitive market management growth resource leadership product strategic corporate business company culture capability performance external change radical	innovation firm strategy competitive market managemen t growth resource leadership product strategic corporate business company culture capability performanc e external change radical	innovation firm strategy market competitive management growth resource leadership corporate product strategic business culture company capability performance external change radical	innovation firm strategy market competitive management growth leadership corporate resource product strategic business culture company capability performance radical external change	innovation firm strategy market competitive growth corporate management leadership corporate resource product business culture strategic capability company radical performance external organizational	innovation firm strategy market culture corporate management leadership competitive business resource strategic growth company capability performance external organizational	innovation firm strategy market management corporate business strategic culture competitive resource leadership external product organizational capability radical change internal growth performance	innovation firm strategy corporate market management strategic business culture resource leadership competitive external product organizational capability radical change internal company	innovation firm strategy corporate strategic management market business external culture leadership resource organizational capability competitive product change internal company radical	innovation firm strategy corporate strategic management market business external organizational culture resource leadership capability competitive product change internal company radical

Appendix VII: Word clouds of collection of first slice topic words in DTM

Topic 1

Topic 2

Topic 3

Topic 4

Topic 5

Topic 6

Topic 7

Topic 8

Topic 9

Topic 10

Topic 11

Topic 12

Topic 13

Topic 14

Topic 15

Topic 16

Topic 17

Topic 18

Topic 19

Topic 20

Topic 21

Topic 22

Topic 23

Topic 24

Topic 25

Topic 26

Topic 27

Topic 28

Topic 29

Topic 30

Topic 31

Topic 32

Topic 33

Topic 34

Topic 35

Topic 36

Topic 37

Topic 38

Topic 39

Topic 40

Topic 41

Topic 42

Topic 43

Topic 44

Topic 45

Topic 46

Topic 47

Appendix VIII: R Function: Harmonic mean log likelihood function to obtain proper topic number

```
harmonicMean <- function(logLikelihoods, precision = 2000L) {  
  llMed <- median(logLikelihoods)  
  as.double(llMed - log(mean(exp(-mpfr(logLikelihoods,  
                                         prec = precision) + llMed))))  
}  
k <- 25  
burnin <- 1000  
iter <- 1000  
keep <- 50  
fitted <- topicmodels::LDA(llisreduced.dtm, k = k, method = "Gibbs", control = list(burnin = burnin,  
iter = iter, keep = keep) )  
## assuming that burnin is a multiple of keep  
logLiks <- fitted@logLiks[-c(1:(burnin/keep))]  
  
## This returns the harmonic mean for k = 25 topics.  
harmonicMean(logLiks)  
## [1] -162256.9
```

Appendix IX: R Function: Generate matrix (CSV file) of topic proportions to articles and topic probabilities of words in LDA

```
get_WordsDocs <- function(directory, k_topic, TopNumWords) {  
  #k_topic <- 47  
  #directory <- paste("C:/MinGW/bin/ldac/lda-c-master/example", k_topic, sep="")  
  #TopNumWords <- 60  
  
  iMax = k_topic + 1  
  setwd(directory)  
  
  VocabList = read.table("txtfilesnew.vocab", header = F, sep=",", quote="", encoding = "UTF-8", stringsAsFactors = F)  
  VocabNo <- nrow(VocabList)  
  
  ArticlesList = read.table("txtfilesnew.dmap", header = F, sep=",", quote="", encoding = "UTF-8", stringsAsFactors = F)  
  ArticlesListYears <- ArticlesList  
  iYear = 2006  
  for (ip in 1:597){  
    if (substr(ArticlesList[ip,1], 33, 36) == "0001")  
      iYear <- iYear + 1  
    ArticlesList[ip,1] = paste("A", substr(ArticlesList[ip,1], 29, 36), iYear, sep="")  
    ArticlesListYears[ip,1] <- substr(ArticlesList[ip,1], 10, 13)  
  }  
  
  ArticlesListTitle = read.table("AllText597Titles.csv", header = F, sep=",", quote="", encoding = "UTF-8", stringsAsFactors = F)
```

```

bb = scan(paste("final.beta" , "", sep=""))
finalbeta = matrix(bb, ncol=VocabNo, byrow=TRUE)
finalbeta <- exp(finalbeta)
finalbeta <- t(finalbeta)

filename = paste("LDA_TopicWordsProb", k_topic, ".csv", sep = "")
write.table(finalbeta, file=filename, sep=",")

bb = scan(paste("final.gamma" , "", sep=""))
finalgamma = matrix(bb, ncol=k_topic, byrow=TRUE)
rs = rowSums(finalgamma)
e.theta = finalgamma / rs
finaltheta <- e.theta

filename = paste("LDA_TopicDocs", k_topic, ".csv", sep = "")
write.table(cbind(ArticlesList,finaltheta), file=filename, sep=",")

i=2
cTopics_word <- NULL
for (i in 2:iMax){
  cc <- cbind(VocabList,finalbeta)
  Pr <- cc[order(cc[,i], decreasing = TRUE),]
  cTopics_word <- cbind (cTopics_word, Pr[1:TopNumWords,1]) # Sorted Words
  cTopics_word <- cbind (cTopics_word, Pr[1:TopNumWords,i])
  #colnames(cTopics_word)[ncol(cTopics_word)-1] <- paste("ItemId" , i-1, sep="")
  #colnames(cTopics_word)[ncol(cTopics_word)] <- paste("Prop" , "", sep="")
}

i=2
cTopics_doc <- NULL
for (i in 2:iMax){
  cc <- cbind(ArticlesList,finaltheta)
  Pr <- cc[order(cc[,i], decreasing = TRUE),]
  cTopics_doc <- cbind (cTopics_doc, Pr[1:TopNumWords,1]) # Sorted docs
  cTopics_doc <- cbind (cTopics_doc, Pr[1:TopNumWords,i])
}

i=2
cTopics_docAll <- NULL
cTopics_docT <- NULL
cTopics_docAll <- c("ItemId", "Topic1", "", "1")
for (i in 2:iMax){
  j <- i+2
  cc <- cbind(ArticlesListTitle, finaltheta)
  Pr <- cc[order(cc[,j], decreasing = TRUE),]
  cTopics_docT <- NULL
  cTopics_docT <- Pr[1:TopNumWords,1:3]
  cTopics_docT <- cbind (cTopics_docT, Pr[1:TopNumWords,j])
  colnames(cTopics_docT)[4] <- "V4"
  cTopics_docAll <- rbind(cTopics_docAll,cTopics_docT)
  cTopics_docAll <- rbind(cTopics_docAll,c("", "", "", "0"))
  cTopics_docAll <- rbind(cTopics_docAll,c("", "", "", ""))
  cTopics_docAll <- rbind(cTopics_docAll,c("ItemId", paste("Topic", i, sep=""), "", "1"))

  colnames(cTopics_docAll)[1] <- "V1"
  colnames(cTopics_docAll)[2] <- "V2"
  colnames(cTopics_docAll)[3] <- "V3"
  colnames(cTopics_docAll)[4] <- "V4"
}

filename = paste("LDA_TopicDocsTitle", k_topic, ".csv", sep = "")
write.table(cTopics_docAll, file=filename, sep=",")

cTopics <- rbind (cTopics_word, cTopics_doc)
filename = paste("LDA_TopicWordsDocs", k_topic, ".csv", sep = "")
write.table(cTopics, file=filename, sep=",")

filename = paste("LDA_Sum_Docs_ProbPerTopic", k_topic, ".csv", sep = "")

```

```

write.table(colSums(finaltheta), file=filename, sep=",")

filename = paste("LDA_Sum_Docs_ProbPerTopic", k_topic, "_0.9Count.csv", sep = "")
write.table(colSums(finaltheta >= 0.9), file=filename, sep=",")

Topic_trends <- cbind (ArticlesListYears, finaltheta)
Topic_trendssum <- aggregate(. ~ V1 , data = Topic_trends, sum)
filename = paste("LDA_Sum_Docs_ProbPerTopicYear", k_topic, ".csv", sep = "")
write.table(Topic_trendssum, file=filename, sep=",")

return (Topic_trendssum)
}

```

Appendix X: R Function: Generate matrix (csv file) of topic proportions to articles in DTM

```

dynamic.topic <- function(path, x,y, y2)
{

path <- "C:/MinGW/bin/dtm/bin/example/model_run/lda-seq"
x <- 11 # slices number
y <- 43768 # words number
y2 <- 20 # Top number
k_topics <- 47 #Topic number
setwd(path)

file.list <- dir( pattern = "^topic-(.*)-var-e(.*?)dat$", full.names = TRUE, ignore.case = TRUE)
words = read.table("txtfilesnew.vocab", header = F, sep=",", quote="", encoding = "UTF-8", stringsAsFactors = F)

#file.list <- system("topic-*.var-e-log-prob.dat", intern=TRUE)
#words<-read.vocab("txtfilesnew.vocab")
TopicNo = 0
CSums <- NULL
CCAllLimited <- NULL
CCAllLimitedFirstCol <- NULL
for (file in file.list) {
#a=scan("topic-047-var-e-log-prob.dat")
a=scan(file)
b=matrix(a,ncol=x,byrow=TRUE)
b[]<-exp(b)
i=1
CC <- NULL
CCLimited <- NULL
CSum <- NULL
for (i in 1:x) {
try.df<-data.frame(b[,i],words, stringsAsFactors=FALSE)
var.col<-colnames(try.df)
var<-var.col[1]
to.sort<-try.df[order(-try.df[[var]]), ]
TT <- head(to.sort[,1], y)
TT = matrix(TT, y, byrow=TRUE)
#TT <- TT[TT[, 1] >= 0.0001,]
TT <- TT[1:20,]

tmpCol = matrix(TT, NROW(TT), byrow=TRUE)
#NROW(TT)
Col1_2 <- head(to.sort[,1:2], y)
TTTopicNo <- TopicNo + 1
Col1_2 <- rbind(Col1_2[1:y2,], c("", ""))
if (i==1)
Col1_2 <- rbind(Col1_2, c(paste("Topic ",TTTopicNo, sep=""), ""))
else
Col1_2 <- rbind(Col1_2, c("", ""))
Col1_2 <- rbind(Col1_2, c(paste("Props ", 2006+i, sep=""),paste("Words ", 2006+i, sep="")))

if (i==1){
CC <- head(to.sort[,1:2], y)

```

```

CCLimited <- Col1_2
CSum <- colSums(tmpCol) #/ nrow(tmpCol)
}
else
{
  CC <- cbind(CC, head(to.sort[,1:2], y))
  CCLimited <- cbind(CCLimited, Col1_2)
  CSum <- cbind(CSum, colSums(tmpCol)) #/ nrow(tmpCol))
}
#print(head(to.sort$V1, y))
}

if (is.null(CSums))
  CSums <- CSum
else
  CSums <- rbind( CSums, CSum)

if (is.null(CCAIILimited)) {
  CCAIILimited <- CCLimited
  CCAIILimitedFirstCol <- CCLimited[1:20,2:3]
}
else{
  CCAIILimited <- rbind( CCAIILimited, CCLimited)
  CCAIILimitedFirstCol <- cbind(CCAIILimitedFirstCol, CCLimited[1:20,2:3])
}
filename = paste("dist-", k_topics, "topicData", TopicNo, sep = "")
filename = paste(filename, ".csv", sep = "")
write.table(CC, file=filename, sep=",")
print(filename)

filename = paste("dist-", k_topics, "topicData_Limited", TopicNo, sep = "")
filename = paste(filename, ".csv", sep = "")
write.table(CCLimited, file=filename, sep=",")
print(filename)

TopicNo <- TopicNo + 1
}

filename = paste("dist-", k_topics, "topicSumsProbs", sep = "")
filename = paste(filename, ".csv", sep = "")
write.table(CSums, file=filename, sep=",")
print(filename)

filename = paste("dist-", k_topics, "topic_LimitedWords", sep = "")
filename = paste(filename, ".csv", sep = "")
write.table(CCAIILimited, file=filename, sep=",")
print(filename)

filename = paste("dist-", k_topics, "topic_LimitedWords_FirstCol", sep = "")
filename = paste(filename, ".csv", sep = "")
write.table(CCAIILimitedFirstCol, file=filename, sep=",")
print(filename)
}

```

Appendix XI: R Function: Generate matrix (CSV file) of topic probabilities to words in DTM

```

dynamic.docs <- function(path, x, y, y2){

# - gam.dat: The gammas associated with each document. Divide these by
# the sum for each document to get expected topic mixtures.
# Proportion of topic 5 in document 3:
# e.theta[3, 5]

path <- "C:/MinGW/bin/dtm/bin/example/model_run/lda-seq"
x <- 11 # slices number
y <- 43768 # words number

```



```

y2 <- 20 # Top number
k_topics <- 47 #Topic number
setwd(path)

a = scan("gam.dat")
b = matrix(a, ncol=as.numeric(k_topics), byrow=TRUE)
rs = rowSums(b)
b1 = matrix(a, ncol=597, byrow=TRUE)

write.table(b1, file= paste("DTM_documents_topics_e.theta597", k_topics, "Raw.csv", sep=""), sep=",")
print(paste("DTM_documents_topics_e.theta597", k_topics, "Raw.csv", sep=""))

write.table(b, file= paste("DTM_documents_topics_e.theta", k_topics, "Raw.csv", sep=""), sep=",")
print(paste("DTM_documents_topics_e.theta", k_topics, "Raw.csv", sep=""))

e.theta = b / rs
finaltheta <- e.theta

Articles = read.table("txtfilesNew.dmap", header = F, sep=",", quote="", encoding = "UTF-8", stringsAsFactors = F)
for (ip in 0:597){
  Articles[ip,1] = paste("A", substr(Articles[ip,1], 29, 40), sep="")
}

Articles1 <- cbind(Articles[,1],e.theta)

#Articles1 <- e.theta
write.table(Articles1, file= paste("DTM_documents_topics_e.theta", k_topics, ".csv", sep=""), sep=",")
print(paste("DTM_documents_topics_e.theta", k_topics, ".csv", sep=""))

TopicMax <- as.numeric(k_topics)-1
cTopics <- NULL
ii = 0
strTopic <- "00"
Words1 <- NULL

while (ii <= TopicMax)
{
  strTopic = paste("", as.character(ii), sep="")
  if (ii < 10)
    strTopic = paste("0", as.character(ii), sep="")

  docs1 <- get_documents(path, k_topics, strTopic, 1, 20, 1)

  if (ii ==0)
    Words <- docs1
  else
    Words <- cbind(Words,docs1)

  print(paste ("topic ", ii, sep=""))
  ii <- ii + 1
}

write.table(Words, file= paste("DTM_documents_pertopics", k_topics, ".csv", sep=""), sep=",")
print(paste("DTM_documents_pertopics", k_topics, ".csv", sep=""))

ArticlesListTitle = read.table("AllText597Titles.csv", header = F, sep=",", quote="", encoding = "UTF-8", stringsAsFactors = F)

iMax = k_topics + 1
i=2
cTopics_docAll <- NULL
cTopics_docT <- NULL
cTopics_docAll <- c("ItemId", "Topic1", "", "1")
for (i in 2:iMax){
  j <- i+2
  cc <- cbind(ArticlesListTitle, finaltheta)
  Pr <- cc[order(cc[,j], decreasing = TRUE),]
  cTopics_docT <- NULL
  cTopics_docT <- Pr[1:TopNumWords,1:3]
  cTopics_docT <- cbind(cTopics_docT, Pr[1:TopNumWords,j])
}

```

```

colnames(cTopics_docT)[4] <- "V4"
cTopics_docAll <- rbind(cTopics_docAll,cTopics_docT)
cTopics_docAll <- rbind(cTopics_docAll,c("", "", "", "0"))
cTopics_docAll <- rbind(cTopics_docAll,c("", "", "", ""))
cTopics_docAll <- rbind(cTopics_docAll,c("ItemId", paste("Topic", i, sep=""), "", "1"))

colnames(cTopics_docAll)[1] <- "V1"
colnames(cTopics_docAll)[2] <- "V2"
colnames(cTopics_docAll)[3] <- "V3"
colnames(cTopics_docAll)[4] <- "V4"
}

filename = paste("DTM_TopicDocsTitle", k_topics, ".csv", sep = "")
write.table(cTopics_docAll, file=filename, sep=",")

return (cbind(Articles,b))
}

get_documents <- function(dir, k_topics, k_topic, sliceNo = 1, TopNumdocs = 10, WordORValue = 1) {

  path <- "C:/MinGW/bin/dtm/bin/example/model_run/lda-seq"
  setwd(dir)

  k_topics <- "47" # Topic number
  TopNumdocs <- 20 # Top 20 documents
  #k_topic <- "00"

  docs = read.table(paste("DTM_documents_topics_e.theta", k_topics, ".csv", sep=""), header = T, sep=",", quote="", encoding = "UTF-8",
stringsAsFactors = F)

  k_t = as.numeric(k_topic) + 2

  Pr <- docs[order(docs[,k_t], decreasing = T),]

  Ret <- paste("", substr(Pr[1:TopNumdocs,1], 2, 5), sep="")
  Ret <- cbind (Ret, Pr[1:TopNumdocs,k_t])
  colnames(Ret)[colnames(Ret)=="Ret"] <- "Wname"
  colnames(Ret)[2] <- paste("topic", k_topic, sep="")

  dw <-data.frame("", "1")
  colnames(dw)[1] <- "Wname"
  colnames(dw)[2] <- paste("topic", k_topic, sep="")

  de<-data.frame("", "-100")
  names(de)<-c("Wname",paste("topic", k_topic, sep=""))

  Ret <- rbind(dw, Ret)
  Ret <- rbind(Ret, de)

  return (Ret)
}

```