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ORIGINAL

Fostering innovation through collective intelligence: a literature review

Favorecer la innovación mediante la inteligencia colectiva: un análisis de la literatura

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ABSTRACT

In the twenty-first century, Collective intelligence (CI) arose as a social phenomenon to assist organizations in managing future uncertainty. It pushes a broad diverse group to come up with new solutions that outperform those uncovered within the organization itself. Accordingly, CI has been widely acknowledged as a means to foster innovation, and develop, and sustain an organization's creative potential. This paper aims to conduct a literature review to examine the existing body of literature regarding the ways collective intelligence improves innovation. The findings emphasized the importance of collective intelligence in fueling a firm's knowledge and innovation in all of its forms to overcome public and private organizational challenges. Furthermore, our review underlined the mediating role of information technology in taking full advantage of collective intelligence via digital platforms. In addition, our analysis pointed out the multifaceted traits of collective intelligence as reflected in the literature under several terms, including crowdsourcing. Our research revealed several gaps in the current literature, including insufficient analysis and modeling of the relationship between the two concepts. Finally, we concluded our paper by identifying the limits of our research and suggesting avenues for future studies on collective intelligence and innovation.

Keywords: Collective Intelligence; Innovation; Knowledge; Information Technology; Digital Platforms; Crowdsourcing.

RESUMEN

En el siglo XXI, la Inteligencia Colectiva (IC) surgió como fenómeno social para ayudar a las organizaciones a gestionar la incertidumbre futura. Impulsa a un grupo amplio y diverso a idear nuevas soluciones que superan a las descubiertas dentro de la propia organización. En consecuencia, la IC ha sido ampliamente reconocida como un medio para fomentar la innovación y desarrollar y mantener el potencial creativo de una organización. El objetivo de este artículo es realizar una revisión bibliográfica para examinar la literatura existente sobre las formas en que la inteligencia colectiva mejora la innovación. Los resultados ponen de relieve la importancia de la inteligencia colectiva para alimentar el conocimiento y la innovación de una empresa en todas sus formas para superar los retos organizativos públicos y privados. Además, nuestra revisión subrayó el papel mediador de la tecnología de la información a la hora de aprovechar al máximo la inteligencia colectiva a través de plataformas digitales. Además, nuestro análisis señaló los rasgos polifacéticos de la inteligencia colectiva reflejados en la literatura bajo varios términos, incluido el de crowdsourcing. Nuestra investigación reveló varias lagunas en la bibliografía actual, entre ellas un análisis y modelización insuficientes de la relación entre ambos conceptos. Por último, concluimos nuestro artículo identificando los límites de nuestra investigación y sugiriendo vías para futuros estudios sobre inteligencia

colectiva e innovación.

Palabras clave: Inteligencia Colectiva; Innovación; Conocimiento; Tecnologías de la Información; Plataformas Digitales; Crowdsourcing.

INTRODUCTION

Collective intelligence (CI) is not a novice. It traces its roots back to evolutionary processes and refers to intelligence in groups to achieve a common goal.[1] This behavior was originally observed in nature when creatures work together towards achieving a shared goal, such as ant colonies.[1] Humans, in addition to animals, have exhibited collaborative behavior in various domains (e.g. scientific research, humanitarian and environmental initiatives, crisis management, politics, etc.). Thus, several studies proved the importance of collaborative work forms in supporting shared and impactful decisions.[1,2,3,4] Accordingly, collective intelligence has been a subject keen of interest in academia for decades. The challenges and opportunities in using CI are required to improve the effectiveness of decision-making or to solve complex problems, especially within organizations.[2]

Collective intelligence is hard to define.[4] It can be theorized as the collective ability of a team to use and integrate different available resources to generate solutions to complex problems.[5] However, Collective intelligence does not only involve solving problems but collaborating to arrive at a solution greater than the sum of what any of the members have achieved individually.[2,4] Simply stated, it stands for individuals doing things collectively that seem intelligent.[2,4] Consequently, Collective intelligence can offer organizations a wide range of possibilities and opportunities to improve their creativity and enhance their innovative capabilities.[1] It enables them to tap into the expertise, creativity, and knowledge of their different stakeholders (e.g. employees, customers, and partners).[1,4] In addition, CI ensures a high degree of harmony, synergistic effects, and mutual engagement between these parties to improve decision-making and achieve higher group performance.[2] Accordingly, several authors pointed out the incorporation of collective intelligence in creative and innovative environments.[2]

Against this background, the relationship between collective intelligence and innovation seems to be an interesting subject keen of a literature review. Thus, this paper assesses the status quo of the research on Collective intelligence and innovation by addressing the following research questions:

- RQ1: What is the relationship between collective intelligence and innovation?
- RQ2: How do collective intelligence and innovation interact with one another?
- RQ2: How does collective intelligence improve the innovation process?
- RQ3: What are the current research gaps in the frameworks and approaches utilized to investigate the relationship between innovation and collective intelligence?

We structured this paper as follows. We first introduced the subject of our literature review. Then we presented the methodology used to address our research questions. Afterward, we summarized and analyzed the selected studies. Finally, we outlined the key findings of our study with an emphasis on the related research avenues.

METHODS

In this research, we conducted a literature review to assess the evolution and status quo of research on the association of Collective Intelligence and Innovation. To achieve this aim, we focused solely on the Scopus Database to collect data on this subject. Then, we refined our findings by applying well-thought inclusion and assessment criteria, enabling us to retain only relevant papers to our research. We summarized the methodology used in this literature review in figure 1.

As stated earlier, we first undertook a preliminary search on the Scopus database, focusing on titles and abstracts that included the terms ‘Collective Intelligence’ and ‘Innovation’. The following search yielded 396 papers:

TITLE-ABS-KEY (collective-intelligence, AND innovation)

Afterward, we narrowed our research scope by focusing on papers and conference papers in the business, management, and accounting areas, generating 71 papers. We formulated the corresponding search query as follows:

TITLE-ABS-KEY (collective-intelligence, AND innovation) AND (LIMIT-TO (SUBJAREA, “BUSI”)) AND (LIMIT-TO (DOCTYPE, “ar”) OR LIMIT-TO (DOCTYPE, “cp”))

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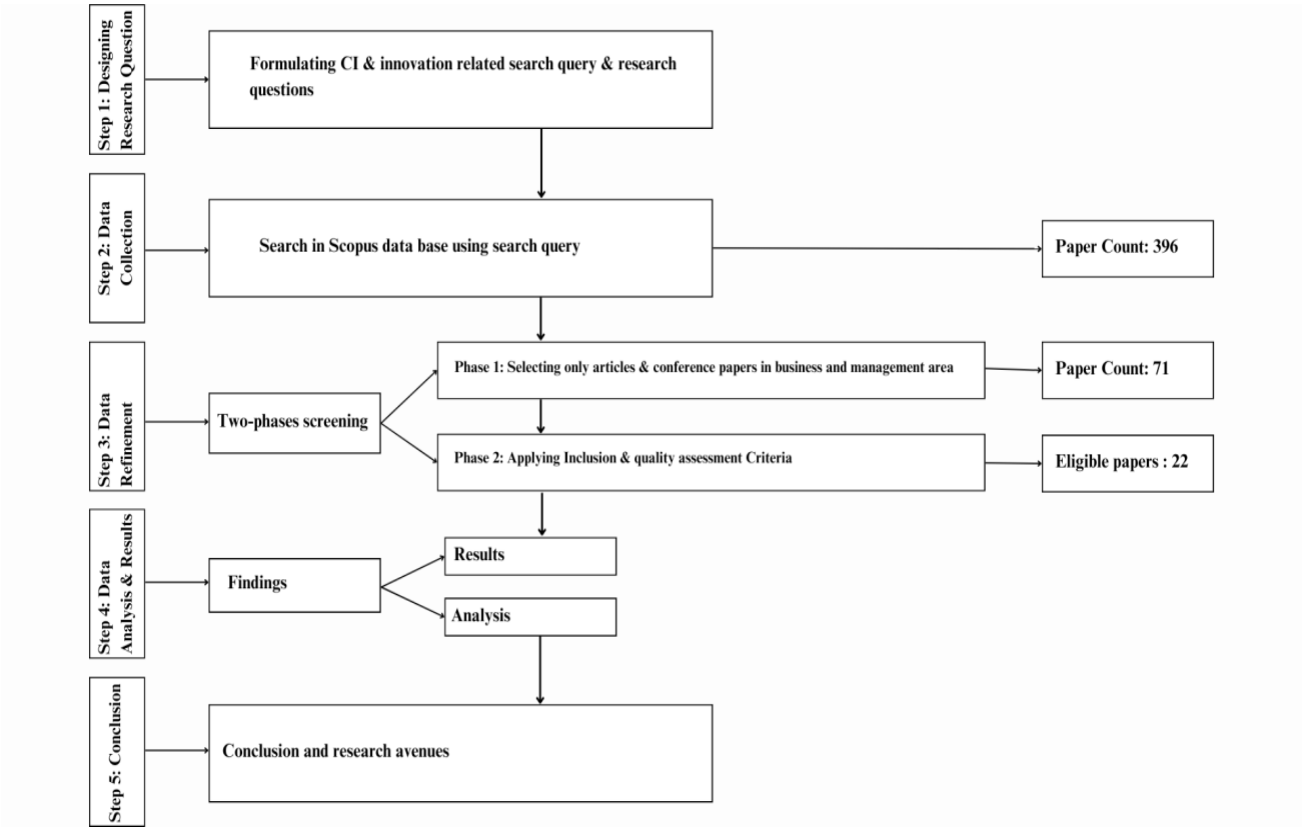

Figure 1. The methodology for Collective intelligence and Innovation literature review

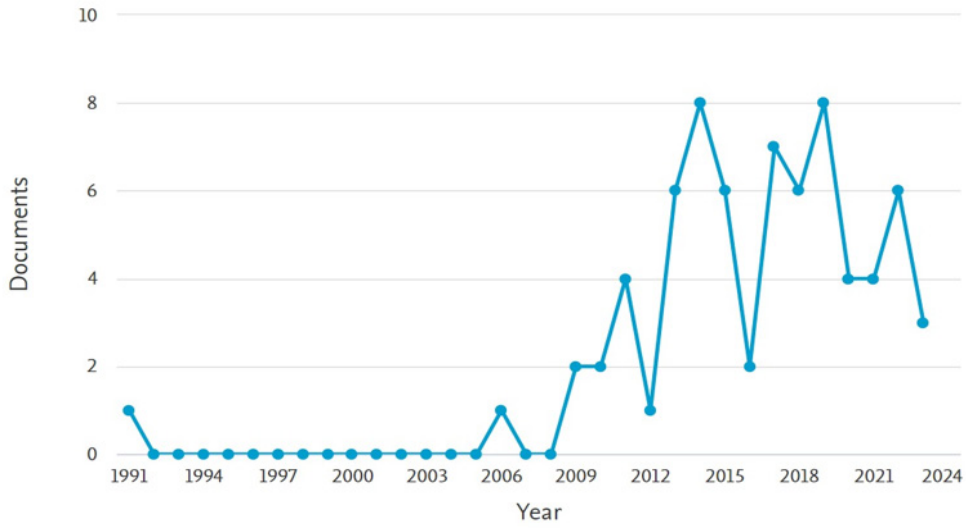

Figure 2. Timeline evolution of research on Collective intelligence and innovation

Figure 2 illustrates the evolution of research on ‘Collective Intelligence' and 'Innovation' from 1991 to 2023 in the business, management, and accounting area. From 1991 to 2006, we noticed a lack of literature on the relationship between Collective intelligence and Innovation. However, starting from 2006, we have noticed a steady increase in interest in the subject from the academic community, especially in 2009, 2012, 2015, and 2018. Thus, despite some fluctuations, we believe that the subject is becoming increasingly important in academia, which justifies the need for our research.

During the second selection phase, we applied the inclusion criteria shown in table 1 to identify the most relevant paper on the intersection of collective intelligence and innovation. In addition, we included studies that tackle a certain type of innovation, namely Open innovation. We also included research that integrates Crowdsourcing, owing to its emergence as a new and non-traditional collaboration form. Consequently, we identified 22 papers that satisfy the inclusion criteria after removing duplicates manually to avoid redundancy.

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Finally, to wrap up this phase, we have established additional criteria to ensure the quality of the previously selected research.

Table 1. Inclusion and quality assessment criteria

Inclusion criteria	The research discusses the theoretical basis of innovation.
	The research discusses the theoretical basis of collective intelligence.
	The research addresses a specific type of innovation.
	The research examines crowdsourcing as an enhanced type of CI.
	The research discusses the role of collective intelligence in innovation.
	The research describes the architecture/frameworks/study case including CI.
Quality assessment criteria	The paper provides a clear research objective.
	The paper proposes a new framework for an existing CI system.
	The paper proposes a clearly defined architecture, framework, or design.
	The paper compares a new framework against an established one.
	The paper explores the role, importance, and behavior of individuals.
	The paper proposes solutions to innovation issues using collective intelligence.

We conducted the quality evaluation through an independent assessment by the authors, utilizing the previously mentioned criteria. For each paper, we evaluated and scored the criteria based on the responses provided by the authors. We chose papers with a score of 3 or above for data synthesis, as shown in the table below.

Table 2. Comparison of the selected papers

Reference	QC1	QC2	QC3	QC4	QC5	QC6	Total
(6)	Yes	No	Yes	No	Yes	No	3
(7)	Yes	No	No	Yes	Yes	Yes	4
(8)	Yes	No	No	No	Yes	Yes	3
(9)	Yes	Yes	Yes	No	Yes	Yes	5
(10)	Yes	No	No	No	Yes	Yes	3
(11)	Yes	No	No	No	Yes	Yes	3
(12)	Yes	No	No	No	Yes	Yes	3
(13)	Yes	Yes	Yes	No	Yes	Yes	5
(14)	Yes	No	Yes	No	Yes	No	3
(15)	Yes	No	No	No	Yes	Yes	3
(16)	Yes	No	No	No	Yes	Yes	3
(17)	Yes	Yes	Yes	Yes	Yes	Yes	6
(18)	Yes	Yes	Yes	No	Yes	Yes	5
(19)	Yes	Yes	Yes	No	Yes	Yes	5
(20)	Yes	Yes	Yes	Yes	Yes	Yes	6
(21)	Yes	No	No	No	Yes	Yes	3
(22)	Yes	No	No	No	Yes	Yes	3
(23)	Yes	No	No	No	Yes	Yes	3
(24)	Yes	Yes	Yes	No	Yes	Yes	5
(25)	Yes	Yes	Yes	No	Yes	Yes	5
(26)	Yes	No	No	No	Yes	Yes	3
(27)	Yes	No	No	No	Yes	Yes	3

Summary of selected studies

We have summarized the 22 selected studies below:

Boder et al.[6] discussed the importance of collective intelligence in generating new knowledge and innovation. He highlighted the difference between information sharing and the creation of new knowledge. He stressed the

importance of drawing on individual skills, guidelines, informal networks, and strategic marketing knowledge to build organizational collective intelligence. Thus, the author proposed a new paradigm and practical model for knowledge management in organizations focusing on integrating collective intelligence to address organizational challenges such as innovation and consumer requirements. He stated that collective intelligence is divided into three blocks, each addressing a different aspect of business challenges and demonstrating how they contribute to problem-solving. Furthermore, he provided practical recommendations to boost the collective intelligence application in various fields including electrical engineering, healthcare, and information technology.

Karakas et al.[7], incorporated the global brain metaphor to highlight the importance of collective intelligence and open innovation in nurturing creativity. They introduced the Service-learning 2.0 model based on connectivity, creativity, community, and complexity paradigms and explored its impact on service-learning practices. This model aims to develop critical thinking abilities for the twenty-first century, such as interactivity, innovation, inspiration, and integrative thinking. It examines the issues raised by globalization, technological, and social changes to enable transformative service-learning projects that empower students to contribute innovatively to their communities. The model promotes collaboration and dynamic learning approaches. It also emphasizes the integration of multidimensional performance outcome measures. Moreover, this model embraces intuitive, systemic, and nonlinear approaches to knowledge and action, constituting a shift in values and consciousness.

Fähling et al.[8] tackled the need to integrate consumers throughout the whole innovation process by exploiting the collective intelligence phenomenon. Thus, they presented an analysis to identify possibilities for using crowdsourcing at each stage of the innovation process. For this aim, the authors categorized the innovation process into four phases: search, select, implement, and capture. They also subdivided crowdsourcing into Crowd Wisdom, Crowd Creation, Crowd Voting, and Crowd Funding. However, in their context (e.g. Pico Jobs) authors only used Crowd Wisdom, Crowd Voting, and Crowd Creation. They uncovered collective intelligence can be applied in the searching phase to identify the threats and opportunities for change. In the selection process, collective intelligence helps generate and evaluate possible ideas and solutions. In the implementation stage, crowds can help improve and accelerate decision-making. Finally, after launching the product, crowds can also participate in the continuous improvement process.

Chandra et al.[9] pointed out the lack of collective intelligence literature in the disruptive innovation theory. Therefore, they emphasized the importance of co-innovating through collective intelligence as it enables firms to gather innovative opportunities from diverse external sources and select the most convenient ones. Moreover, the authors presented a theoretical framework that integrates the effectuation theory of entrepreneurship, evolutionary entrepreneurship, lead-user innovation, collective intelligence, and opportunity tournament. Finally, the authors stated that collective intelligence reduces risks related to disruptive innovations, as they are the fruit of collective creativity.

Papadopoulos et al.[10] highlighted the lack of literature exploring the role of Open Innovation (OI) practices and collective intelligence in influencing the private-collective model of innovation, particularly in economies facing crises. They advocate for using Open Source (OS) software as a cost-saving tool in times of crisis. They also emphasize the need for a shift towards OI practices, such as collective intelligence and participation in voluntary communities to foster innovation and stimulate growth. However, the study uncovered issues caused by inadequate national innovation policies and organizational characteristics. Therefore, the authors proposed the establishment of a national innovation policy based on the private-collective model to leverage innovation and growth through collective intelligence.

Majchrzak et al.[11] discussed the importance of firms exploring new ways and going beyond their limits for innovation. Crowdsourcing is one of the options to achieve this. Thus, the authors emphasized the role of crowdsourcing in innovation, as it enables firms to gather a large amount and diversity of innovative ideas that solve complex problems. They stated that the diversity of the ideas depends on the size and expertise of the crowd. Moreover, the authors stressed the need for co-creation in crowdsourcing for innovation. However, several prerequisites must be met to implement the co-creation, namely: engaging the crowd in the entire innovation process, encouraging the crowd to share all types of ideas, and allowing the crowd to volunteer for various engagement initiatives.

Mergel et al.[12] investigated the implementation of open innovation and collective intelligence in the public sector using the Challenge.gov platform. This platform allows seeking ideas from an unknown group of problem-solving individuals which helps to boost collaboration and tackle complex challenges in public management. The authors interviewed two public managers to uncover means to facilitate collaboration between policymakers and public agencies. These managers stated that transferring open innovation methods from the private sector to the public sector comes with its own set of challenges. However, the authors discovered that federal agencies have successfully embraced Challenge.gov as an effective tool for sourcing innovative ideas and solutions. This is due primarily to the active participation of citizens on the platform, which reflects their willingness to contribute to democracy and improve public institutions' performances.

Boulesnane et al.[13] promoted knowledge management and collective intelligence as tools for managing an

organization's innovation. They proposed a conceptual model that highlights the interdependence of collective intelligence, knowledge management, and innovation in organizations. The model emphasizes the role of information technology in moderating the influence of these previous capabilities on the decision-making process and financial performance.

Pór[14] highlights the importance of collective intelligence and the interdependence of mental models across systems communities in addressing global issues. Therefore, He emphasized the need to harness the collective intelligence of these communities to define, map, and address challenges by identifying potential policies and anticipating their consequences. However, the author stresses the inability of today's dispersed intellectual groups in the systems sciences to provide relevant assistance. As a result, Collective intelligence must necessarily be improved. To address this issue, the author suggests the creation of a Collective Intelligence Enhancement Lab. It's a platform with an innovative architecture that integrates various technologies and processes, including social, electrical, cognitive, and inner aspects.

Martínez-Torres et al.[15] investigates the exploration of open innovation within online communities by analyzing the behavior of community members using social network analysis. They aim to use collective intelligence assessment techniques to examine the various types of engagement that lead to identifying significant ideas. However, they uncovered a disparity between the collective scoring system and the application of ideas by organizations. As a result, they proposed assisting users during the scoring process to improve collective intelligence outcomes.

Martínez-Torres et al.[16] examined collective intelligence in the context of OSS communities revealing the power of interactions and collaborations among individuals. They claimed that OSS communities should be seen as a transversal with a huge research potential that goes beyond computing. They also emphasized that due to their interdisciplinary nature, successful exploitation of OSS communities' intelligence can provide organizations with a significant competitive advantage.

Wang et al.[17] emphasized the role of collective intelligence and open innovation in knowledge accumulation. They proposed a methodology based on a bilayer social wiki network to facilitate open knowledge accumulation in manufacturing process innovation. This approach enabled full participation and integration of collective intelligence by considering the multidisciplinary and fuzzy nature of process innovation knowledge. The authors organized the process of innovation knowledge (PIK) through two stages, PIKN and PIKNN, drawing inspiration from biological neural networks. They developed an open systematic methodology that involved key knowledge activities of social wiki users, such as knowledge contribution, fusion, and refinement. Through this approach, the authors found that collective intelligence can be effectively harnessed to address the complex and multidimensional aspects of process innovation. Furthermore, this approach helps address the multidisciplinary and fuzzy characteristics of process innovation knowledge (PIK) and contributes to its comprehensive refinement.

Chiui et al.[18] considered collective intelligence as a common type of crowdsourcing. They explored the concept of crowdsourcing and its applications in managerial decision-making and problem-solving. They developed a four-component framework that categorizes prior research and identifies potential areas for future exploration. The framework highlighted the importance of collective intelligence and crowdsourcing in open innovation. It also emphasized the need to use external ideas to enhance innovation, share risks, and improve productivity. Moreover, the framework serves as a roadmap for understanding crowdsourcing activities and research issues as it offers insights for both operational and academic purposes.

Sharma et al.[19] stressed the importance of Web 2.0 technologies in open innovation. Whereas, Web 2.0 functionalities allow firms to take advantage of the crowd's intelligence. It feeds firms with quality and quantity knowledge, effective interactions between individuals on social networking sites, and innovative solutions at a low cost. Therefore, the authors presented a theoretical framework explaining how firms might use collective intelligence to be competitive by capturing user-generated value. The framework identified four Web 2.0 criteria and five Business Strategy Components necessary for crowdsourcing success. Finally, the authors formulated three rules for using crowdsourcing effectively.

Beretta et al.[20] highlighted the crowdsourcing capability to harness both internal and external parties' collective intelligence. This pushes firms to incorporate crowdsourcing in their innovation processes to gather innovative solutions. Moreover, the authors have uncovered three obstacles that limit the appropriate utilization of web-enabled ideation systems. Therefore, they proposed a conceptual model that explains the role of moderators in managing web-enabled ideation systems and addresses the challenges often associated with using them. The findings also contributed to the innovation literature by unveiling three practices enabling firms to succeed in the early phases of their innovation process, namely: Formulating an ideation strategy, combining means for community building, and formalizing the ideation process.

Foss et al.[21] designed a collective intelligence platform to propose an innovation system based on bee swarm logic. The platform is driven by six key functions needed to establish a collective intelligence system, mainly: Power decentralization, solutions diversity, opinion independence, Natural solution selection, Evidence gathering, and quorum-based decision-making. These components provide the innovation system with self-

organization and a large number of advantages as it bring individuals and researchers from various backgrounds to generate diversified solutions. Next, it chooses the highest-performing individuals among them. Afterward, it tracks the supporters of each proposal to find the winning solution. This enables firms to be more competitive by developing, implementing, and marketing innovations faster.

Cappa et al.[22] discussed the impact of crowdsourcing on a firm's future profits through brand value and investment opportunities. They presented Crowdsourcing as an outside-in form of open innovation that enhances the firm's innovation capacity as it leverages the crowd's wisdom and competencies to solve complex problems that firms cannot address by relying only on internal resources. Furthermore, the authors led a quantitative study that proved that not all companies benefit from crowdsourcing. Thus, they defined conditions that allow firms to harvest value from the crowd and identified the limits that allow open innovation to benefit the firm's performance.

Celis et al.[23] discussed how public organizations innovate under the lens of open innovation by harnessing collective intelligence. They highlighted the government's need to leverage the potential of collective intelligence by involving citizens in the innovation process to drive public affairs. The citizen's implication helps generate innovative public offerings, solve complex problems, ensure the effectiveness of public initiatives, and citizen satisfaction. Therefore, the authors addressed public innovation laboratories' (e.g. InCilab) capacity to generate collective intelligence by analyzing citizens' experiences, as well as catering solutions and diagnoses for public problems. Moreover, they underlined the effectiveness of diverse citizen profiles in increasing creativity, communication, and innovativeness.

Elia et al.[24] tackled the role of open innovation and collaborative systems in the emergence of collective intelligence which can solve sustainable development challenges. The authors discussed virtual communities as a tool for open innovation. These communities can be viewed through the lens of collective intelligence. Given that, they enable knowledge and ideas to be exchanged online by and among a diverse set of individuals. Therefore, Socio computational systems or collective intelligence systems may lead to effective decision-making for the public good, implement innovative solutions, and deal with challenging societal problems. To address this issue, the authors developed a framework (MSP) following an open innovation approach. The MSP allows external parties to join the innovation process by bringing their knowledge, skills, capabilities, and experiences to solve real-world problems.

Al-Omoush et al.[25] describe the impact of collective intelligence on collaborative innovation in response to the COVID-19 crisis. These uncertainties push organizations to look for new ways to deal with imperceptible changes by fostering collaboration and value co-creation. Thus, organizations must take advantage of collective intelligence relying on collaborative creativity capabilities to transform possibilities into innovative solutions. Moreover, the authors presented a research model that posits the causal relationship between social capital, collective intelligence, collaborative innovation, and organizational sustainability. They confirmed that social capital influences collaborative innovation, collective intelligence, and organizational sustainability. They also proved that collaborative innovation can influence organizational sustainability.

Erbguth et al.[26] outlined the importance of well-orchestrated collective intelligence in boosting innovative efforts to promote sustainable development. Hence, they proposed a new framework that supports cross-sector collaboration and fosters sustainable innovation in times of crisis. The authors emphasized that due to the COVID-19 pandemic, collective intelligence itself is insufficient. It must be supported by a systems thinking perspective that combines design thinking and agile development methods. Given that system thinking theory can help create more space for groups to innovate, plan innovation process, and adapt the process to complexity and change.

Attalah et al.[27] underlined the role of collective intelligence in open innovation and the overall innovation process. Granted that, collective intelligence enables firms to extract value from internal parties, as well as from users and other participants in the innovation process. In this study, authors focused on Hackathons, known as innovation contests with collective intelligence tools that leverage value creation and open innovation. However, the findings indicate that maintaining this type of value capture must be supported by explaining the benefits of these Hackathons to participants, offering monetary prizes, and putting more effort into community-building.

Analysis

In the initial stage of analysis, we used Nvivo Software to provide a visual overview of the predominant themes of the selected papers. We first generated the word cloud (see figure 3) to provide a visual representation of the frequency of words within the 22 papers.

Figure 3. Word cloud of the selected papers

We found that the word cloud revolves around the theme of innovation and represents a multifaceted landscape. Furthermore, the word cloud features the remarkable terms surrounding innovation, namely “knowledge”, “ideas”, “intelligence”, “systems”, “management”, “open”, “collective”, “business”, “information”, “process”, and “crowdsourcing”. For instance, the word “knowledge” for example entails the role of “collective” “intelligence” in generating knowledge and new “ideas” to succeed in the innovation “process”. In addition to these major components, the word cloud reveals several subtle yet significant features. The terms "public," "community," and "collaborative" imply that some papers emphasize the social and collaborative components of innovation, in both public sector and community-driven settings. In addition, the terms "technology," "information," and "software" all refer to the importance of IT and software in the context of innovation and collective intelligence. In summary, the selected papers jointly explore the theoretical foundations, practical applications, and strategic importance of innovation, emphasizing the role of collective intelligence, knowledge management, and information technologies in these processes.

To gain more understanding of the thematic landscape, we utilized the word frequency chart to analyze quantitatively the prevalence of the key terms throughout the selected articles to validate the insights acquired from the word cloud (see figure 4). This analysis pinpoints innovation as the most prevalent word, with a superior number of occurrences. Followed by “knowledge”, “open”, “crowdsourcing”, “collective”, and “intelligence”. This finding sheds light on the interrelated aspects that lead to the synergy between innovation and collective intelligence.

Mot	Longueur	Nombre	Pourcentage pondéré (%)
innovation	10	1879	1,42
knowledge	9	897	0,68
open	4	733	0,55
crowdsourcing	13	721	0,54
collective	10	612	0,46
intelligence	12	560	0,42

Figure 4. The word frequency chart

To complete this quantitative analysis, we used the Matrix Crossover Graph to identify the co-presence of terms in a specific paper (see figure 5). The findings validate the relevance of our search methodology as we found that the majority of the papers discuss our central themes “collective intelligence” and “innovation”. Whereas, some papers go beyond by integrating “open innovation”, “crowdsourcing”, and “knowledge”.

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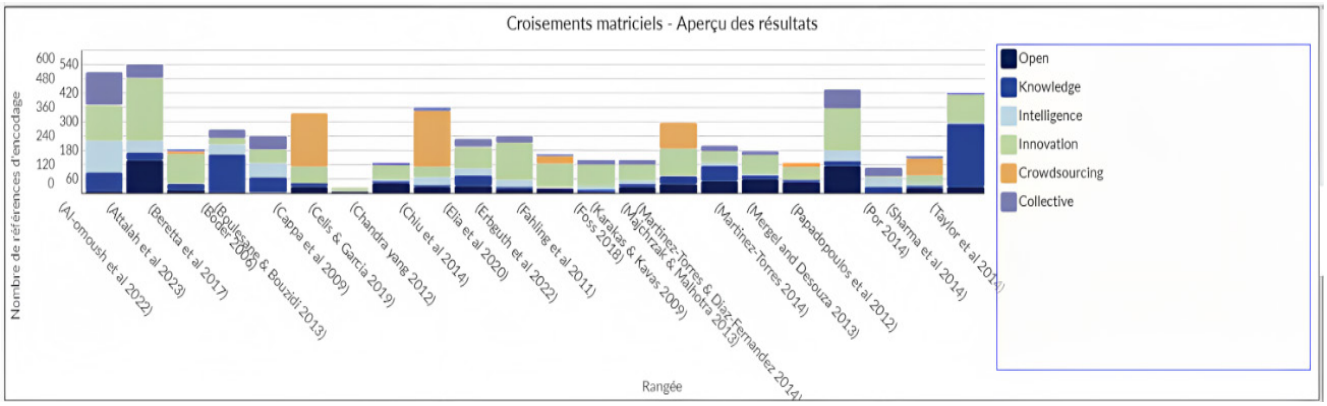

Figure 5. The Matrix Crossover Graph

In the second and final stage of our analysis, we proceeded to a more in-depth content analysis of the selected papers. This evaluation resulted in four main themes:

Firstly, we noticed that most of the papers integrate differently knowledge as a key aspect of the relationship between collective intelligence and innovation. Accordingly, some authors addressed the importance of collective intelligence in generating both knowledge and innovation.[6,24] They emphasized the need for leveraging crowd intelligence to create and exchange new ideas and knowledge capable of addressing organizational, social, and societal challenges, and this, in turn, fuels innovation.[6,24] Others believe that knowledge management and collective intelligence mutually reinforce and contribute to organizational innovation.[13] However, Wang et al.[17], (2015) stated that the junction between collective intelligence and innovation can facilitate the acquisition and sharing of knowledge. Thus, we conclude that the relationship between these three concepts is dynamic and bidirectional.

Secondly, we discovered that "open innovation" is the most commonly used word to describe the link between collective intelligence and innovation. 11 papers used open innovation instead of innovation. However, we noticed that the authors advocated the relationship between open innovation and collective intelligence differently. The first category of authors states that collective intelligence and open innovation go hand in hand both in the public and private sectors to improve collaborative idea generation, face crises, and tackle complex public management challenges.[7,10,12] The second category argued for the importance of collective intelligence in open innovation.[18,28,29,30] Given the importance of integrating internal and external parties in the process of value creation to enhance innovation. They emphasized the role of innovation contests like hackathons in capturing and creating value.[28] In contrast, several authors supported open innovation as a means of fostering collective intelligence, with a focus on the public sector.[23,24,31,32,33] Open innovation allows external parties to join the innovation process, enabling organizations to nurture collective intelligence. Consequently, organizations will be able to generate innovative public offerings, ensure effective decision-making for the public good, and increase citizens' satisfaction and experience.[23,24,34,35,36] In summary, acknowledging this diversity of perspectives provides an in-depth understanding of the dynamics between collective intelligence and open innovation.

Thirdly, we noticed that numerous authors use the terms crowdsourcing and collective intelligence interchangeably.[8,11,19,37,38] They point out the need to leverage the crowd's intelligence in the different phases of the innovation process to produce novel ideas, accelerate the decision process, and promote continuous improvement.[8,19] Alternatively, some authors considered crowdsourcing as a type of collective intelligence used to enhance innovation, limit risks, and improve productivity.[18,39] Contrarily, a distinct perspective asserts crowdsourcing as a form of open innovation that enhances the firm's innovation capacity.[22,40] Similarly, other academics indicated that crowdsourcing leverages the potential of collective intelligence, allowing organizations to succeed in the early phases of the innovation process.[20,41] We conclude that the literature lacks consensus on the precise definition of crowdsourcing, collective intelligence, and their relationship. This highlights the complexities and diverse interpretations of the collaborative techniques in innovation processes.

Finally, the literature advocated traditional collective intelligence tools, namely Hackathons, innovation laboratories, and Collective Intelligence Enhancement Labs.[28] However, the literature did focus more on the pivotal role of technologies as a mediating tool to ensure the successful exploitation of collective intelligence in the innovation process. Accordingly, Technologies offer several opportunities to amplify the creative synergies such as social and virtual communities (e.g. OSS communities & bilayer social wiki network);[15,16,17,29] websites (e.g. social networking sites & challenge.gov platform);[12,19] and software and systems (e.g. Open Source Software, web-enabled ideation systems, innovation system based on bee swarm logic, and Service-learning 2.0 model).[7,10,20,30] In sum, the usage of technologies constitutes a bridge between collective intelligence and

innovation, enabling transformative and groundbreaking ideas.

CONCLUSIONS

In this paper, we conducted a literature review to evaluate the existing body of literature on the potential of collective intelligence in fostering innovation. To this end, we analyzed Data gathered from the Scopus database from 1991 to mid-2023. To refine our findings, we limited our search to papers in Business, management, and accounting study fields along with inclusion, exclusion, and quality assessment criteria. This meticulous screening process led to the identification of 22 papers that meet the aim of our study. To analyze these papers we conducted a double analysis using a visual overview of the prominent themes via Nvivo Software and a content analysis for a more in-depth examination of the key insights within each study. According to our findings, the papers cover the importance of collective intelligence in innovation in both public and private sectors under different lenses. Some authors discuss integrating knowledge management as a means to facilitate knowledge and innovative ideas accumulation from the crowds.[6,7,13,19,24] Other authors focused on the role of collective intelligence in different types of innovation. Namely, the role of collective creativity in reducing the risk related to disruptive innovations by integrating external parties in the innovation process.[9] Moreover, some papers stated that open innovation and collective intelligence go hand in hand to nurture creativity and enhance the innovation process.[7,10,12,15,17] While others implied the potential of collective intelligence tools in enhancing open innovation and the overall innovation process. Controversially, one paper discussed the role of open innovation in creating a fertile ground for peer collaboration and collective intelligence.[24] In addition, we noticed that several authors refer to "crowdsourcing" as a synonym for collective intelligence.[8,11,20] They emphasized its importance in overcoming organizational limitations and succeeding in the innovation process. Some authors consider collective intelligence as a common type of collective intelligence.[18,42] They outlined its role in facilitating innovation, decision-making, and problem-solving. Whereas, other authors refer to crowdsourcing as a form of open innovation that enhances a firm's innovative capabilities.[22] In addition, several papers advocated the mediating role of information technologies in boosting collective intelligence for innovation by integrating digital tools (e.g. Open Source (OS) software, online and virtual communities, Web 2.0 technologies, OSS communities, etc.). However, we have noticed that most of the evaluated papers do not sufficiently and solely focus on collective intelligence and innovation but integrate other concepts such as knowledge management, decision-making, problem-solving, etc. This extends into a lack of modelization and new frameworks that tackle solely the targeted problem. This calls for future studies to conduct empirical and more oriented studies that focus on innovation and collective intelligence and model the link between the two by relying on their key components. Moreover, following the quality assessment, we noticed that most of the papers do not compare their work with existing frameworks. This indicates that the author's primary purpose is to focus on his or her own unique points of view.

In addition, the principal limitations of our study lie in our research methodology. The first limitation lies in our database choice as we only relied on Scopus due to time constraints. However, future research must conduct a longitudinal study that integrates the other existing databases, namely Web of Science, IEEE Explore, PLOS-One, ACM digital library, etc. This could have expanded our research territory and provided more relevant, straightforward, and quality articles. The second limitation resides in our keyword choice as our analysis through Nvivo Software showed the interdependence of our subject with other terms, namely crowdsourcing and open innovation. The third and final limitation rests in our exhaustive inclusion and quality assessment criterion as they could have constrained our search and limited our findings. To sum up, our research confirmed that organizations must take full advantage of collective intelligence to unlock innovation opportunities, respond to social challenges, and achieve economic growth.

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CONFLICT OF INTEREST

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