A SYSTEMATIC REVIEW OF THE LITERATURE ON INTELLECTUAL CAPITAL MANAGEMENT, TECHNOLOGY AND INNOVATION

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Cite as: *Dinu, E. (2022). A systematic review of the literature on intellectual capital management, technology and innovation, Ekonomicko-manazerske spektrum, 16(1), 58-75.*

Available at: *dx.doi.org/10.26552/ems.2022.1.58-75*

Received: 11 February 2022; Received in revised form: 16 March 2022; Accepted: 20 April 2022; Available online: 30 June 2022

Abstract:
Research background: Since no previous work was found to cover a general assessment of the literature on the relationship between intellectual capital management, technology and innovation, this study undertook a general review of the articles dedicated to the aforementioned relationships. As demonstrated by the academic literature, organizational knowledge and innovation are grounded on intellectual capital. In the past two decades, and more so during the Covid-19 pandemic, economy and society have become deeply reliant on technology, and specifically on digital information systems. It is therefore of utmost scientific interest to assess the knowledge regarding the relationships between intellectual capital management, technology and innovation, with the view to revealing the overall significant findings on these topics.
Purpose of the article: This paper provides a first comprehensive analysis of the empirical research covering the integrated studies on intellectual capital management, technology and innovation, unveiling its extent, focus, gaps and trends, for the gain of future research.
Methods: With the aim to investigate the empirical academic papers dedicated to the relationship between the concepts of intellectual capital, technology and innovation, a systematic literature review has been conducted, covering all the articles published by the end of April 2022. In the end, based on the review protocol, 37 works have been selected and further examined.
Findings & Value added: The findings of the analysis on the core body of work in the field confirm the empirically proven significant relationships that exist between technological orientation, intellectual capital management, and innovation performance. It is envisaged that post-pandemic studies will cover under-researched areas such as the relationship between technology, intellectual capital and innovation in specific industries and sectors e.g. healthcare and pharma, or in novel business models, and the impact of advanced technologies on knowledge acquisition and management. This study facilitates future research orientation by unveiling the

literature focus so far, as well as the research gaps. From the practitioner's perspective, this study offers arguments for organizational strategy development, based on the emphasized findings.

Keywords: Intellectual Capital Management; Technology; Innovation; Systematic Literature Review

JEL Classification: 034

1. Introduction

The digitalization process continuously and profoundly changes economy and society. Advanced economies already capitalize on their innovation strategies centred on the Industry 4.0 technologies - Big Data analytics, cloud computing, IoT, 3D printing, advanced robotics - (Rupp et al., 2021), and envision the ''super-smart'' Society 5.0 (Fukuda, 2020). More recently, in the context of tackling the Covid-19 pandemic and its effects, information and communication technology (ICT) have become irreplaceable and ubiquitous, by enabling and supporting the management of the crisis by both public and private organizations, as well as the aftermath, bringing about strategic and behavioural changes that will endure beyond the pandemic.

In the digital economy the word "technology" constantly appears in the academic literature, being positively associated with organizational innovation - when used purposefully for management processes - (Kianto et al., 2017; Cabrilo et al., 2020), organizational performance (Coombs & Bierly, 2006; Steinfield et al., 2010; Andreeva and Kianto, 2012; Khan et al., 2019; Palazzi et al., 2020) and growth (Porter & Heppelmann, 2014). However, such findings are not always fully endorsed by other sources (Aramburu et al., 2015; Usai et al., 2021), that sometimes nuance their conclusions by underlining that IT capital supports firm performance only in coordination with other intellectual capital elements, and its value depreciates quickly because of fast technological changes and large diffusion (Bharadwaj, 1999; Huang and Liu, 2005). Orlando et al. (2020) while testing the relation between intellectual property and digital technologies concluded that the latter are marginally useful for IC creation and the curvilinear function indicates that beyond a certain level, undifferentiated use of such technologies can hinder value creation.

Nevertheless, as noted by Palazzi et al. (2020), today's economy relies on knowledge and knowledge assets are supplied by the IC components. Technological capability is seen as a significant constituent of a firm's knowledge base (Renko et al., 2009) and IT has a paramount role in enabling knowledge sharing processes (Mazzuchelli et al., 2021) and R&D (Nakahara, 2001). But, according to Orlando et al. (2020), the relationship 'IC-digital technologies' has been scarcely studied. On the other hand, though the literature on IC and innovation appears to thrive, a 2017 structured literature review conducted by Buenechea-Elberdin rendered some conflicting findings.

Despite the debates, the decades-long existence of the intellectual capital research field and the societal increased dependency on IT, it has not been possible to find in the academic literature a structured overview of these topics of interest. A first search attempt on the relationship between specific concepts such as ''intellectual capital'', ''technological orientation" or ''technological capability'', and ''innovation performance'' yielded scarce results. As a consequence, this study set out to produce a structured review of the literature concerning the association of IC, technology and innovation. Nevertheless, given the difficulties mentioned above, it has been

decided to keep the search terms more general, since the work in this field was found to be less extensive than initially assumed. Encountering a research gap, it seemed worthwhile to scrutinize the academic literature in the field, to reveal its extent, to classify its focus and findings, and to emphasize the research trends. This research endeavours a first systematic literature review of the literature concerning intellectual capital management, technology and innovation with the aim to extend the theoretical framework. Apart from its novelty and contribution to the Intellectual Capital field, this study offers to practitioners' arguments for organizational development through strategic orientation, by highlighting the empirical findings regarding the relationship between IC resources' management, technological orientation and innovation performance. In order to scrutinize and analyse the papers that cover the subjects, with the view to reveal the literature's interest, gaps and streams, the following research questions have been formulated:

RQ1: What has been the focus and the framework of the scientific literature on the relationship 'intellectual capital management-technology-innovation'?

RQ2: What are the trends in the study of the relationship 'intellectual capital management-technology-innovation'?

The paper follows the structure already established in the academic literature, by presenting a review of the concepts, explaining the research method, providing the findings and discussing them, and proposing some conclusions.

2. Conceptual framework

2.1 Intellectual capital management

The concept of IC was introduced by Galbraith already in 1969 (Bellucci et al., 2020). However, even nowadays, there is no broad, common understanding of the IC definition or its components (Choong, 2008). Nevertheless, it is accepted that IC is grounded on knowledge resources that have the potential to be transformed into value (Buenechea-Elberdin et al., 2018). Santos-Rodrigues et al. (2011) have stated that the aim of IC management is to harness the value of knowledge. According to Kianto et al. (2010), while knowledge management (KM) is concerned with the management of information and knowledge at tactical and operational level, IC management is focused at strategic level and comprises a variety of intangible resources.

Knowledge and information have strategic importance for organizations (Bratianu & Orzea, 2010; Paoloni et al., 2020) and knowledge is the fundament of value creation (Nielsen, 2019). The reiteration of the tacit and explicit (codified) knowledge processes ensures organizational innovation, where enterprises create and share knowledge that is afterwards embedded into new products and technologies (Nonaka, 2007). Heffner and Sharif (2008) have posited that knowledge creation and technological innovation are the outcome of fusion processes between knowledge, technologies and various organizational resources.

Knowledge is found in various forms and organizational areas. The tacit knowledge flow is associated with the human capital (HC), which was seen by Bontis (1998) as the fundament of innovation and strategic renewal. Knowledge is transformed into structural capital through organizational routines, that ensure efficiency and innovativeness, while information is codified into structural, explicit knowledge. Building on the model introduced by Edvinsson and Malone (1997), IC came to be traditionally seen as comprising human capital (HC), structural capital

(SC) and relational capital (RC). Information and networking systems pertain to SC (Petty & Guthrie, 2000).

Kianto (2007) proposed another IC dimension, the renewal capital. Inkinen et al. (2017) presented a model of the IC structure that includes seven components, namely trust capital and entrepreneurial capital, in addition to the previously mentioned elements, and then divides the relational capital into internal and external. Altogether, these assets provide a company the means to build new knowledge and skills, to achieve competitive advantage and to innovate, and thus to renew its knowledge resources (Inkinen et al., 2017; Kianto et al., 2010). According to Martin-de-Castro et al. (2013), SC is organizational knowledge expressed through intellectual property rights, R&D, databases, structures, processes, and systems.

Quinn et al. (1996) argued that companies can capitalize on intellectual and information processes, which are the bases for profit in the new economy, i.e., through R&D and technological innovation, as well as through the use of advanced ICT, that can increase the value of IC (Murray et al., 2016). Technological and network competences positively influence innovation success in the digital economy, and they are linked to the organizational technological strategy (Ritter & Gemünden, 2004). But the impact of IC on organizational performance can be different in advanced versus emergent economies, affected by brain drain, underdevelopment of intangibles, and (IC) management (Kianto et al., 2018).

2.2 Technological capability, technological orientation and technological intensity

According to Gatignon and Xuereb (1997) technological orientation (TO) is a dimension of strategic management that refers to an organization's propensity to acquire and employ advanced technologies to sustain innovation. Halac (2015) sees TO as a multidimensional construct, which comprises top management capability, technological capability, commitment to learning and commitment to change.

Within the dynamic capabilities framework, the technological capability (TC) is concerned with competence renewal to adapt to a changing environment, where competition is fierce, especially in the high-technology sectors (Teece et al., 1997). Campos et al. (2020) view TC as innovative technologies prowess, which includes acquiring, adapting and perfecting such technologies for organizational needs. TC implies the faculty to carry out the required organizational technical functions that lead to effectiveness and efficiency, but also allow the development of new products and processes (Tzokas et al., 2015). Furthermore, developing TC is linked to exploratory and exploitative learning, relying on absorptive capacity (AC).

The digital transformation requires understanding technology, and is contingent on AC and partnership interdependencies (Siachou et al., 2021). Technological AC relies on an organization's ability to take in knowledge assets and to valorise them as dynamic capabilities. AC associated with TC that depend on advanced technologies impacts new product development (Tzokas et al., 2015; Wua et al., 2019).

Companies with higher technology intensity are better placed to innovate (Kianto et al., 2017). Technology intensity has been defined within the ISIC rev.3 framework to differentiate between four levels of technology utilization in manufacturing industries, namely high, medium-high, medium-low and low (OECD, 2011). Smart technologies can support not only the operational management (e.g. transport and distribution, quality checks, etc.), but also strategic tasks, like resource planning, staff selection, etc., (Gerst, 2019). Technological transformation inside an

organization is usually linked to enhanced IC components i.e., structural and human (Brynjolfsson & Hitt, 2000, 2002).

2.3 Innovation

Successful companies rely on innovation, whose key driver is IC (Buenechea-Elberdin et al., 2017a). Innovation has been described as the organizational capacity for renewal of products, services, processes, strategies, management activities, etc., which should permeate the entire organization (Nisula & Kianto, 2013). According to Gatignon et al. (2002) innovation can be understood within a structural framework that includes four dimensions, namely product complexity, innovation locus (core vs. peripheral), innovation type (generational vs. architectural, i.e. changes in subsystems or linkages between them) and innovation characteristics (incremental vs. radical, and new acquisition of competence vs. enhancing/destroying competence).

Subramanian and Youndt (2005) found that innovation in business has been studied from perspectives such as organizational knowledge and KM, and they stressed the link between IC and innovation. It has been posited that IC components have different impact on the types of innovative capabilities, depending on how they are combined. The innovation capability has been defined as the ability to convert knowledge and ideas into new products and processes (Lawson & Samson, 2001). More recently attention was drawn to the concept of open innovation, which is understood in opposition with the closed model, as inbound and outbound knowledge flows, to stimulate the internal innovation and to secure markets for its external use (Chesbrough et al., 2006).

The management of innovation has been analysed from the point of view of innovation degrees (incremental or radical), innovation types (product or process) and innovation sources (generation or adoption) (Dost et al., 2016). Innovation management is complex, as it has to organize and direct relationships between new ideas, multiple stakeholders, numerous and intricate transactions, while institutional leadership should ensure organizational strategies, culture, structure and systems that sustain innovation (Van de Ven, 1986). While incremental innovation improves and exploits existing technology, radical innovation is disruptive, by questioning existing knowledge and aiming for new solutions (Subramanian & Youndt, 2005). Product innovation is significantly linked to R&D in technological-intensive industries, while process innovation is more important for other sectors (Hervas-Oliver et al., 2021).

According to Verbano and Crema (2016), innovation performance is dependent, apart from the technical resources, on their management inside the company, and larger firms are favored, while small and medium size enterprises (SME) have to be more agile and to develop their IC to innovate, as they have limited resources compared to bigger companies.

Research has provided mixed empirical results on the relationship between technology and innovation (Kohli & Melville, 2018). Though IT usage was not found to have an impact on innovation processes and performance, findings showed that this association is positively influenced by higher TO (Haug et al., 2021). Carmona-Lavado et al. (2013), on the other hand have determined that IC components - particularly HC - influence innovation performance in technical knowledge-intensive business services (t-KIBS), namely in the software and R&D

industries. Unlike professional KIBS (p-KIBS) which offer consultancy, i.e., in legal, accountancy, or advertising field, and which are themselves users of technology, t-KIBS are more innovative in the IT industry. At the same time, the effect of renewal capital and entrepreneurial capital on innovation is related to the technology level (Buenechea-Elberdin et al., 2017b). Technological diversification strongly impacts innovative capability (Quintana-Garcia & Benavides-Velasco, 2008).

3. Methodology

In line with Tranfield et al. (2003) and Massaro et al. (2016) works concerning systematic/structured literature reviews, a protocol for review has been developed. Subsequently selected works have been collected for further analysis and data has been extracted in accordance with a structured framework, as to allow examination. The insights achieved after analysis grounded the answers to the research questions stated in the introductory part of this paper.

For this study the review protocol comprised the following inclusion/exclusion criteria:

- papers regarding the relationship between IC management-technology-innovation;
- articles published in academic journals, subject to peer-review, to ensure accurate and valuable insights;
- work based on empirical research that concerns management and business, with the view to provide objective, reliable and generalizable results, useful for both practitioners and academia;
- research contained in main academic databases accessible online, published until 25 April 2022;
- studies written in English, which is deemed the language employed by academia (Bunechea-Elberdin, 2017).

In the first phase, the established databases for academic purposes Scopus and Web of Science (WoS) Core Collection have been interrogated, by using the search terms ‘’intellectual capital* AND innovation* AND technolog*’’, the volume of returned results being comparable, 257 vs. 253 respectively, and therefore ensuring cross-checking. The search included title/abstract/key words/article and has been refined for the categories: management, business, economic, social sciences multidisciplinary, computer science. A keyword search on Scopus, using the predefined terms ‘’intellectual capital’’, and its components ‘’human capital’’, ‘’social capital’’, ‘’relational capital’’, ‘’organizational capital’’, as well as ‘’knowledge management’’, ‘’technology’’, ‘’innovation’’ led to further narrowing the results to 178 entries.

In the second phase, abstracts of the identified articles have been checked individually, and 39 articles have been retained from the WoS collection, and 35 from Scopus, for further full text examination. In the third phase, the scrutiny has extended to sources identified in the references of selected works. In the final phase, a total number of 37 documents have been included in the list of studies to be analysed for the systematic review.

From this sample, data for analysis has been extracted according to the following framework: publication year, author(s) name, article title, journal of publication, citations, author(s) country, sample’s country, industry, technology type, firm type, method, sample size, findings (Appendix Table 1).

4. Results

Author(s) and Sample Location

As indicated by the data plotted in Figure 1, Spain is the country with the greatest number (10) of articles testing the relationship between 'IC-technology-innovation'. Italy is second with 9 articles. In the third position is China/Taiwan with 5 papers. Finland, Canada and Pakistan are in the fourth position, with 3 articles each, then USA, UK and Jordan with 2 articles each. Countries where IC first gained prominence - Sweden and Denmark - are represented with one article each, as do Russia, Kenya, Tunisia, Colombia, Brazil, Oman, Mexico, New Zealand and Indonesia.

In the vast majority of cases, researchers investigate local and regional companies. As a consequence, the same positions in top 3 based on sample location are occupied by the same three countries: Spain, Italy and China/Taiwan. The research focus on the local business could be justified by a better knowledge of the local business environment, facilitated access to databases within local projects, and also the location of the co-authors. It can be concluded that the topic that makes this paper's object has been mostly researched in Europe (20 articles) and Asia (11 articles), while North America and Africa were responsible for two articles each, as reflected in Figure 2.

International cooperation

One third of the selected articles (13) have been co-authored by researchers from different countries. It can be noted that Spain is again a front runner, with 5 articles on this topic written in international co-authorship, then comes Finland. While Italy constantly appears among the top countries in the IC discipline research, Italian researchers are represented here only with national groups of authors.

Figure.1 Author(s) location

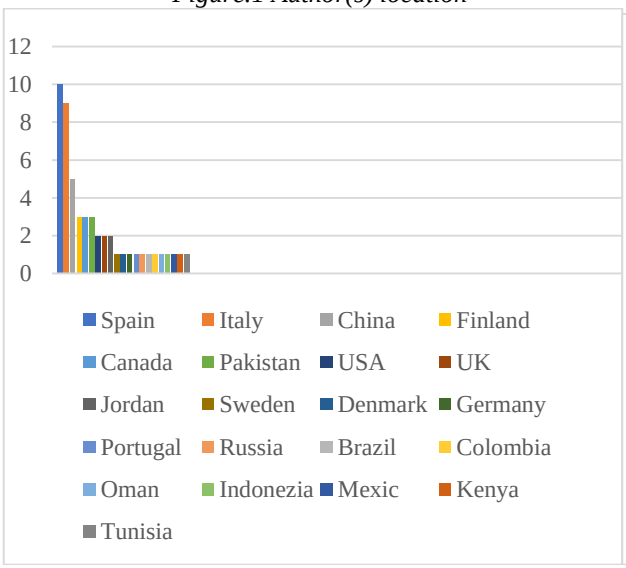
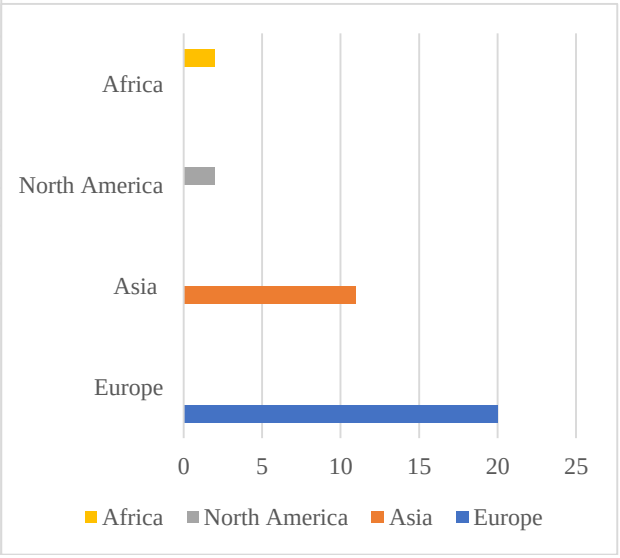


Figure 2. Sample's location



Source: Author's analysis

Specialized authors

Spain is on top position once more in respect of authors that specialize on topics related to IC, innovation and technology, with two researchers that have jointly written 3 articles on the subject, namely Miriam Delgado-Verde and Gregorio Martín-de Castro (2011, 2013, 2016).

Citations

Table 2 shows the articles with more than 50 citations in WoS, Scopus or combined.

Table 2. Most cited articles

Year	Author(s)	Title	Citations	
			Wos	Scopus
2009	Renko, M., Carsrud, A., Brännback, M.	The Effect of a Market Orientation, Entrepreneurial Orientation, and Technological Capability on Innovativeness: A study of Young Biotechnology Ventures in the United States and in Scandinavia.	121	147
2005	Huang C.J., Liu C.J.	Exploration for the relationship between innovation, IT and performance.	-	125
2015	Tzokas, N., Ah Kim Y., Akbar H., Al-Dajanid, H.	Absorptive capacity and performance: The role of customer relationship and technological capabilities in high-tech SMEs.	92	113
2016	Delgado-Verde M., Martín-de Castro G., Amores-Salvadó J.	Intellectual capital and radical innovation: Exploring the quadratic effects in technology-based manufacturing firms.	48	56
2016	Murray A., Papa A., Cuozzo B., Russo G.	Evaluating the innovation of the Internet of Things. Empirical evidence from the intellectual capital assessment.	35	42
2013	Martin-de Castro, G., Delgado-Verde, M., Amores-Salvado, J., Navas-Lopez, J.E.	Linking human, technological, and relational assets to technological innovation: exploring a new approach.	34	40
2016	Verbano C., Crema M.	Linking technology innovation strategy, intellectual capital and technology innovation performance in manufacturing SMEs.	31	40

Source: Author's analysis

Articles & Journal of Publication

As confirmed by the analysis, articles on the relationship IC-technology-innovation are published not only in the journals dedicated to the field of intellectual capital, but also in journals that focus on innovation and technology. The number of articles focusing on this topic appears to have been increasing each year almost without exception, with a peak in 2020/2021, which is in concordance with the technological development and its impact on society. It is too early to assess the evolution for the current year, but the year 2022 has been marked in the plot, as one article has been retained in the selected articles' list (Figures 3, 4).

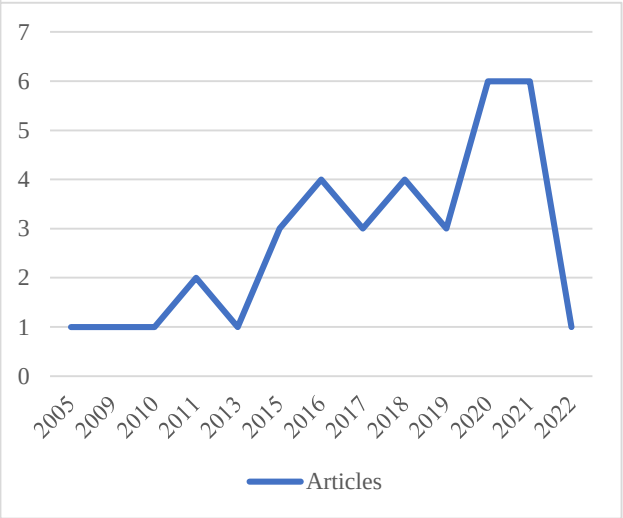
Industry and Technology Type

The selected articles cover a range of economic sectors, cross sector manufacturing and services being investigated the most. A couple of articles are dedicated to FinTech and biotechnology respectively, and one to pharma industry and agriculture each. As anticipated, the

overarching technology researched is ICT, even in those cases where the generic term ‘’technology’’ is used, without further specification. The intended use of the term becomes apparent only after studying the constructs utilized, when content is available. In few cases the specific technology concerned by the study is described. In three cases the subject of research are specifically the digital technologies associated with Industry 4.0 (i.e. 3D printing, Big Data, cloud computing, robotics, IoT), and they have been published during 2021-2022 (Figures 5, 6).

Figure 3. Journal of Publication

Figure 4. No. of articles/year



Source: Author’s analysis

Figure 5. Industry sector

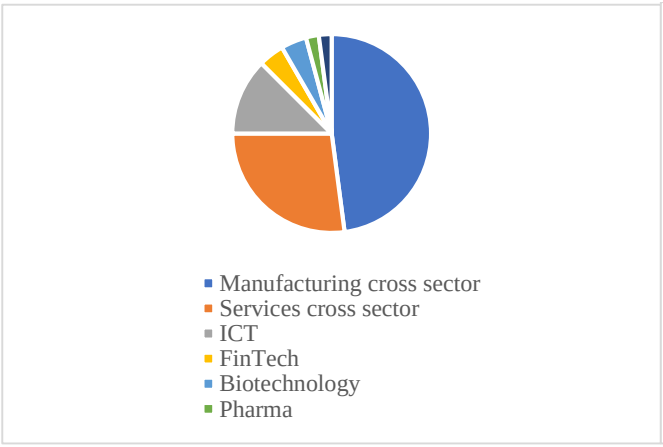
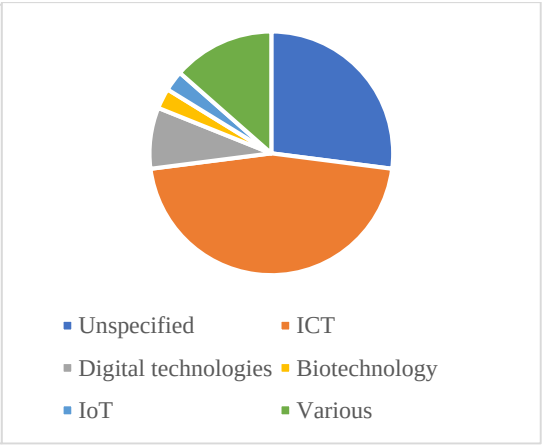


Figure 6. Technology type



Source: Author’s analysis

Firm Size and Sample Size

The distribution of data shows that various firm types (SME, large, combination) have been investigated, with SMEs being predilect. The sample size ranges from one firm (case study), to vast regional (EU) data sets (Figures 7, 8).

Figure 7. Firm type

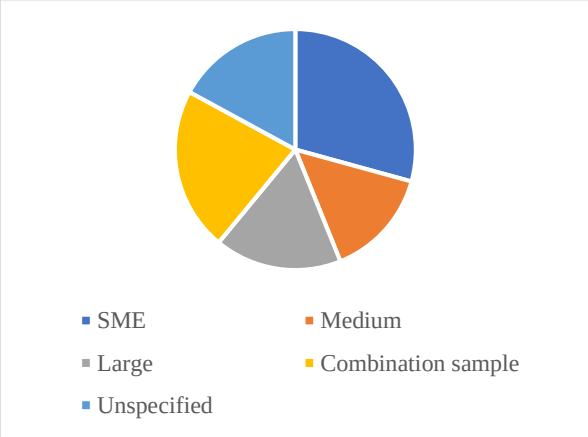
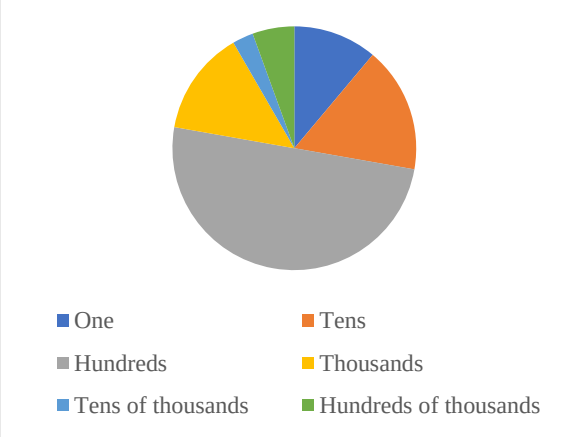


Figure 8. Sample size



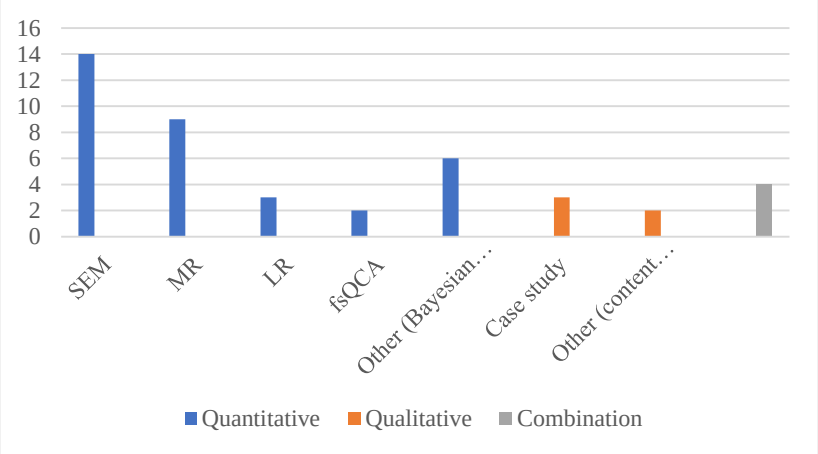
Source: Author's analysis

Method

Quantitative methods have been preferred by researchers, which indicates an inclination towards achieving empirical, objective and generalizable results. While a variety of methods have been utilized, the structural equation modelling is prevalent in 14 cases, as shown in Figure 9. Qualitative methods encountered more often were case studies and interviews. A combination of quantitative and qualitative methods was used in 4 cases.

Figure 9. Method employed

 ISSN 1337-0839 (print) / 2585-7258 (online)



Source: Author's analysis

5. Discussion

With the view to answer the first research question (RQ1), concerning the focus and framework of the scientific literature on the relationship 'intellectual capital management-technology-innovation' we could distinguish between three main streams of research:

5.1 Technological orientation as enabler of IC management to leverage knowledge for innovation

According to Kipkirong Tarus and Kiptanui Sitienei (2015), while IC influences innovativeness in small firms, larger firms are better placed for harnessing structural capital through ICT systems and increase innovativeness, unlike SMEs, which have to remain nimble to substitute for the lack of extensive resources (Verbano & Crema, 2016). A proper IT infrastructure supports better synergy between business functions and improved management processes (Torre et al., 2020). Technological capital together with RC can substitute for other IC components in older firms (Martin de Castro et al., 2013). Zhang and Lv (2015) confirmed a significant relationship between social capital and supply chain learning and technological innovation. ICT usage enables IC development and innovation (Delgado-Verde et al., 2011; Murray et al., 2016; Cassol et al., 2016; Molodchik & Jardon, 2017; Andersson et al., 2021) e.g. by providing HC with advanced training and education capabilities, collaborative tools, networking opportunities for exchanging knowledge (Steinfield et al., 2010; Cabello et al., 2011). However, as stressed by Cabrilo et al. (2020), Huang and Liu (2005) having the technological capacity is not sufficient and what is important is how organizations utilize it to manage IC and create value. In addition, an appropriate IT system can be a remedy to fragmentation of knowledge, especially in the case of geographically dispersed teams (Mazzucchelli et al., 2021). Also, according to Andersson et al. (2021), harnessing the potential of advanced technologies is dependent on the organizational absorptive capacity.

5.2 Technological capital as an organizational dynamic capability to enhance innovation performance

While referencing Gatignon and Xuereb (1997)'s work on TO, a strategic dimension leveraged to achieve innovation, Renko et al. (2009) focused their work on the technological capability, described as an organizational pledge to expand its IP and R&D, pertaining to a firm's knowledge base. The authors found that technological capability is a predictor for product innovativeness, as confirmed also by Mulyana et al. (2019). Other authors defined TC as organizational endeavours to master innovative technologies (Campos et al., 2020; Wang et al., 2020). Rehman et al. (2022) have determined a significant relation between IC, IoT, interorganizational learning and innovation performance

As Martin-de Castro et al. (2013) indicated, the technological capital comprises the blended organizational knowledge such as R&D and IP, connected to the activities and functions of the operational technical system, aimed at generating new products and services. Technological knowledge affects the innovation capabilities (Galeitzke et al., 2017). According to Najar et al. (2020) advanced technological capital supports open innovation (OI) by integrating external knowledge, and OI is grounded on ICT platforms that enable communication and knowledge exchange. Knowledge management for OI relies on IC management and technology assimilation Terán-Bustamante et al. (2021). Unlike incremental innovations, radical ones require changes in a company's technological trajectory and associated competencies (Delgado-Verde et al., (2011). However, as underlined by Delgado-Verde et al. (2016), excessive investments in technological capital are not reflected in radical innovation performance.

5.3 Technological intensity and organizational performance

Technology intensity (TI) augments the positive effect of HC efficiency on firm performance (Palazzi et al., 2020). Buenechea-Elberdin et al. (2017, 2018), Martín-de Castro et al. (2013) established that TI mediates the relationship between IC and business performance, as well as innovation. IT knowledge and infrastructure prevail in highly innovative SMEs (Popa et al., 2021).

Mahmood and Mubarik (2020) stated that technological absorptive capacity (TAC) allows companies to adapt and grow within a dynamic industry context, and IC is paramount in stimulating TAC and innovation**.** OI enables organizations to enhance technological competences by assimilating external technologies and technological knowledge. TO positively affects performance (Masa'deh et al., 2018; Khan et al., 2019; Andersson et al., 2021) and the interaction between HC and SC is required in order to leverage innovative technologies (Cavicchi & Vagnoni, 2018). New technologies offer the tools for improved performance, enhanced knowledge management and are essential in generating value (Torre et al., 2020).

The positive effect of technology is not undisputed, though. According to Usai et al. (2021), Orlando et al. (2021) digital technologies increase firm efficiency, but they can negatively affect HC and RC, through reduced interactions and standardised learning. Nevertheless, digital technologies such as 3D printing, robotics, and Big Data analysis are valuable for innovation up to a certain extent.

5.4 Emergent research trends

This section aims to provide the answer to the second research question (RQ2).

As Martin-de-Castro et al. (2019) have noted, despite the fact that the study of IC has approached maturity, this field of study still has an interdisciplinary nature, and its findings are not unified and undisputable. The cited authors have also stated that, since the inception of this research field, several phases corresponding to specific periods could be distinguished, namely conceptualization and business focus (1990-1999), measurement and management models, including IC component research (2000-2009) and IC as a practice (2010-2016). In this respect, taking into consideration the evolution of ICT, which is either the driver or the enabling technology studied in relation to IC, it can be concluded that the literature reviewed for our topic corresponds to the third phase.

Looking at the analytical data presented in the previous section, while taking into consideration the current global economic and social setting, it can be suggested that the research could be heading towards the study of IC, technology and innovation in various industries and sectors, especially since some currently relevant ones are under-researched e.g. healthcare, pharma and green IC. Furthermore, the effect of technology advancement e.g. robotics and AI on HC, knowledge generation and innovation is still to be undertaken. The relationship between IC and innovative business models that rely on new technologies is another avenue for investigation. Finally, studies that employ new research methods that rely themselves on advanced technologies e.g. machine learning, vast data sets, etc., are expected to become more numerous.

6. Conclusions

Following a systematic literature review, what could firstly be stressed as a consequence is the need to build a more in-depth conceptual framework underlying the research on the relationship 'IC management-technology-innovation', which should also be better embedded in practice, with the aim to understand how organisations actually use technology in developing IC for operational and strategic purposes. As various investigations have brought out conflicting findings, researchers should consider the fitness of the frameworks and the methodologies used, as well as the specificities of the local business context and the proper understanding of the technology concerned.

Despite the fact that many digital technologies and other ICT enabled technologies originated or are extensively employed in North America, it appears that the focus on their relationship with IC is mainly an endeavour of European and Asian researchers, therefore a large geographical area is not covered by the current research. At the same time, certain economic sectors have scarcely made the object of IC research in the proposed paradigm, e.g., healthcare, pharma, agriculture, fintech etc. Most studies have focused on general purpose ICT applications, while technologies pertaining to the Industry 4.0 framework have just started to be considered by researchers.

As a theoretical contribution to the extant literature, the present study provides an unprecedented overview of the empirical work testing the relationships between intellectual capital, technology and innovation. Furthermore, this paper provides an integrated analysis of the research focus in the indicated fields, revealing its prevailing themes and trends, as well as its gaps. From a practitioner's perspective, this work emphasizes the recurrent findings that confirm

significant correlations between intellectual capital, technological orientation and innovation, offering therefore an argument for organizational strategy development.

Some limitations arise. First of all, this research has considered only empirical - and not theoretical – studies regarding the abovementioned relationships. Secondly, the research involved only sources available in the online databases, and could have overseen therefore some older works which could not be retrieved online. Finally, the selection of the articles was restricted to those papers associated primarily with the fields of management and business, and could have omitted works published in journals dedicated to further-related scientific domains.

Author contributions: All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

Funding: This research received no external funding.

Data Availability Statement: The Appendix containing the selected list of articles can be accessed openly using the link: https://figshare.com/s/d0caa98ac62d5294a8f9.

Conflicts of Interest: The author declares no conflict of interest.

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