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A Bibliometric Analysis of Knowledge Dynamics and Open Innovation Process

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Abstract. *The article investigates from an analytical perspective the relationship between knowledge dynamics and open innovation and their influence on today's business environment. The present study starts from the premise that the development of a fluid and constant flow of knowledge exchange outside the organization influences the processes of open innovation. Allowing the rapid adaptation of organizations to the new effervescent demands of the market and consumers. The addition brought by this paper represents a conceptual expansion of the need to understand the possible implications of external and internal knowledge, of a rational, emotional, or spiritual nature, on the processes of development of new strategies, products, and services. There is no substantial information available in the specialized literature about the two concepts, which highlights the need to develop more qualitative and quantitative research in this direction. Using the bibliometric analysis with VOSviewer software, the paper presents a series of results that can be further developed and analyzed. The first perspective highlighted by this study is the potential of emotional, rational, and spiritual knowledge to improve relationships with consumers as a result of implementing a constant flow of communication. This fact is supported by the symbiotic relationship between the role of knowledge dynamics in encouraging the exchange of knowledge between consumers and organizations that stimulates an open, transparent communication environment focused on continuous learning. The study also emphasizes the involvement of collaboration, adaptability, and dynamic capabilities to explore how knowledge dynamics influence and stimulate innovative culture.*

Keywords: knowledge, knowledge dynamics, open innovation, innovation, knowledge management, customer.

Introduction

The fast-paced development of the business landscape determines the vitality of the development and understanding of new ways of innovation and development of companies. In understanding the relationship between knowledge dynamics (KD) and open innovation (OI), KD must be understood as a fluid and adaptive flow of knowledge between organizations and other stakeholders. This knowledge flow involves the creation, use, development, and sharing of knowledge between all parties involved (employees, departments, customers, and other stakeholders). OI should be seen as a transformational paradigm involving collaborative processes based on mutual trust between parties, enabling co-creation processes. Understanding the relational dynamics between KD and OI is a vital key for companies adapting to the complex challenges of the modern marketplace.

Exploring KD and OI is still very new and developing in the current literature. However, there are both quantitative and qualitative studies that have emphasized the importance and significant influence of emotional and spiritual or tacit knowledge in innovation processes (Bratianu, 2022; Barret, 2010; Chua & Banerjee, 2013). By way of consistency, following this direction, this paper aims to cover this gap highlighted through qualitative research developed

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based on a thorough analysis of the databases and the realization of a bibliometric analysis using the VOSviewer software (Van Eck & Waltman, 2021) to determine what are the conceptual links highlighted in the papers included in the SCOPUS and WOS databases. This approach opens the way to new perspectives for the development of the work through quantitative studies that provide concrete data on the potential of KD in OI processes.

The paper aims to analyze the existing connections between KD and OI starting from the exploration of how KD can influence the development of relationships with consumers so that the flows of knowledge captured enhance the OI processes. Therefore, the paper aims to answer the following research questions: 1) What are the links between knowledge dynamics and open innovation? 2) Do knowledge dynamics serve as an influencing factor on the open innovation process?

The research is structured as follows: The first part is constituted by the literature analysis, which provides a better understanding of the KD and OI concepts. In the second part, the methodology underlying the bibliometric analysis, the principles of database selection, and the method of refining the obtained data will be highlighted and followed by entering the data into the analytical tool VOSviewer (Van Eck & Waltman, 2021) and interpreting the main results. In the last part of the paper, the conclusions related to the present study, limitations, and future development directions will be drawn.

Literature review

Having the essence extracted from metaphorical thinking, as a consequence KD involves the use of metaphors to elucidate and understand the concept of knowledge, drawing attributes of new knowledge starting from familiar elements, known to widen the semantic field (Andriessen, 2008; Bratianu et al., 2021). The development of the concept of KD started from metaphors based on tangible elements, evolving to stocks and flows (Davenport & Prusak, 2000). Nonaka and Takeuchi's SECI (Socialization, Externalization, Combination, Internalization) model illustrates KD as a dynamic and constant flow of tacit and explicit knowledge (Nonaka et al., 2009; Nonaka & Takeuchi, 1995). This model facilitates the generation, transfer, and transformation of knowledge by applying a constant and directed cycle of the four activities (Nonaka and Takeuchi, 1995). As the creation of this knowledge transfer evolves in a controlled environment, a development of knowledge complexity is generated in the cycle (Bratianu, 2010; Gourley, 2006).

In Nonaka's view, KD is based on two distinct types of knowledge, tacit and explicit (Nonaka et al., 2009). Tacit knowledge is based on personal perspectives, attitudes, and values that cannot be easily expressed. Explicit knowledge can be easily transmitted and shared with other parties, being expressed in writing or graphic tools (Nonaka & Takeuchi, 1995). KD's SECI model has been accepted and taken up globally, but the model is not perfect. The main criticisms of the concept relate to the linearity of the model (Gourley, 2006). Completing and developing the concept, Brătianu introduces the metaphor "knowledge as energy", which makes the transition from the level of metaphors based on tangible elements to intangible ones and through which the fields of knowledge are expanded to rational, emotional, and spiritual (Bratianu & Bejinaru, 2020). The field of rational knowledge is similar to that of explicit knowledge, it can be encoded, decoded, and transmitted easily. Interferences that can affect the message are minimal, these types of knowledge being data-oriented. Emotional knowledge is based on emotions and reactions rooted in individual sensory experiences. Moral values, beliefs, social norms, and customs rooted in our behavior are part of the spectrum of spiritual knowledge. Emotional and spiritual knowledge merge into tacit knowledge in Nonaka's vision, (Nonaka et al., 2009) proving to be the ones with the

greatest innovative potential, directly influencing organizational objectives and culture (Bratianu, 2022). The transformation of these fields of knowledge represents KD (Kahneman, 2011).

To increase competitiveness and achieve superior performance, consultants and scientists support strategies centered on innovation and active participation in OI practices. An organization's innovation orientation encompasses leadership, resources, knowledge management, and processes and is reflected by a firm's dedicated commitment to promoting innovation (Dobni et al., 2022a). Chesbrough (2003) defines OI as attracting, engaging, and leveraging ideas internal and external to the organization to discover and develop new ways to stand out in the market. In contrast to traditional innovation, this collaborative approach involves sharing and exchanging knowledge and resources with external partners, collaborators, consumers, customers, partners, competitors, etc., to establish new ways of differentiation and development. Thus, OI involves a constant process of input and output of knowledge, which increases the capitalization of ideas internal and external to the organization (Lindegaard, 2010). Firms with strong collaborative OI orientations outperform competitors and increase their sustainability (Dobni et al., 2022b). Chesbrough (2006) highlighted how OI forces firms to reassess and reform their management strategies, creating new business models to harness collective creativity.

OI-centric business models grow in value by using internal and external knowledge, in this process, KD positions itself as a tool to feed the flow of knowledge. Suppose the forms of governance of OI include capitalizing on market partnerships to attract new knowledge to the organization (Felin & Zenger, 2013). In that case, a communication process based on KD allows the fair transfer of trust between consumers and the organization and implicitly achieves the central objective of OI to increase the flow of external knowledge attracted to the organization.

According to the OI paradigm, companies should develop ways to listen to their customers and turn them into co-creators of the organization, incorporating the knowledge captured from them actively into innovation processes (Dobni et al., 2022a). In this spectrum, Von Hippel (2005) launches the Lead-User method, through which he exemplifies the first way in which consumers can be integrated into innovation processes. The method allowed highlighting how communities can innovate for their benefit and how their capabilities increase as they become more involved.

Stefan Lindegaard characterizes OI as a two-way process, emphasizing the importance of seamless integration of external resources throughout the innovation process (Lindegaard, 2010). We emphasize here that in order to achieve this goal of OI, a process that constantly stimulates the exchange and transmission of knowledge from consumers to the company is essential, which, from the perspective of this paper, implies the use of KD in the entire flow of communication with the consumer. The metaphorical thinking underlying the concept of KD aligns with OI's emphasis on integrating external resources and continuous learning.

If we look at KD and OI in terms of process complementarity, we can highlight the fact that, at a conceptual level, the interaction of knowledge through the 4 quadrants of the SECI model and the transformation of the fields of rational, emotional, and spiritual knowledge, resonates with the processes of knowledge attraction internal and external and the continuous learning and adaptation of OI.

This vision and connectivity between the two concepts opens new avenues for a comprehensive understanding of organizational learning and innovation, emphasizing collaboration, adaptability, and knowledge utilization.

Methodology

The results revealed by this research are based on the bibliometric analysis carried out on the set methodological criteria. The analysis is based on the works that record the keywords specific to the concepts, either mentioned by the author or indexed in the database. This first criterion was established to ensure a relevant and sufficiently comprehensive database for carrying out the study, achieving the objectives, and drawing conclusions. The database also focuses on the development of the central theme of the study. Thus, the data extracted allows detailed analysis of trends and potential connections between constructs. In this note, Table 1 highlights the database selection criteria.

Table 1. Research protocol and characteristics and types

Search Criteria	First analyses
Search expressions	KD AND OI
Search database	Web of Science & Scopus
Search Within	Keywords
Search fields	All fields;
Type of publications	All types of publications indexed
Subject Areas	All subject areas included
Timespan	2000 - January 2024
Language	English
Techniques for the Bibliometric Study	Research field charting
Software for bibliometric research	VOSviewer

Source: author's research.

Data for this analysis were collected from both the SCOPUS and Web of Science (WoS) databases, following the criteria presented in Table 1. The selection criteria were chosen to ensure a database balance between generality and specificity. We emphasize the impossibility of analyzing all published works, limiting ourselves only to English-written studies. However, the extracted database ensures the integrity of the data that allows relevant results for the research, which answers the research questions.

The first step in data extraction was the individual analysis of each construct, to identify the evolutionary course of each construct and to analyze the attention given by researchers and the business environment to the concepts (represented in Table 2). This stage of the analysis shows a significant increase in the interest given to concepts and their conceptual development.

Table 2. Key constructs: KD and OI

Construct & Keywords	The year of the first paper in SCOPUS	The year of the first paper in WoS	Number of research papers between 2000 and 2024 in SCOPUS	Number of research papers between 2000 and 2024 in WoS
Knowledge Dynamics	1962	1990	6586	1915
Open-Innovation	2000	1993	7660	3886

Source: author's research.

We can see in Table 2 that the concepts of KD and OI are still in the first stages of development, and can be considered relatively new concepts both in the academic environment and in business practice. Examining the year of the first paper, the concept of KD dates back to 1962

in SCOPUS and 1990 in WoS, while OI dates to the 2000s in SCOPUS and 1993 in WoS. Although the appearance of the concepts dates early in the databases, the upward trajectory of the academic interest given to the concepts is registered late, after the years 2000 in SCOPUS and 2004 in WoS. The attention paid to the concepts of the business environment, as well as by academics, coincides with the impact of emerging technologies and the changing dynamics of purchasing on the market in the business environment

Taken individually, on the highlighted timeline, the concepts record a substantial and robust number of papers, but the combination of keywords restricts the database to 29 papers included in the analysis.

After analyzing the evolution of concepts in the market and highlighting their dependence on technological advances, we proceed to step 2, namely the selection of the database according to the search criteria explained in Table 1. Thus Table 3 presents the results of the database, showing details such as the first year of appearance on WoS and SCOPUS, together with the total number of publications to date on both platforms. This information serves as a baseline data set for our further analysis.

Table 3. Data extracted from Scopus and Web of Science

Researched Labels	The First Year of Appearance on WoS	The First Year of Appearance on Scopus	Total Number of Publications to Date – on WoS	Total Number of Publications to Date – on Scopus	Total number of publications included in the analysis
Knowledge Dynamics AND Open-Innovation	2009	2009	16	13	29

Source: author's research.

After bases were extracted from SCOPUS and WoS, the data were refined, followed by a process of combining the extracted bases into a robust and comprehensive database for analysis, followed by cleaning of duplicates. According to the selected criteria, the final database generated a finite data set of 29 papers.

The data used in the analysis focus on English-language publications. The methodology thus included 3 steps: data collection, a strategic and controlled combination of databases, and meticulous refinement of the final database. In the next stage of the study, by including the data in the VOSviewer software, strategic connections and conclusions regarding the two concepts of KD and OI will be highlighted.

The perspectives derived from the bibliometric analysis will contribute to the achievement of the paper's objectives and the understanding of the term connection, as well as the possible implications they could have in business practice.

Results and discussions

The integration of knowledge processes with innovative practices in an environment characterized by collaboration, openness, and transparency facilitates the transfer of knowledge between the company and stakeholders, external to the organization or internal, this dynamic defines the relationship between KD and OI. KD facilitates the creation and development of a communication process based on co-creation and co-design, through constant and evolving dynamic processes of knowledge flows both internally and externally. This process is crucial in adapting communication strategies, transmission, and knowledge capture related to current market technologies (Choi & Lee, 2002; Chesbrough, 2003; Laursen & Salter, 2006) to facilitate the OI process. The synergy

between KD and OI is thus found in the dynamic exchange of knowledge within or across organizational boundaries, a dynamic that facilitates a relational ecosystem based on cooperation, trust, development, and innovation.

Starting from the theoretical premises developed and highlighted until now, the inclusion of data in the bibliometric analysis was controlled according to the following criteria: the type of analysis used is that of co-occurrence, analyzing all words as a unit and using the full counting method. A minimum number of simultaneous keyword occurrences of 3 was set, resulting in 20 keywords out of 262 meeting the threshold for analysis. For the graphic representation of the analysis, the fractionation method was established, and for the creation of clusters, a minimum number of 4 terms was established to avoid excessive fragmentation of the analyzed content and to ensure a focused and relevant result. The graphic result of the bibliometric analysis can be viewed in Figure 1.

In Figure 1, you can see the division of the terms into three distinct clusters that respect the selected criteria. Different colors highlight clusters. While the bibliometric analysis software has determined the cluster, the term distribution, and the cluster color, the author has chosen the cluster labels. The bibliometric analysis for this construct identified 13 items that meet the criteria selected, and the items registered 46 links and a total link strength of 109, included in 3 Clusters: Cluster 1 – Open – Innovation, represented by red color; Cluster 2 – Dynamic Capabilities, represented by green color; Cluster 3 – Knowledge, represented by blue color. At this point, the bibliometric analysis exposes valuable insights in exploring the interconnectedness of the constructs. The highlighted terms are vital in defining the basis of the relationship between KD and OI, each term exposed by the analyses either defines or determines the constructs. The study results provide a consolidated basis for researchers to conduct in-depth explorations of KD and OI implications in business development.

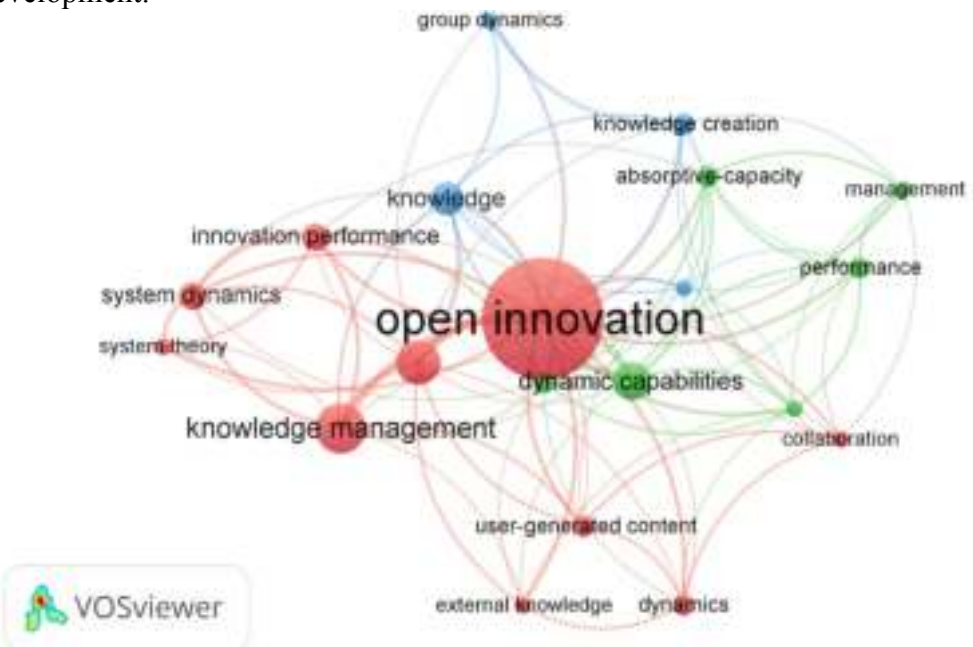

Figure 1. Bibliometric analysis: KD and OI

Source: author's research.

Cluster 1 presents the connected terms with the open-innovation concept and propounds the relationships and linkages between the following terms: Collaboration, Dynamics, External

knowledge, Innovation, Innovation performance, Knowledge management, OI, System dynamics, System theory, and User-generated content. OI emerges as the central term, with the highest link strength (of 67), indicating its overarching influence overall terms of the analysis. This emphasizes the shaping position of OI in the development of current business strategies and discussions across various domains.

Table 4. Cluster 1 for the Second analysis - KD and OI

Keyword	Cluster	Occurrences	Link	Link strength
Collaboration	Cluster 1 – Open – innovation	3	8	11
Dynamics		4	8	13
External knowledge		3	7	11
Innovation		8	13	27
Innovation performance		5	9	18
Knowledge management		9	11	26
Open – innovation		22	19	67
System dynamics		5	7	17
System theory		3	5	10
User-generated content		4	7	13

Source: author's research.

The first cluster focuses on OI, highlighting a strong relationship of connections with themes strongly centered on knowledge and the ability of resources to generate innovation. Such as Knowledge management, innovation, and system dynamics. A significant link is registered between OI and "collaboration" (link strength: 11). OI as a process depends on the creation of a climate characterized by collaboration between the organization and external factors, so as to facilitate organizational co-creation. Collaboration in OI processes is a process that must be facilitated both within the organization's internal environment and across its borders, being a facilitator of knowledge exchange and a promoter of new ways of organizational innovation.

External knowledge is a vital resource of OI processes, and "collaboration" creates an environment of trust and continuous learning that facilitates the attraction of this type of knowledge. "Innovation performance" is closely related to Knowledge Management (linkage strength: 26). The performance of OI is given by the quality of the knowledge attracted, as well as by the internal knowledge management processes. Not all external or internal knowledge attracted has the potential to innovate.

The role of "User-generated content" (linkage strength: 14), is investigated in the specialized literature as a facilitator of innovation, being the one that stimulates trust and collaboration. User-generated content enables firms to generate and attract new knowledge from customers and foster collaboration with customers by engaging them in a co-creation process.

Table 5. Cluster 2 for the Second analysis - KD and OI

Keyword	Cluster	Occurrences	Link	Link strength
Adaptive capacity	Cluster 2 – Dynamic capabilities	4	7	13
Dynamic capabilities		7	12	23
Management		3	7	10
Microfundations		3	11	16
Performance		4	9	15
Product development		4	10	17

Source: author's research.

Dynamic capabilities, (link strength of 23) a term associated in the literature with the ability of an organization to focus its resources to adapt and change in accordance with market developments, defines Cluster 2. This Cluster, by exposing the connectivity between the terms, highlights the importance of management processes in managing company resources in order to develop and achieve the desired performance. "Microfoundations", (with a link strength of: 16) strongly connect with dynamic capabilities, emphasizing their role in understanding and developing dynamic capabilities. "Performance" is connected with the absorptive capacity of the organization, with dynamic capabilities and management processes, and externally to the cluster, directly with OI and knowledge creation. This network of connections suggests that performance is generated by internal strategies that can influence the capacity to absorb external knowledge from the market, so as to generate OI processes. A strong association between the performance outcomes of dynamic capabilities and the broader dynamics of knowledge within organizational processes (Bratianu et al., 2021; McInerney, 2002)

The present Cluster underscores the role of dynamic capabilities in influencing KD within organizational contexts. Also, the network of connections showcased in this cluster shows the strategic dimension of the whole process of knowledge co-creation (Bratianu, 2022; Bratianu & Lefter, 2001).

Table 6. Cluster 3 for the Second analysis - KD and OI

Keyword	Cluster	Occurrences	Link	Link strength
Business	Cluster 3 – Knowledge	3	11	14
Group dynamics		3	4	9
Knowledge creation		4	9	15
Knowledge		6	10	21

Source: author's research.

Cluster 3 integrates knowledge as a strategic resource in OI and business development. As we also saw in the previous bibliometric analysis, knowledge and knowledge management remain important in emerging OI. This Cluster, exhibits a link strength of 21 for "knowledge", and "knowledge creation" shows a link strength of 15, a fact that highlights a significant association between knowledge creation processes and the mother concept of KM. According to what is highlighted both from the literature review and from bibliometric analysis results, the creation, capture, and transfer of knowledge are crucial in stimulating the processes of OI. The network of connections that surrounds the concept of "knowledge" provides once again the knowledge centric business landscape. Knowledge is the main connecting element between the concepts subject to this analysis, the revolutionary and evolutionary power of knowledge can shape organizational capabilities, the organizational environment, and development strategies.

This bibliometric analysis provides valuable insights into the interconnectedness of the terms and provides a basis for future academic efforts that aim to explore the relationship between KD and OI

Conclusion

Collaboration processes between farms and external partners have received more and more concentrated attention in the last decades. This type of collaboration facilitates access to external knowledge networks and attracts and incorporates ideas and knowledge from various sources (internal

and external). These sources of knowledge are considered generators of strategies and more appropriate models of adaptation to reality-oriented innovation processes (Chesbrough, 2006).

It can easily be seen that studies that focus on analyzing the conceptual connections and links between OI and KD are limited, which highlights a gap in the literature and emphasizes the need to develop quantitative and qualitative studies in the field. A connection between KD and OI does not appear directly in the bibliometric analysis performed. The relationship can be inferred by exploring conceptual connections such as customer connection, knowledge transfer, knowledge creation, knowledge transformation, and KM.

Consequently, knowledge attraction and capture find resonance in OI's emphasis on collaborative partnerships and user-centered innovation (Nonaka et al., 2009; Von Hippel, 2005). The application of the SECI model of KD at the external level of the organization allows the creation of an environment of trust, exchange of knowledge, and continuous learning (Bratianu & Bejinaru, 2020; Chesbrough, 2006), a vision that perfectly aligns with the central objective of OI, to attract, document and use external knowledge in all stages of innovation. Additionally, Brătianu's dimension to the KD concept resonates with OI's emphasis on continuous knowledge acquisition and open strategic architecture, enabling knowledge transfer and transformation. The involvement of the dynamics of rational, emotional, and spiritual knowledge in the external and internal relations of the organization is essential to generate new flows of knowledge, a fact that corresponds to customer-centered innovation collaboration, and co-creation (Bratianu, 2015).

The paper draws attention to the multiple facets of the interconnection of KD and OI and provides an overview of the relationship between the terms as well as a road map for academic research that aims to explore these relationships. However, the work is limited to offering a qualitative study perspective. The first limitation of the study is given by the use of the bibliometric analysis software VOSviewer, which restricts the spectrum of data interpretation. The present paper is based on the analysis of databases from SCOPUS and WoS, therefore it lacks the ability to cover the entire body of research on the concepts of KD and OI. The database extracted, through the restrictive amount of data and the restrictive nature of the study offers a limiting spectrum of results. In this direction, a quantitative expansion of the study and a more extensive and detailed bibliometric analysis that takes into account the various qualitative nuances in the publications including publications in other languages, and accurately analyzes the contextual complexities of the research field is recommended.

In conclusion, this paper reveals an overview of the relational symbiosis of the concepts of KD and OI. The analysis highlights the main common elements that are at the conceptual intersection of the terms and that define their conceptual interdependence, communication, collaboration, consumers, and knowledge. Thus, OI processes can be improved and accelerated by applying KD in the external and internal communication of companies. The holistic understanding of knowledge as an endless and indeterminate resource is key to understanding and developing the relationship between OI and KD. The present work launches an academic and practical exploration track of constituencies highlighting their importance in the academic environment as well as in business practices.

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