Systematic Review

The Performance of Knowledge Organizations and Modelling Human Action

Quantitative Models for Economic Analysis and Management

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Abstract

This systematic review aims to highlight how modeling is a useful tool to get better performance in knowledge organization. According to *The Organization of Information* by Joudrey and Taylor, information organization: "examines the activities carried out and tools used by people who work in places that accumulate information resources for the use of humankind, both immediately and for posterity". The traditional approaches performed by librarians, archivists and specialists are increasingly challenged by computational algorithmic techniques that deal with Big Data. What we really want to investigate in this review is the contribution of a good knowledge management system and of a good knowledge organization in the firms and humans' performances.

Introduction

Knowledge organizations' success depends on how they manage their knowledge, in fact only being able to improve this capacity they can innovate and survive in the market. In this systematic review we focus our attention on how modeling can be used to improve performance, in particular on how it's possible to model mechanisms where the human action is an input.

Methodology

To do our research we extracted specific keywords from the area of "knowledge organizations". In addition, we add "model" and also "performance" to restrict the domain and answer our question better.

We limited our research only to articles in "English" and we considered only the ones from 2010, in order to get new and updated articles. Thanks to these limitations it was easy to find several results among international papers, academic researches and transcriptions of international conferences.
To retrieve these papers we used primarily the SCOPUS portal. More precisely, we used the following query into the advanced research:

(TITLE-ABS-KEY ("knowledge organi?ation*") AND TITLE-ABS-KEY (model*) AND TITLE-ABS-KEY (performance*)
) AND PUBYEAR > 2009 AND (LIMIT-TO (LANGUAGE , "English"))

It is relevant to notice that we used the keyword *organi?ation* in order to check for both the words organization and organisation. In addition, we added * at the end of each word in the query, so we can also consider the plurals of the given words.

From this advanced research we obtained 65 papers. Then, we joined this group of papers with a group of 31 papers obtained by looking among the connected papers of the article "*Designing a maturity model for analyzing information and knowledge management in the public sector*" by Aki Jääskeläinen. In our opinion, this article was really on target with our analysis, so we don't want to miss it and we thought that looking into its connected paper would be interesting too.

At the end, we joined the two groups of documents, we removed the duplicates, and we obtained 96 papers. We are a team of 5 members, so we searched 19 documents each, more or less.

After a quick review of the titles and of the abstracts of all these articles, we decided to keep 9 documents in total, as some of the other articles were not strictly related to our research.

Results

At the end of our research, we obtained a total of 96 documents, 65 from the query performed on the SCOPUS database and 31 connected papers to the article "*Designing a maturity model for analyzing information and*

knowledge management in the public sector"
by Aki Jääskeläinen.

In the "Appendix" section, at the end of the review, are shown the bibliographic analysis that we have made using the R package Bibliometrix for the file exported from SCOPUS and the Connected Papers web tool.

Organization Capital

For a knowledge organization the ability of innovating and its performance depend on the organization capital.

Organizational capital is the value to an enterprise which is derived from organization philosophy and systems which leverage the organization's capability in delivering goods or services.

We start focusing on the link between Knowledge management and performance.

What is Knowledge Management and how it is linked to organizational performance in companies?

In *"Knowledge Management, Knowledge Management System, and Organizational Performance: An Empirical Study"* the authors W. Han and Y. Wang analyzed the relationship among these three factors. Knowledge is the determinant factor to keep the competitive advantage of enterprises and the purpose of this study is to examine how the usage of it can support management and organizational performance. But first, let's define what knowledge management is.

Knowledge management is a dynamic process consisting of many parts.

1. ***Knowledge creation***. Knowledge creation is the capability of developing valuable new thoughts and schemes.

2. ***Knowledge organization***. Knowledge organization involves several processes: storage, maintenance, retrieval and protection of knowledge.
3. ***Knowledge transfer***. Knowledge transfer is a specific process by which knowledge is transformed, transmitted and absorbed by users. It consists of three dimensions: acquisition, dissemination and absorption.
4. ***Knowledge application***. The competitiveness of an organization depends on how effectively it can apply and integrate the existing knowledge in the decision making process.

The model proposed by the authors verified the relationship between knowledge management (KM), knowledge management capability (KMC) and organizational performance. KMC can improve the learning ability at individual, group and organizational level. The higher learning ability will support the organizations to absorb new knowledge and integrate new and existing knowledge. KM practices can enhance new products and services development processes, reduce the time-to-market and increase the probability of innovation success. In addition, KM can improve the adaptability to market environment change and ability to make quick responses to new business opportunities.

This paper focuses on verifying different hypotheses on the relationship between KM and organizational performance. They conducted a study in which 176 organizations with KM practices were involved.

In particular, they found that knowledge application impacts directly the organizational performance instead of using the KM capability as mediator. Then, the use of IT will lead to more effective knowledge creation, organization, transfer and application but it will not directly affect the KM

capability and they will not improve the organizational performance.

The limitations of this research are the focus only on technical factors. There are also some non-technical factors like culture and organization structure that are not considered.

Applying Knowledge Management to Human Performance

Apart from allowing enterprises to coordinate and develop efficient routines to enhance working performance, KM can and should be applied to human performance: when we think of an enterprise often we focus only on the higher end of the production chain, but John Dumay's paper "*Using critical KM to address wicked problems*" shows how KM should be used to address wicked problems amongst those who contribute to provide the raw product to the higher level companies that apply KM to enhance their productivity.

This issue has not been covered often, but articles that treat it mostly recommend that researchers should change their approach to both research and practice: concentrating too much on organizational performance can distract from the whole, and other than to asking us "What is KM made up of?" we should ask "What should KM do?".

The Finnish Model
An example of this change of approach can be found in the paper "*Knowledge management and hybridity of institutional logics in the public sector*" from H. Laihonen and P. Kokko, which focuses on the Finnish journey of shifting public administration to an hybrid approach, making data public and involving organizations in administration.

At the starting time of the study, Finland's goal was to enhance productivity of the public sector starting with the Isaacus Project. This programme raised knowledge management to a national agenda and in 2015 this was also extended to administrative branches.

The Data Lake
Apart from improving health care and social provision, the purpose of the Isaacus project was to make knowledge accessible to most actors, enabling scientific research, statistics and effectively shifting the focus from organizational information to platform based thinking. This was achieved by introducing a new technology: the "data lake".

As cited by J. Dumay, according to Callon, M. (p. 206, 1986) the common interest is an "obligatory passage point" that bonds all companies from the same fields, because "they cannot attain what they want by themselves" but could, by forming coalitions, tackle problems that are way too big for one to solve.

This is exactly what Finland has done by introducing Data Lakes: many actors managed to learn and provide knowledge on shared topics; all the interviewed parts in the study were seen to have learned a lot and gained in performance.

Observations on the Finnish Model
This project highlights how a new information structure could challenge and reform the whole institutional order, and shows how thinking about KM as a "problem-driven discipline", breaking the individual enterprise boundary, could improve organizational performance by forming collaborative coalitions capable of approaching and solving major problems. Effectively, this change of approach could not only enhance working performance, but *human performance.*

An Organizational Capital Decision Model for Knowledge-Intensive Organizations

We highlighted the link between knowledge management and performance, however to have effective management we need to to deploy the right organizational capital.

Usually, when we think about capital, we think about the capital used to get the physical needed resources to create a product/service, but especially for the knowledge organizations, their success depends heavily on their capacity to innovate.

Therefore, we can't decide approximately how many resources we should give to this fundamental area in a firm. We need a model to analyze and make this decision. A model used to answer the following question: How to allocate the budget between physical capital and organizational capital?

Organization capital, human capital

To define this model, we need first to define the roles and what aims this capital should go for, but in a real context we don't always have a clear boundary, and we can't find little pieces of information about what is and what it includes from firms' reports and accounting books.

Therefore the first step is to define these boundaries, and using the definitions proposed In "*An Organizational Capital Decision Model for Knowledge-Intensive Organizations*" we define human capital as the contribution to work output affiliated with the amount of knowledge in the firm (but also new sources like DB, patents) and organizational capital as the contributions to all the means by which human capital creates innovation.

The model: the authors suggest a model for asserting optimal allocation to organization capital maximizing expected income, to analyze potential benefits and expected income.

They implemented this model using a *Monte Carlo simulation* with also real data from the top global software firms. They used these companies because software companies heavily operate on the main quantitative elements defining organizational capital, such as training, the knowledge integration

mechanisms and organizational capabilities. Additionally, various aspects of the software industry are ubiquitous in several other industries, such as online retailers, and transportation.

Results analysis: They proceed to analyze these companies dividing them into 2 categories: "*High delta / Low delta*" depending on their optimal allocation of total budget to organizational capital. They compared the expected income using this model and its optimal allocation with the number reported in the financial filings. They discovered the firms with the highest optimal delta would have almost doubled their income if they used the suggested model.

The importance of information retrieving

The fundamental ability of a knowledge organization is retrieving knowledge efficiently from the resources, and therefore it's one of the mechanisms where a firm should invest.

M. A. A. Leite and I. L. M. Ricarte studied how knowledge organizations can improve their performance in retrieving information based on users' queries. In "*Relating ontologies with a fuzzy information model*" they present a novel way to represent and organize knowledge, from distinct domains, using multiple ontologies that can be related.

A basic information retrieval system stores and indexes documents in such a way that, when users express their information needs in a query, the system retrieves the related documents assigning a relevance score to each one. Usually, documents are retrieved when they contain terms or keywords specified in the user's query. However, many other documents may contain the desired semantic information, even though they do not contain the user-specified keywords, in which case the traditional approach leaves out relevant documents. One way to deal with this limitation is to consider not only the

lexical information explicit in documents but also its semantics.

Each domain can be represented as a conceptual structure, such as a lightweight ontology. They include concepts, concept taxonomies, relationships between concepts and properties that describe concepts.
Relationships between concepts can be represented by fuzzy relations, with crisp relationships being a particular case.

The model evaluation uses a 129 document collection sample of the agrometeorology domain in Brazil; a 83 query set; a lightweight ontology of the geographical Brazilian territory and a lightweight ontology of the climate distribution over the Brazilian territory. Both ontologies are manually constructed.

The query set is composed of queries containing a single concept from each ontology, as well as queries containing combinations of two concepts from both ontologies connected by AND or OR Boolean operators. Each document is examined and reassigned to the ontology concepts by a domain expert.

The knowledge representation and the method proposed for query expansion were tested using the Apache Lucene Engine. After that, the performance was compared with the multi-relationship fuzzy concept network information retrieval model. It has been shown that the proposed model performs better than the others. For fuzzy ontologies, the precision for low recall values is above 95% and remains above 50% for higher recall values.

The innovation of this approach is that the ontologies can deal with knowledge of distinct domains and they can be related to each other by casual, spatial or similarity relationships.

They demonstrate that human actions are needed to have good models for knowledge organization and they proposed a new information retrieval system that performs better than the others.

Sense induction in folksonomies

A real complex aspect of information retrieval is the presence of folksonomies.

Folksonomies often known as tagging system, widely used in many websites, use a very simple knowledge organization system, this allows to create quick extensive knowledge annotations, but it incurs in some barriers for the automatic use of such knowledge organization systems by computers and new techniques have to be developed to extract the semantic of the tags used.

The authors Pierre Andrews and Juan Pane and Ilya Zaihrayeu (DISI - University of Trento, Italy) had explored new ways to deal with this complex aspect.

Introduction
Folksonomies are described as uncontrolled knowledge organization systems where users can use free-text tags to annotate resources. In fact, they create a network of user-tag-resource triplets that encodes the knowledge of users. This structure however must deal with language ambiguity issues and synonymy which represent a great problem for computer algorithms.

Word Sense Disambiguation unfortunately are not completely adapted to folksonomies: they use an existing vocabulary to link terms (in our case tags) to concepts, thus discovering the semantics of the tags used.

Sense induction
The method used to extract the semantics from folksonomies is what is called *tag clustering* and its principle is based on machine learning clustering algorithms. This clustering is based on the principle that similar tags will have the same meaning and can thus be attached to the same "concept" in the created vocabulary. However, to compute the similarity between tags to run

the clustering algorithms that will attach similar tags together remains the main issue. For instance, the authors claim that all the methods available currently use a mix of measures based on the collocation of tags on resources and their use by users. If two tags are often used by the same user on different resources or by different users on the same resource, then they can be considered similar. Since tags are often ambiguous in folksonomies and can bear more than one meaning this is the main weak point. In the article to obviate this issue it is added an extra step to the clustering to first identify the diverse senses of polysemous tags and in the following clustering steps, we do not consider tags directly, but the unique senses that they can take.

The algorithm

In the article the well-known KNN and K-means algorithms are avoided since they don't match the purpose: the step in which clustering is applied to detect the different senses in which one tag can be used. In this case, it is not possible to find an overall optimal value for the number of clusters to look for as each term might have a different number of senses.

For instance, the DBScan algorithm is used to do a density based clustering. This approach to clustering has various advantages for our application:

- It does not require as input the number of clusters to be found.
- The DBScan algorithm can decide that some of the items to be clustered are noisy and should not be considered.
- The DBScan algorithm can detect clusters that have more complex "shapes".

The authors in the end present their algorithm which is divided in 3 step:

1. For each tag, we cluster the user-resource bipartite graph that is attached to this tag.

2. Then apply the same principle as the one discussed in the state of the art on the user-resource-sense tripartite graph to cluster similar senses together.
3. Identify new concepts for each of the clusters. This process is equivalent to finding the relation of the new concept in the structured vocabulary.

The Authors then affirms that there is not yet an appropriate evaluation methodology in the field and proceeded by defining this evaluation metrics:

Evaluation methodology
- *Accuracy*
- *Parsimony*
- *Recall*
- *Precision*
- *Production*
- *Learning Accuracy Results*

The research ended with these results: when using only tag collocation, the first step clustering algorithm can achieve a maximum F-measure of 59.7%4. The user collocation measure achieves a very similar result with a maximum F-measure of 59.1%5.

Factors influencing the effectiveness of performance measurement systems

A Knowledge organization needs to measure its performance efficiently.

A successful Performance Measurement System (PMS) allows an organization to match its strategy with a measured and controlled performance. In this way, it allows us to determine if goals are being achieved but also identifies areas of improvement.

This paper explores the between multidimensional performance measures and the effectiveness of Performance Measurement Systems (PMS).

An effective PMS encourages the alignment of performance with desired goals, allows a more detail-oriented tracking of areas of

improvement and it can help to build future strategies.

Furthermore, PMS has evolved from consisting only of financial measures, up to also including non-financial measures. This since outcome-centered measures have some disadvantages: first, it prevents managers from measuring employees' integral performance over strategic objectives; second, these measurements rarely indicate what needs to be fixed; third, it can encourage short-term results at expense of long-term stability.

The **Balance Score Card** (BSC) allows to join financial with non-financial measures as it includes other areas as customer satisfaction, internal processes, and learning. At the same time, it enables the components of the organization to align to the firm's strategy and contribute to it.

Hypothesis Formulation
The authors formulate five hypotheses, which they evaluate then by means of a survey. The hypotheses are the following:

- *Hypothesis 1*: extensiveness of multidimensional performance measures is associated with effectiveness of PMS.
- *Hypothesis 2*: extensiveness of top management support is associated with effectiveness of PMS.
- *Hypothesis 3*: extensiveness of PMS-related training is associated with effectiveness of PMS.
- *Hypothesis 4*: extensiveness of employee participation in designing PMS is associated with effectiveness of PMS.

The evaluation of these hypotheses is conducted by means of a survey questionnaire of a random sample of 445 Australian Manufacturing business units, from which 118 questionnaires were used to carry out the data analysis.

The study finally finds that organizations have used PMS mainly to implement strategy and objectives but not so extensively to address concerns of the staff, for instance. This is an important area of improvement since results are achieved by focusing on both staff and performance related topics. As a matter of fact, the paper provides evidence on how staff-related outcomes serve as a boost for performance-related outcomes achievement.

Furthermore, the study finds evidence that financial measures are still being more extensively used on their own than coupled with non-financial measures. For this reason, the authors encourage firms to adopt more extensively non-financial oriented measures into their PMS.

Finally, authors provide evidence on how multidimensional performance measures along with top management support and training, displayed a significant association with PMS's effectiveness.

Conclusion

We understood that using modeling in a knowledge organization context improves not only the firm's working performance but also the human performance. The principal issues that a firm should address are: the budget for the organizational capital and the knowledge application process. In addition, it is really important to have an efficient information retrieval system to access the knowledge within the organization. We have seen that another modeling perspective is the need for a reliable performance measurement system in order to determine if goals are being achieved but also to identify areas of improvement.

Bibliography

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[9] *Factors influencing the effectiveness of performance measurement systems*; Tung, A; Baird, K; Schoch, H. (2011)

APPENDIX
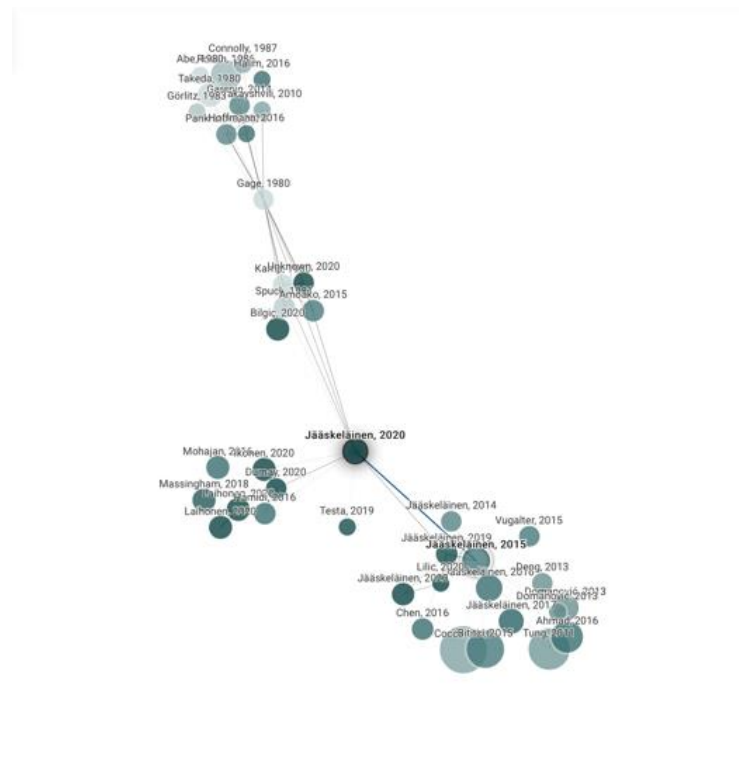
FIG. 1: Connected papers of "*Designing a maturity model for analyzing information and knowledge management in the public sector*" by Aki Jääskeläinen.
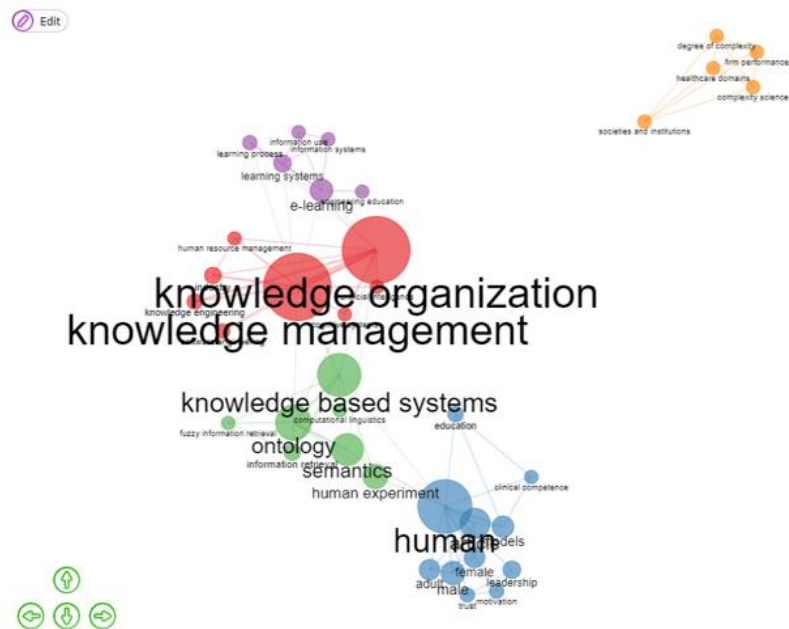
FIG. 2: Through Bibliometrix: Co-occurrence network of the 65 articles found in SCOPUS. The fields are the keywords plus. The most used keywords are knowledge management, knowledge organization and human.
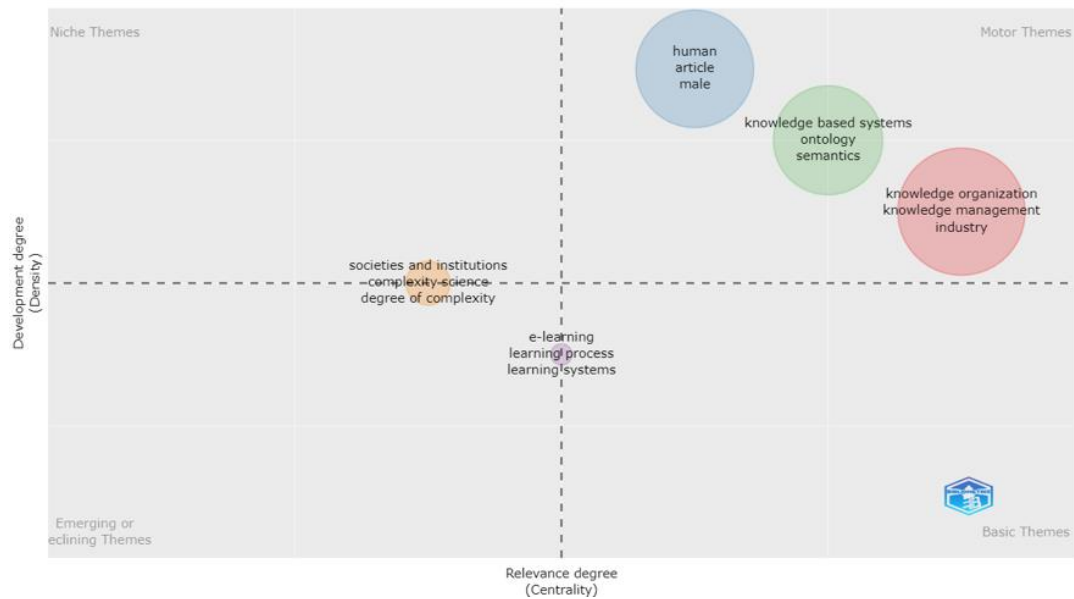
FIG. 3: Through Bibliometrix: Thematic Map of the 65 articles found on SCOPUS. We can see that the motor themes of our research are human actions, knowledge based systems (ontology, semantics) and knowledge organization and management.
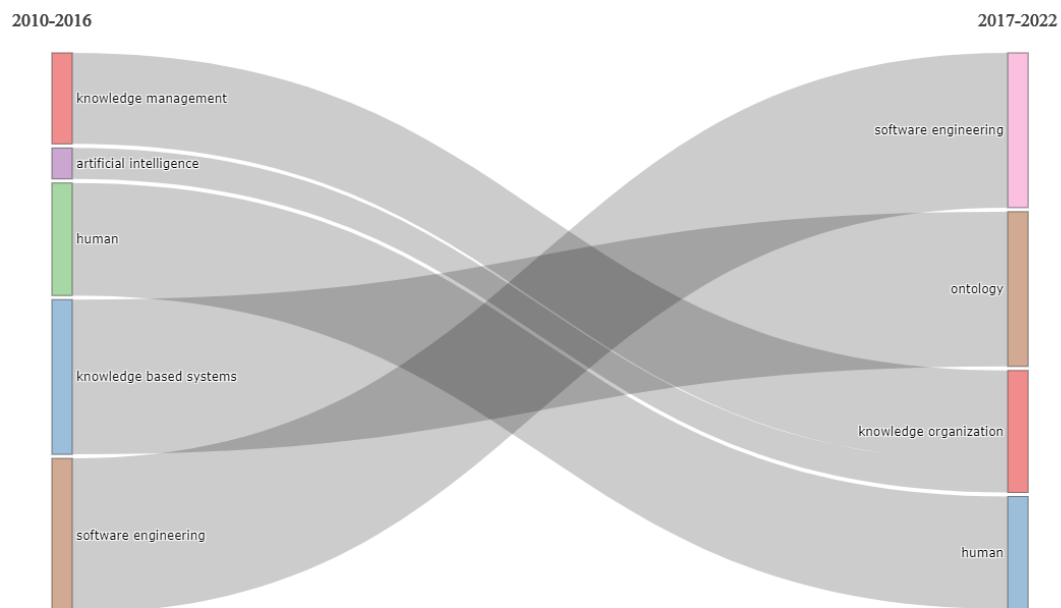
FIG. 4: Through Bibliometrix: Thematic Evolution Map of the 65 articles found on SCOPUS. We can see some interesting developments in the papers. In particular, knowledge management and artificial intelligence topics moved to knowledge organization and the knowledge based systems focused on ontology.