

# Intellectual capital and human dynamic capabilities in decarbonization processes for net-zero business models: an in-depth examination through a systematic literature review

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## Abstract

**Purpose** – Although intellectual capital (IC) and human dynamic capabilities (HDCs) play a significant role in decarbonization processes, their measurement and reporting is under-researched. Hence, this study aims to identify the link between HDCs, carbon accounting and integrated reporting (IR) in the transition processes, investigating IC and HDCs in decarbonization processes to achieve net-zero business models (n-ZBMs).

**Design/methodology/approach** – A systematic literature review with a concise bibliometric analysis is conducted on 229 articles, published from 1990 to 2023 in Scopus database and Google Scholar. Reviewing data on publications, journals, authors and citations and analysing the article content, this study identifies the main search trends, providing a new conceptual model and future research propositions.

**Findings** – The results reveal that the literature has rarely focussed on carbon accounting in terms of IC and HDCs. Additionally, firms face pressure from institutions and stakeholders regarding legitimacy and transparency, necessitating a response considering IR and requiring n-ZBMs to be developed through IC and HDCs to meet social and environmental requirements.

**Originality/value** – Not only does this study link IC with HDCs to address carbon emissions through decarbonization practices, which has never been addressed in the literature to date, but also provides novel recommendations and propositions through which firms can sustainably transition to being net-zero emission firms, thereby gaining competitive advantage and contributing to the nation's sustainability goals.

**Keywords** Intellectual capital (IC), Human dynamic capabilities (HDCs), Net-zero business models (n-ZBMs), Carbon accounting, Sustainability transition

**Paper type** Research paper

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## 1. Introduction

Over the last 3 decades, the world has experienced tough periods of climate change because of which concepts of decarbonization and integrated reporting (IR) in sustainability transition have grabbed the attention of practitioners and scholars. Therefore, regulatory bodies have tried to get firms to take precautionary measures to minimise the negative environmental impacts caused by them by adopting decarbonization practices and improving their reporting capabilities according to defined standards (Eastburn, 2000; Gregurec *et al.*, 2021). Growing concerns regarding firms' operational activities are pressurising, firms to focus on social issues and transparency through IR to maintain legitimacy (Khan *et al.*, 2021). To meet the challenges of this global threat, the United Nations (UN) Climate Change Conference introduced the historic Paris Agreement in 2015, setting long-term goals for all nations towards sustainability. This has led to firms facing many challenges in maintaining their competitiveness in the decarbonization process (Singh and Rao, 2016).

Recognising this, local governments are designing short- and long-term decarbonization practice policies at local levels (Linton *et al.*, 2020). This is because countries that focus on adopting sustainability practices have high disclosure quality (Stuart *et al.*, 2023). In fact, decarbonization depends on the complete transformation of society in terms of net-zero business models (n-ZBMs), sustainability goals, social equity and climate change mitigation (Linton *et al.*, 2020). Therefore, strategic management is essential to explore dynamic capabilities (DCs), which are defined as resources that provide business organisations with a competitive advantage (Teece *et al.*, 1997), and influence innovation. Most firms invest in human resources and technological innovation to maintain their capabilities (Canibano *et al.*, 2000). A firm's ambidexterity refers to its capacity to simultaneously manage business demands in a coordinated and effective manner (explorative dynamic capability) and adapt to environmental changes (exploitative dynamic capability) (O'Reilly III and Tushman, 2008).

Singh and Rao (2016) found that human dynamic capabilities (HDCs) and intellectual capital (IC) enable firms to achieve their goals because both are positively associated with sustainable development. The DCs are a firm's potential to configure its competencies to respond to rapidly changing environmental challenges (Garavan *et al.*, 2016), whereas IC, as defined by the World Intellectual Capital Initiative is "the dynamic existence of internal and external intangible assets in an organization" (Wang *et al.*, 2019, p. 3). Scholars are investigating these concepts from different perspectives to understand them deeply because they are the most important drivers of growth and development for firms over time (Halberstadt *et al.*, 2019). However, the literature lacks the development to link these concepts with business models (Baima *et al.*, 2020).

In the last decade, carbon accounting has also attracted the attention of scholars as it is an essential tool for fighting global warming by reducing carbon emissions (Farbstein *et al.*, 2022). More than a decade ago, Stechemesser and Guenther (2012) elucidated that carbon accounting refers to endeavours to integrate climate change mitigation into accounting protocols. This designation is employed by natural scientists and financial analysts. Stechemesser and Guenther (2012) comprehensively reviewed carbon accounting definitions, contributing to discussions on including both monetary and non-monetary emission values in accounting systems, emphasising that carbon accounting definitions focus on the measurement, compilation, evaluation and communication of emissions by firms to inform stakeholders.

While global warming is threatening the world with its negative environmental impacts, firms are being pressurised by institutions and stakeholders regarding carbon emissions and carbon accounting focus (Rohani *et al.*, 2023). Stakeholders are more concerned about firms' environmental issues and pressurise them to obey regulatory body rules to meet sustainable development (Chuang and Huang, 2018). Stakeholders also urge firms to sustain their HDCs. Therefore, firms must exploit IC to make their businesses more effective in the digital economy (Gupta *et al.*, 2020). Meanwhile, firms manage their strategies and design their business models according to environmental policies to reduce their negative environmental impacts (Essid and

Berland, 2018). The n-ZBMs depend on e-businesses, strategy management, green technology adoption, and responsible innovation (De Giacomo and Bleischwitz, 2020). To date, most of the literature has elaborated that to design business models, firms must focus on sustainable energy (Niesten and Alkemade, 2016), a circular economy (Nussholz, 2017) and sustainable innovation (Geissdoerfer *et al.*, 2018), necessitating the adoption of environmental management practices that address the environment's sustainability aspect by implementing decarbonization processes and n-ZBMs (De Giacomo and Bleischwitz, 2020).

Previous literature has rarely discussed IC and HDCs in light of decarbonization practices. Therefore, utilising ambidexterity, institutional, legitimacy, resource-based view and stakeholder theories, this study analyses the link between IC and HDCs towards n-ZBMs, focussing on carbon accounting. Based on the aforementioned theories, firms agree on a social contract between themselves for the betterment of society. Specifically, the legitimacy, institutional, and stakeholder theories ensure that firms' operations are within societal norms, accepted by all stakeholders and based on institutional pressures (Paoloni *et al.*, 2023). In contrast, ambidexterity, and resource-based view theories support DCs to improve firms' performance towards sustainability by considering IC as a primary source (Rehman *et al.*, 2023). Thus, this study examines the implementation of decarbonization methods that incorporate green technology and renewable resources to mitigate carbon emission-related concerns. All these are closely associated to obtain n-ZBMs based on corporate accountability, which besides being dependent on environmental dimensions is also dependent on sustainability's social dimensions. Firms can use their capital resources to obtain technological innovation and design long-term business models to gain a competitive edge (Xiao and Yu, 2020). However, the link between IC and HDCs to address carbon emissions through decarbonization practices is missing in the literature. There is insufficient theoretical understanding of IC and HDCs' roles in the decarbonization process to achieve n-ZBMs. Additionally, knowledge regarding their measurement and reporting is limited. Therefore, aiming to bridge the aforementioned gap in the literature, this study analyses the literary corpus and highlights the current knowledge in the field by answering the following research question (RQ):

*RQ1.* Which IC and HDCs measures are significantly related to carbon accounting systems towards the decarbonization processes?

*RQ2.* How are HDCs accounted for in decarbonization processes apropos IR?

*RQ3.* What are the contributions of IC and HDCs for firms to meet n-ZBMs targets?

Following Snyder (2019), this study uses a systematic literature review (SLR) as a research method. It is optimal to adopt SLR to elucidate the connections between HDCs, carbon accounting, and IR during sustainability transition. Similarly, the SLR serves to comprehensively grasp how previous research endeavours in accounting have addressed various research questions. SLR aids in identifying, analysing and discussing the connections established in prior studies, while also providing theoretical and practical implications, introducing new conceptual frameworks and outlining future directions for research advancement in the accounting domain (Burrill *et al.*, 2023; Damschroder *et al.*, 2022; Elbardan *et al.*, 2023; Guthrie and Parker, 2011). Using the visualisation of similarities viewer (VOSviewer) program version 1.6.5, we analysed 229 articles published between 1990 and 2023 in English from the Scopus database and Google Scholar (GS), through descriptive, bibliometric and network analyses, exporting the publication metadata to Microsoft Excel 2019; Waltman *et al.*, (2010). By using bibliometric analysis, this study offers a comprehensive overview of academic networks, helping researchers determine "how" to place themselves within research areas and map out the major evolutionary paths (Krishen *et al.*, 2021).

The remainder of this study is organised as follows. Section 2 comprises the theoretical background of the study. Section 3 describes the methodology used. Section 4 presents the results. Section 5 presents the discussion, followed by the conclusion in Section 6.

## 2. Theoretical background

### 2.1 IC in regulatory framework for carbon accounting in sustainability transition

Sustainability transition has gained considerable attention over the last 2 decades. Theoretically, four frameworks (transition management, strategic niche management, multi-level perspective on sociotechnical transitions and technological innovation systems) concerning sustainability transitions have emerged in policy and research interests (Markard *et al.*, 2012). Carbon accounting is an important tool for measuring carbon emission reduction, leading towards a sustainability transition (He *et al.*, 2021; Schaltegger and Csutora, 2012).

The Corporate Sustainability Reporting Directive (CSRD) reviews the sustainability reporting standards prepared by the European Financial Reporting Advisory Group (EFRAG) to ensure reliability and information availability for stakeholders (Ostir, 2023). Regulatory bodies urge firms to align their goals with the UN 2030 Agenda, COP27 and 2015 Paris Agreement to reduce carbon emissions. The Kyoto Protocol also aimed to reduce or limit greenhouse gas (GHG) emissions. Carbon accounting is the outcome of the Kyoto Protocol and the European Union Emissions Trade Scheme (EU ETS). Replacing the Kyoto Protocol, the Paris Agreement motivates firms to decarbonize their routine activities, leading to sustainability transition (He *et al.*, 2021). Regulatory policies cause survival issues for firms unable to respond to net-zero goals (Glynn and Cooper, 2022). Therefore, under the broad lens of the institutional theory and with the increasing awareness of climate change, it is necessary to know how firms respond to these policies and measures (Andrews-Speed, 2016). Adopting carbon accounting in sustainability transition helps reduce firms' carbon emissions and the institutional theory helps bring advancements to meet institutional pressures (Dagilene and Nedzinskiene, 2018; Gunarathne *et al.*, 2021).

Using existing literature, we try to cover the responses of firms to institutional pressures; however, there are some gaps that need addressing (Bui and Fowler, 2019; Jeswani *et al.*, 2008). Carbon accounting plays a major role in helping firms design low-carbon business models (Alrazi *et al.*, 2015; Bui and Fowler, 2019). Therefore, regulatory bodies regularly scrutinise firms' practices, aligning them with environmental policies and helping them develop human resource capabilities to support sustainability transition (Hahn *et al.*, 2015; Singh *et al.*, 2021). Firms cannot sustainably transition without focussing on their employees and other stakeholders. Over the last 3 decades, human resource management issues have increased, and this topic has gained immense attention (Di Vaio *et al.*, 2020a).

In light of the sustainability debate, some scholars are focussing on IC as it is directly connected to achieving sustainability goals (Vale *et al.*, 2022). Moreover, IC, natural resources, and increasing innovation investments are main drivers toward the transition to a zero-carbon economy (Greco, 2023). Scholars argue that IC is an important pillar for the sustainable development of firm (Matos and Vairinhos, 2017; Secundo *et al.*, 2020; Suci and Nasulea, 2019). IC comprises three main components: employee/human, structural, and relational capital (Zerenler *et al.*, 2008). Among these, human capital, which is a strategic resource for firms, is most important. In fact, IC considers it to be as an engine of growth for firms as it leads to innovative and competitive sustainable development (Alvino *et al.*, 2021), which highlights its importance in dealing with climate change.

### 2.2 IC and HDC measures for decarbonization processes in carbon accounting and IR

Climate change calls for a thoughtful adoption of decarbonization practices for technological innovation to reduce or eliminate carbon emissions (Yang *et al.*, 2023). Decarbonization practices help sustainability transition by adopting technologies that depend on fossil fuels and redesigning institutional structures (Linton *et al.*, 2020). Therefore, DCs are considered as important factors for firms to frequently adopt environmental changes. Since the introduction of the Paris Agreement, decarbonization practices have gained increasing attention (Buana

*et al.*, 2023). Environmental accounting practices, which form part of decarbonization practices, are positively associated with firms' management operational planning and decision-making to achieve a circular model (Scarpellini *et al.*, 2020). Carbon accounting practices help firms manage their natural resources and capabilities and addresses environmental sustainability in terms of regulatory and societal standards (Gibassier and Schaltegger, 2015). Moreover, carbon reporting fairly represents firms' efforts in reducing emissions to external stakeholders (Gibassier and Schaltegger, 2015). For the last 20 years, firms are being pressurised to focus on sustainability related consideration in their strategies (Castiaux, 2012). To promote sustainable development and create value, firms must formulate and execute innovative strategies, improving environmental quality. Accordingly, they must explore the ambidexterity theory to balance exploratory and exploitative practices and improve their performance (Asiaei *et al.*, 2022). The ambidexterity theory helps firms discover new opportunities to use their existing capabilities to attain a competitive advantage, specifically by utilising existing knowledge related to environmental factors (Asiaei *et al.*, 2022). IC can help arrange firms' routine practices to understand and explore their capabilities to meet their goals (Singh *et al.*, 2021). Bueno *et al.* (2004) proposed an IC model that included "social innovation capital", as IC supports the development of new ideas (Dabić *et al.*, 2021). IC, based on social innovation, benefits society in achieving carbon neutrality (Konno and Schillaci, 2021).

IC disclosure is an important element of IR. As the IR framework is based on capital management, the International Integrated Reporting Council (IIRC) classifies firms' capital into six categories: natural, social, intellectual, human, financial, and working (Pratama *et al.*, 2020). The resource-based view theory argues that firms can evaluate their resources' weaknesses and strengths, selecting a suitable strategy to achieve their goals (Hsu and Wang, 2012). Equitable decarbonization practices are essential to adopt legitimate practices (Sareen and Haarstad, 2020). Apart from this, firms need HDCs to design their sustainability-oriented business models, however, the role played by firms to encourage has been rarely addressed (Bocken and Geradts, 2020). Therefore, the purpose of this study is to link IC with HDCs to design n-ZBMs using carbon accounting. Firms are encouraged to adopt decarbonization practices to mitigate climate change issues, satisfy the stakeholder requirements and effectively address institutional pressures.

### 2.3 HDCs: from IR to n-ZBMs

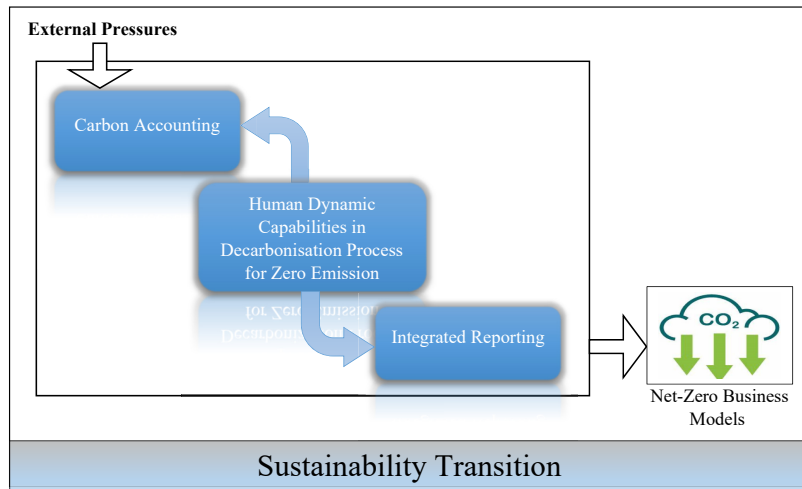
Over the last couple of decades, DCs have actively aroused the interest of scholars. According to the resource-based view theory, DCs are necessary to achieve competitive advantages for firms (Barrales-Molina *et al.*, 2015), and human resources are micro-foundations for DCs (Verona and Zollo, 2012). While under the resources-based view, resources are important for developing sustainable business models, the stakeholder theory highlights the critical role played by stakeholders in developing these models (De Giacomo and Bleischwitz, 2020). Stakeholders are motivated to make firms accountable for their interests in sustainable development through environmental, social, and governance (ESG) disclosures (Al Amosh and Khatib, 2021; Hahn *et al.*, 2015). Therefore, stakeholder pressure on firms to conduct their activities within societal acceptance and HDCs helps manage stakeholders' expectations of being proactive towards renewable resources and n-ZBMs (Singh *et al.*, 2021).

Accordingly, human resources can help firms transform towards n-ZBMs in three key areas, that is, purpose, value, and culture, further divided into decision-making, learning, ecosystem, talent, structure, and platform (Komm *et al.*, 2021). Human resources form the basis of business models, enabling firms to create and protect their resources to innovate and sustain their performance. Firms with strong DCs are good adaptors of eco-friendly environments, as they not only create n-ZBMs, but also enhance their performance through more innovation (Teece, 2007).

Firms must disclose the sources of their competitive advantages to stakeholders, regulatory bodies, and financial analysts. However, financial statements do not sufficiently represent all

the relevant human resources-related information (Salvi *et al.*, 2022). Existing literature highlights that non-financial disclosure (NFD) highly influences firms' value creation (Hail, 2013; Der Zahn, 2022) and is associated with high stakeholder engagement (Stuart *et al.*, 2023). Sustainability depends on firms' transparency regarding the integration of social and environmental concerns into their strategies (Ostir, 2023). In this regard, the legitimacy theory is concerned with incorporating ESG factors in reporting (Liesen *et al.*, 2015) because legitimacy is "a generalised perception or assumption that the actions of an entity are desirable, proper or appropriate within some socially constructed system of norms, values, beliefs and definitions" (Suchman, 1995, p. 574). Additionally, business model-related disclosure is associated with the IIRC's agenda, specifically in terms of addressing problems in IR (Tweedie, 2017). Therefore, to maintain legitimacy, satisfy stakeholders and comply with regulatory regulations, firms try to engage in carbon accounting and decarbonization practices (Juusola and Srouji, 2022).

To achieve n-ZBMs, firms must incorporate their transition plans into their routine operations. Furthermore, they must be accurate in reporting, specifically regarding Scope 1 (direct emissions), Scope 2 (indirect emissions from electricity and cooling consumption), and Scope 3 (all other value chain-related emissions) (Montgomery and Van Cleef, 2023). However, the disclosure of human resources in IR is yet to be examined (Salvi *et al.*, 2022). Therefore, to bridge this gap, this study designs a theoretical framework based on the existing literature by conceptualising IC with HDCs in sustainability transition. This study examines decarbonization practices and carbon accounting as tools to reduce carbon emissions using IR. Figure 1 presents the conceptual framework of this study.



Source(s): Authors' compilation

Figure 1. Conceptualisation of the study

### 3. Methodology

In this study, we employed a transparent, scientific and reproducible SLR proposed by Tranfield *et al.* (2003). Contributing to the existing body of literature in the field, SLR examines the role of theories supporting our theoretical framework on IC, HDCs, n-ZBMs, carbon accounting and IR studies (Paul and Criado, 2020). This study utilised an integrated approach, combining both quantitative and qualitative data analysis strategies. According to Hardies *et al.* (2023), SLR is the most appropriate methodological choice for objectively and concisely capturing all available evidence regarding research questions on accounting research topics



that have received limited attention. We decided to employ SLR to advance knowledge in the area under investigation by comprehensively understanding specific topics addressed within our theoretical framework. Therefore, this method enables a comprehensive interpretation of earlier scientific discoveries using previous findings and evidence along with new conceptual frameworks and lines of enquiry. According to [Larrinaga and Stolowy \(2019\)](#), accounting literature reviews, particularly adhering to a specific procedure such as SLR, are necessary to identify and delve deeper into underrepresented accounting research issues.

In this study, we assessed 229 articles from the Scopus databases and GS, published between 1990 and 2023, retrieving them from the disciplines of “business, management and accounting”, “social sciences”, “economics, econometrics and finance”, and “environmental science”. Scopus is one of the largest “peer-reviewed” databases worldwide, with approximately 22,794 active titles from 11,678 publishers. Compared with the Web of Science (WoS), Scopus contains more articles, as well as most of the publications listed in the WoS ([Di Vaio et al., 2020b](#)). We used GS to analyse the citations of additional works published in high-impact journals, ensuring that no relevant article was overlooked ([Martín-Martín et al., 2017](#)). These publications were selected because they disseminate theoretical or empirical research related to IC, HDCs, n-ZBMs, carbon accounting, and IR studies ([Di Vaio et al., 2023](#)).

After defining the research topics, we followed [Hardies et al. \(2023\)](#) and [Di Vaio et al.'s \(2023\)](#) systematic approach for conducting SLRs as follows: First, we searched through Scopus and GS using predetermined inclusion and exclusion criteria. After reading the titles and abstracts, we determined the relevance of the articles to our study, thereby creating a dataset. Second, we performed a bibliometric analysis on the identified articles, gathering quantitative data. Third, we manually analysed the content of the 229 articles (qualitative analysis), a methodology commonly employed by scholars to identify changing patterns in article and journal performance research elements and examine the intellectual structure of a specific area in the current literature ([Donthu et al., 2021](#)). [Figure 2](#) presents the implementation strategy for the aforementioned data collection processes and reporting for all the SLR phases, providing insights into the identification, screening, and inclusion of pertinent data, including the preferred reporting items for systematic reviews and meta-analyses (PRISMA) flowchart ([Page et al., 2021](#)). We established the eligibility criteria for data collection, involving the screening of peer-reviewed journal articles, as these are deemed more reliable and influential than other authored sources ([Lombardi and Secundo, 2021](#)). Studies were collated by employing predetermined keywords in titles and/or abstracts and combined using Boolean operators (AND and OR). Initially, 833 papers published in eminent journals between 2000 and 2023 were identified using the following designated search terms in Scopus and GS:

- (1) *Group 1: (intellectual capital) AND (carbon emission)*
- (2) *Group 2: (intellectual capital) AND (decarboni\*)*
- (3) *Group 3: (carbon accounting) AND (human resource)*
- (4) *Group 4: (account\*) AND (climate change) AND (intellectual capital)*
- (5) *Group 5: (account\*) AND (decarboni\*) AND (HR OR human resource)*
- (6) *Group 6: (carbon account\* OR carbon-account\*) AND (decarboni\*) AND (climate change)*
- (7) *Group 7: (account\*) AND (decarboni\*) AND (climate change)*
- (8) *Group 8: (dynamic capab\*) AND (climate change)*
- (9) *Group 9: (dynamic capab\*) AND (intellectual capital)*
- (10) *Group 10: (dynamic capab\*) AND (intellectual capital) AND (technology)*

- (11) Group 11: (dynamic capa\*) AND (environmental account\*)
- (12) Group 12: (dynamic capa\*) AND (reporting)
- (13) Group 13: (dynamic capa\*) AND (decarboni\*)
- (14) Group 14: (dynamic capa\*) AND (carbon emission) AND (disclosure OR reporting)
- (15) Group 15: (dynamic capa\*) AND (human) AND (business model) AND (climate change OR environm\*)
- (16) Group 16: (intellectual capital\*) AND (business model) AND (climate change OR environm\*)

Duplicate and extraneous articles were discarded, resulting in 631 articles. The selected articles were written in English. Next, we meticulously examined the abstracts, analysed content and selected relevant publications based on our research themes. This process was derived from our individual work. We collaborated to identify deficiencies and discrepancies in the article selection process. These sequential steps yielded a final sample size of 229 articles.

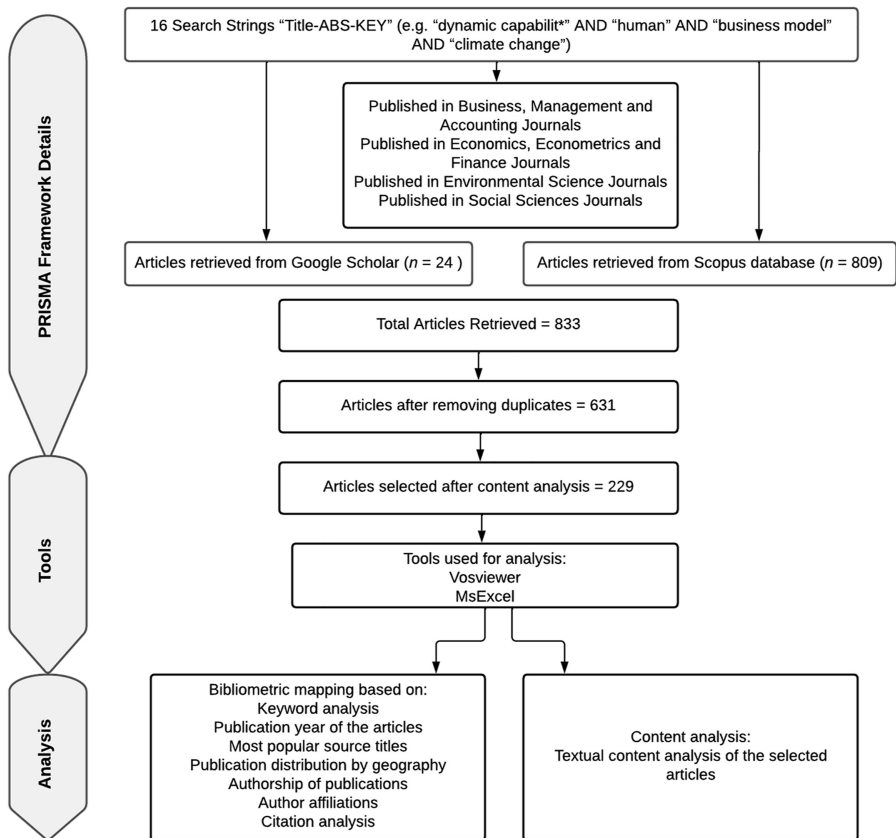


Figure 2.  
Research protocol

Source(s): Authors' compilation



The data collection methods used in a bibliometric analysis are crucial to determine the validity and reliability of the results. Additionally, ensuring reproducibility and generalisability necessitates the adoption of a systematic approach (Baas *et al.*, 2020; Zupic and Cater, 2015). Therefore, to outline the bibliometric study's key elements, we depict them in a flow diagram (Figure 2). These elements include the choice of database, search terms, search strings, inclusion and exclusion criteria, analytical and visualisation software, and bibliometric indicators.

Bibliometric and network analyses, encompassing publication and citation trends, the most popular keywords and source titles, the most prolific contributing authors' institutions and countries, as well as keyword co-occurrence analysis, were conducted using the VoSviewer application version 1.6.19 (Van Eck and Waltman, 2014) and Microsoft Excel (Microsoft, Rochester, New York). Supplementary material Appendix 1 provides a summary of the chosen articles.

#### 4. Results

After summarising the studies, the spatiotemporal characteristics of the data derived from the chosen publications were highlighted using bibliometric analysis to conduct advanced statistical and graphic categorisation tests. Bibliometric analysis consistently produces trustworthy results for a specified topic without potentially ignoring earlier works (Di Vaio *et al.*, 2022). The results of the bibliometric analysis are as follows:

##### 4.1 Most prolific authors

Table 1 lists the most prolific authors who have conducted research in fields of carbon accounting, green IC, HDCs, n-ZBMs and IR. Nancy Bocken (Netherlands) tops the list with

Author	Documents	% of total documents*	Citations
Bocken N.	10	4.37	527
Abeyssekera I.	3	1.31	271
Fujimori S.	3	1.31	20
Konietzko J.	3	1.31	21
Van Vuuren D.P.	3	1.31	23
Guthrie J.	2	0.87	296
Kianto A.	2	0.87	154
Scarpellini S.	2	0.87	144
De Villiers C.	2	0.87	123
Hawkes A.D.	2	0.87	103
Raimo N.	2	0.87	78
Rubino M.	2	0.87	78
Vitolla F.	2	0.87	78
Chen L.	2	0.87	52
Wang H.	2	0.87	45
Corbella S.	2	0.87	36
Florio C.	2	0.87	36
Sproviero A.F.	2	0.87	36
Stacchezzini R.	2	0.87	36
Bigerna S.	2	0.87	26

**Note(s):** \*Total number of documents = 229

Total number of authors = 652

**Source(s):** Authors' presentation using Ms Excel and Vosviewer

**Table 1.**  
Most prolific authors

ten documents, followed by Indra Abeysekera (Australia), Shinichir Fujimori (Japan), Jan Konietzko (Netherlands), and Detlef P. Van Vuuren (Netherlands), each with three documents.

4.2 *Most popular papers*

Citations in research articles show how much an author has borrowed from the concepts, findings and content of other authors. Consequently, the number of citations a study employs determines its influence (Moed, 2006). Table 2 presents the most frequently cited authors and

Authors	Title	Year	Cites	Cites/ year
"Hsu L.-C., Wang C.-H."	"Clarifying the effect of intellectual capital on performance: the mediating role of dynamic capability"	2012	286	26.00
"Beattie V., Smith S.J."	"Value creation and business models: Refocussing the intellectual capital debate"	2013	203	20.30
"Bocken N.M.P., Geradts T.H.J."	"Barriers and drivers to sustainable business model innovation: organisation design and dynamic capabilities"	2020	201	67.00
"Pablo A.L.; Reay T.; Dewald J.R.; Casebeer A.L."	"Identifying, enabling and managing dynamic capabilities in the public sector"	2007	197	12.31
"Striukova L., Unerman J., Guthrie J."	"Corporate reporting of intellectual capital: evidence from UK companies"	2008	188	12.53
"Hsu I.-C., Sabherwal R."	"Relationship between intellectual capital and knowledge management: an empirical investigation"	2012	168	15.27
"Abeysekera I."	"A template for integrated reporting"	2013	158	15.80
"Ritala P., Huotari P., Bocken N., Albareda L., Puumalainen K."	"Sustainable business model adoption among S&P 500 firms: a longitudinal content analysis study"	2018	151	30.20
"Vuontisjärvi T."	"Corporate social reporting in the European context and human resource disclosures: an analysis of Finnish companies"	2006	143	8.41
"Fink L., Neumann S."	"Exploring the perceived business value of the flexibility enabled by information technology infrastructure"	2009	134	9.57
"Han Y., Li D."	"Effects of intellectual capital on innovative performance: the role of knowledge-based dynamic capability"	2015	125	15.63
"Wu S.-H., Lin L.-Y., Hsu M.-Y."	"Intellectual capital, dynamic capabilities and innovative performance of organisations"	2007	116	7.25
"Setia N., Abhayawansa S., Joshi M., Huynh A.V."	"Integrated reporting in South Africa: some initial evidence"	2015	115	14.38
"Engelman R.M., Fracasso E.M., Schmidt S., Zen A.C."	"Intellectual capital, absorptive capacity and product innovation"	2017	114	19.00
"Higham J., Cohen S.A., Cavaliere C.T., Reis A., Finkler W."	"Climate change, tourist air travel and radical emissions reduction"	2016	112	16.00

**Table 2.**  
Most cited authors' and articles

**Note(s):** Total number of papers = 229

Total number of citations = 6,426

**Source(s):** Authors' presentation using Ms Excel and Vosviewer

their corresponding articles. “Clarifying the effect of intellectual capital on performance: The mediating role of dynamic capability” by [Hsu and Wang \(2012\)](#) is the most cited paper in the selected database. In this study, we developed and tested a theoretical hypothesis describing how dynamic capability mediates the effect of IC on performance. The definition of IC in this study encompasses relational, human and structural capital.

The second paper on the list is [Beattie and Smith’s \(2013\)](#) “Value creation and business models: Refocusing the IC debate”. It identifies and discusses the conceptual linkages among IC, value creation and business models. The authors posit that resource-based, DC and strategic network concepts of competitive advantage in strategic management literature are effectively absorbed in the business model idea, along with IC literature. The third popular study is [Bocken and Geradts’ \(2020\)](#) “Barriers and drivers to sustainable business model innovation: Organization design and dynamic capabilities”, which highlights how organisational design affects DCs needed for business model innovation.

Thus, interestingly, while the first study establishes a link between IC and HDCs, the second and third highlight the links between IC and business model innovation and DC and business model innovation, respectively. Thus, analysing these three studies, as well as others from those most cited reveals the links between IC, HDCs, and business model innovation. These findings are consistent with our research objectives.

#### 4.3 Keyword analysis

Bibliometric networks comprising several papers gathered using the text-mining function of VOSviewer 1.6.19 are presented in this section. Recent bibliometric investigations confirm these results ([Marzi et al., 2017](#)). The text mining technique maps connections between keywords by calculating their distances. The smaller the distance between two terms, the higher their relatedness with higher co-occurrences ([Van Eck and Waltman, 2014](#)). The keywords in our bibliometric study for the “author terms” analysis included those that appeared at least five times in the database. Manual selection was used to ensure data reliability. Keywords such as “content analysis”, “article”, and “research method” were eliminated. Accordingly, 59 of the 1,620 keywords were deemed relevant for the analysis. Based on the bibliometric analysis, we created a conceptual map showing the association between the database’s keywords. The size of the words in the graphical analysis reflects the number of keyword occurrences. A larger circle represents a higher number of occurrences of the chosen keyword. “Intellectual capital” ( $n = 60, 2.18\%$ ), “climate change” ( $n = 59, 2.14\%$ ), “dynamic capabilities” ( $n = 39, 1.42\%$ ), “sustainable development” ( $n = 28, 1.02\%$ ), “emission control” ( $n = 27, 0.98\%$ ), and “decarbonization” ( $n = 25, 0.91\%$ ) are the top six keywords, according to the statistics. [Table 3](#) lists the most popular keywords used by previous authors. An overlay depiction of the keywords, categorised by a colour match, is shown in [Figure 3 \(a\)–\(e\)](#), displaying the relationship by colour and calculating the frequency index of the recurrence of words over time. Note that while the term “human” has strong links with keywords such as “air pollution”, “carbon footprint”, “global warming”, and “greenhouse gases”, it is also strongly linked to “intellectual capital”, “dynamic capabilities”, “environmental management”, “sustainable development”, and “circular economy” [[Figure 3 \(b\)](#)]. [Figure 3 \(d\)](#) enables us to decipher the strong link between “carbon accounting” with “climate change”, “human”, “decision-making”, and “decarbonization”. Furthermore, [Figure 3 \(e\)](#) reflects the ties among research related to IC, human capital, DCs and business model. The other two links in the same figure can be seen between “business model – business model innovation” and “business model – sustainable business”.

Keyword	Occurrences	Frequency (%)
Intellectual capital	60	2.18
Climate change	59	2.14
Dynamic capabilities	39	1.42
Sustainable development	28	1.02
Emission control	27	0.98
Decarbonization	25	0.91
Carbon dioxide	24	0.87
Decarbonization	23	0.84
Integrated reporting	23	0.84
Greenhouse gases	22	0.80
Sustainability	20	0.73
Carbon emission	19	0.69
Gas emissions	17	0.62
Carbon	16	0.58
Greenhouse gas	16	0.58
Innovation	15	0.54
Environmental management	12	0.44
Global warming	12	0.44
Alternative energy	11	0.40
Environmental impact	11	0.40
Environmental policy	11	0.40
Human capital	11	0.40

**Table 3.**  
Most popular  
keywords

**Note(s):** Total number of keywords = 1,620

Total keyword occurrences = 2,753

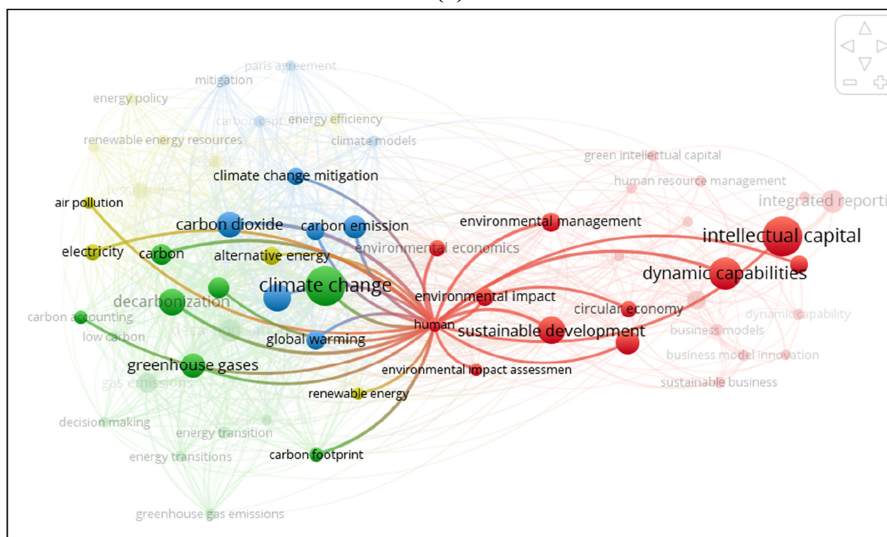
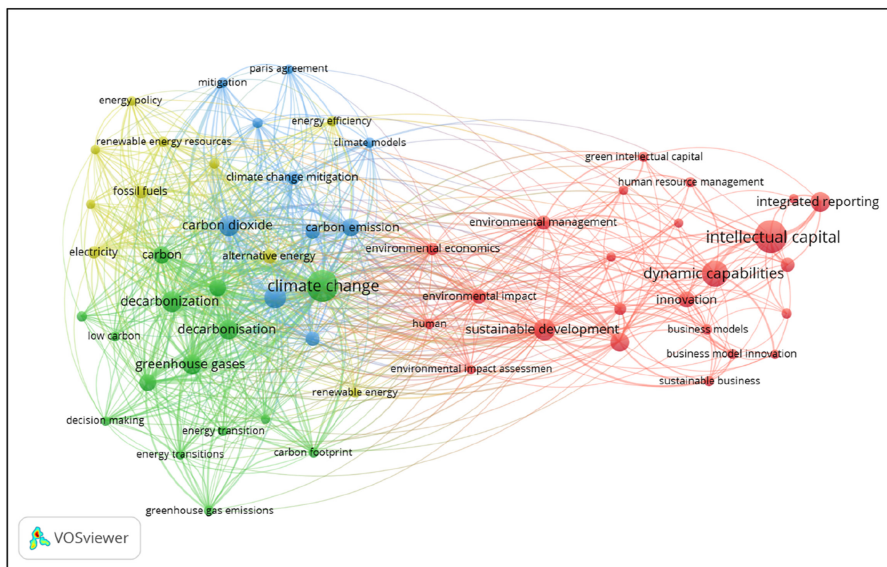
**Source(s):** Authors' presentation using Ms Excel and Vosviewer

The detailed framework of the analysis conducted on 229 articles, based on year, authors, title, subtopics, aims/findings, and methodology is summarised in [Appendix 1 \(supplementary material\)](#). The analysed articles have been categorised into 3 decades: 1990–2000, 2001–2010 and 2011–2023 to provide a comprehensive understanding of how various themes and interconnections have been addressed over each decade by scholars in the field of IC, focussing on HDCs, decarbonization, carbon accounting, and IR.

*Years 1990–2000.* Only one study published in 2000 stated that IC and intangibles provide a guideline for redesigning businesses to have positive environmental impacts by realising their social responsibility (Allee, 2000).

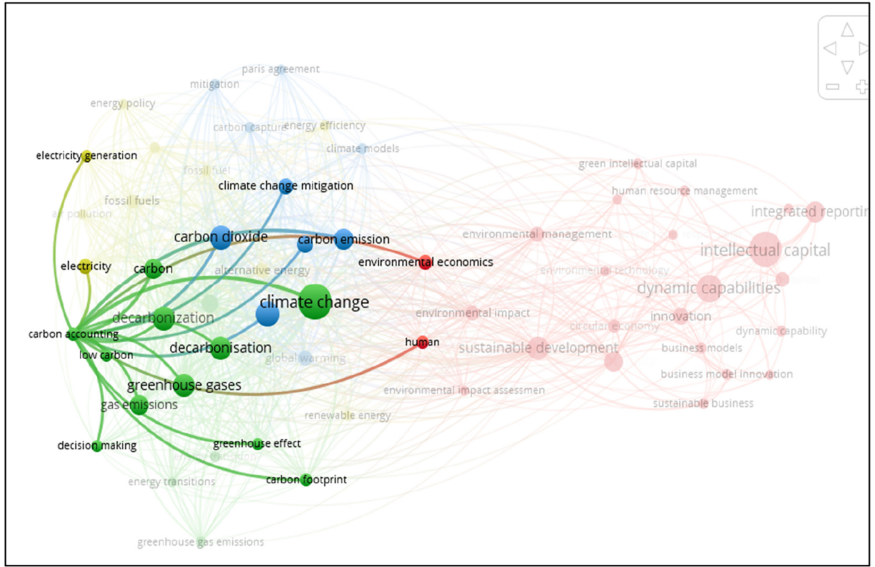
*Years 2001–2010.* Seventeen articles published during this decade were included in the database. The first article of the decade highlighted that businesses should align with environmental changes regarding technological innovation to achieve a sustainable advantage (Alexopoulos and Theodoulidis, 2003). Subsequently, Abeysekera and Guthrie (2004) introduced the concept of human capital in management and accounting. Later, Vuontisjaarvi (2006) focussed on human resource reporting and corporate social responsibility (CSR), revealing that the quality of reporting is not up to the mark and is at an early stage of development. Most of the research conducted during this decade was based on carbon emissions, CSR, IC, and HDCs to improve business practices (Bocken and Allwood, 2012; Ghanam and Cox, 2007). However, even at the end of the decade, there was lack of thorough investigation.

*Years 2011–2023.* Two hundred and eleven articles, published over the last decade, were selected using numerous search strings. During this decade, the authors began investigating these topics because of the severe climate change challenges faced worldwide. In 2012, scholars investigated the relationship between IC and knowledge management (Hsu and Sabherwal, 2012), IC and performance (Hsu and Wang, 2012), IC and HDCs (de Biazzi, 2012), as well as topics such as HDCs required to meet sustainable goals (Castiaux, 2012) and

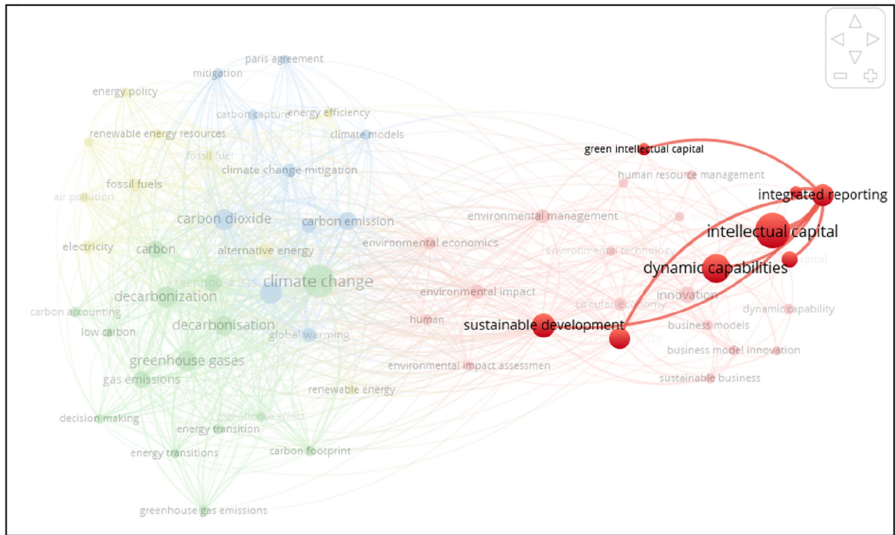


**Figure 3.**  
(a)–(e) Keywords co-  
occurrence network

(continued)



(c)

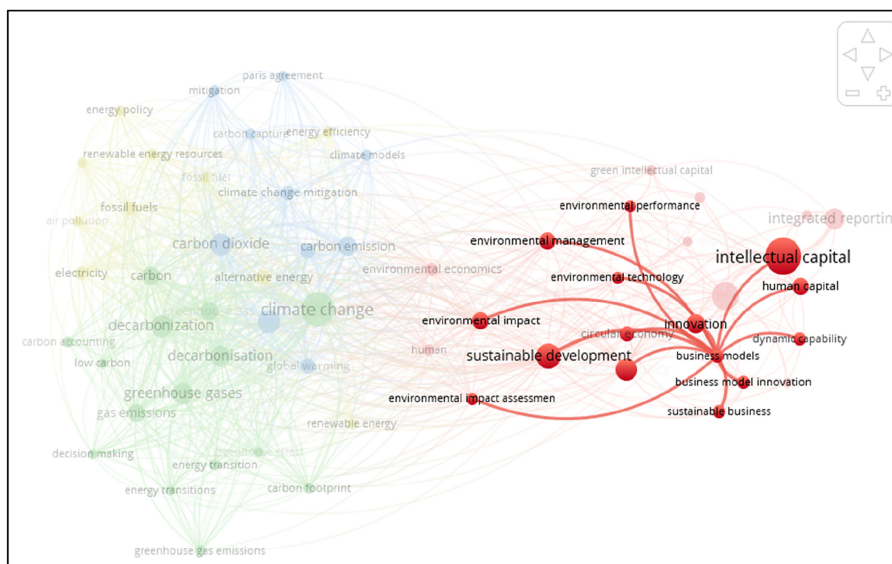


(d)

Figure 3.

(continued)





(e)

**Source(s):** Authors' presentation using Ms Excel and Vosviewer

**Figure 3.**

strategies to reduce carbon footprint (Bocken and Allwood). Subsequently, in 2015 a drastic change was observed in research related to IC disclosure and IR under the resource-based view and institutional theories (Melloni, 2015; Pan *et al.*, 2015), as scholars began to focus on these popular topics. In the following year, Berrill *et al.* (2016) revealed that renewable energy resources could reduce GHG emissions, whereas Higham *et al.* (2016) suggested that policymaking could play a major role in emissions reduction. Haslam *et al.* (2018) found that carbon emissions could be reduced through decarbonization, promoting sustainability. Subsequent to 2018, Wendra *et al.* (2019) studied the relationship between HDCs and IC and the innovation performance of firms, but the concept of reporting was still missing. IR was mostly influenced by environmental and social factors and did not focus much on human capital (Beretta *et al.*, 2019). Most authors have studied IR using IC (Santis *et al.*, 2019; Terblanche and De Villiers, 2019). In 2020, authors found that IC can help firms gain competitive advantage through innovation adoption (Xiao and Yu, 2020), however, there are some barriers at the institutional, strategic and operational levels (Bocken and Geradts, 2020). In the following year, Trusova *et al.* (2021) revealed that the transition towards sustainable business models depends on innovative digital technologies (Bocken and Short, 2021), therefore, firms need to change their routine operations to deal with climate change (Hernandez-Chea *et al.*, 2021). Subsequent to 2021, Charles *et al.* (2022) highlighted some actions and regulations for sustainability and Oshiro and Fujimori (2022) highlighted the role of hydrogen-based energy as an alternative for climate mitigation. Additionally, Abrudan *et al.* (2022) introduced green IC with green innovation by examining the role of green HDCs. Later, Li *et al.* (2022) also found a positive link between green IC and HDCs, leading towards environmental performance. Doorga *et al.* (2023) were the first to disclose a link between carbon accounting and net-zero emissions. Much more exploration is required in terms of the links between IC and HDCs towards n-ZBMs, with a focus on carbon accounting towards sustainability transition.

## 5. Discussion

An SLR is a broad way of reviewing existing literature pertaining to specific areas to highlight issues unaddressed by previous researchers. A literature review helps (1) explore gaps and point out future avenues, (2) highlight the inadequacy of a theory or framework because of which it is insufficiently used in specific fields, and (3) examine overlooked theories or any other perspectives that misguide the existing literature (Hiebl, 2023). Bibliometric analysis is well-known for exploring and analysing large amounts of data to highlight specific underdeveloped and rarely touched areas in emerging fields (Donthu *et al.*, 2021). Designing n-ZBMs is very important for firms in the current decade owing to global warming, wherein saving the environment and natural resources is a top priority. Therefore, to positively impact the environment, building technologically innovative competencies by firms is highly recommended (Ludeke-Freund and Schaltegger, 2023).

To answer RQ1, 170 articles were selected, highlighting different links between IC and HDCs for decarbonization practices under the lens of carbon accounting from different perspectives. The IIRC proposed framework interprets that an integrated report not only displays a firm's stewardship financial capital but also its human, social and intellectual "capitals" (Paoloni *et al.*, 2015). Therefore, creating a cost-effective roadmap for decarbonization practices requires aligning resources and IC with climate commitments, and carbon accounting plays an important role in fulfilling climate commitments (Doorga *et al.*, 2023). A firm's activities may negatively impact society and the environment. Reducing a firm's negative environmental impact, such as its pollution factors, requires carbon accounting adoption (Luo *et al.*, 2022; Sun *et al.*, 2021). The literature urges firms to reduce their emissions by developing n-ZBMs. However, firms face serious challenges in implementing a sustainability transition. Therefore, they are trying to engage in innovation ambidexterity by exploiting their existing resources and exploring new ones (Farzaneh *et al.*, 2022). However, HDCs must be combined with IC for firms to adopt technological innovation to have positive environmental impacts (Wu and Yu, 2023). Moreover, combining green HDCs with green IC can help increase firms' green innovative outcomes, achieving legitimacy (Abrudan *et al.*, 2022). In addition, firms are struggling to adopt decarbonization practices, including emission reduction, that is, carbon accounting and technology portfolios, to achieve the Paris Agreement's goals (Oshiro and Fujimori, 2022).

Concerning RQ2, 45 articles were selected to study how HDCs help in adopting decarbonization practices under the lens of IR. Firms alone cannot create or maintain market value. External factors, such as economic and societal issues and internal factors, such as employees, stakeholders, suppliers, and customers collectively create firm value (Paoloni *et al.*, 2015). Regulatory bodies and their policies to adopt decarbonization practices are gaining the attention of both stakeholders and firms. In this regard, a voluntary program, that is the International Organization for Standardization (ISO) 14,001 standard, introduced in 1996, has been increasingly adopted by firms worldwide to control emissions (Sam and Song, 2022). Human capital is a capable element that guides firms in their value-creation process. Moreover, human capital disclosure extends the scope of firms and provide investors with better opportunities to evaluate disclosure policies regarding a firm's performance (Raimo *et al.*, 2020). Therefore, while IR plays a vital role in improving the disclosure of intangibles (Badia *et al.*, 2019), it is considered an important climate change fighting measure, as it justifies stakeholders' needs regarding adopting decarbonization practices (Bigerna and Polinori, 2022; Leschhorn, 2022; Linton *et al.*, 2022). IR is gaining much attention from external stakeholders, as they want transparent internal stakeholder-related information for future investments (Abeysekera and Guthrie, 2004). Moreover, although NFD is closely associated with HDCs, firms' performance can only increase if firms adopt suitable strategies, pursuing sensing-seizing-reconfiguring capabilities, such that it improves corporate performance (Yang and Yang, 2022).

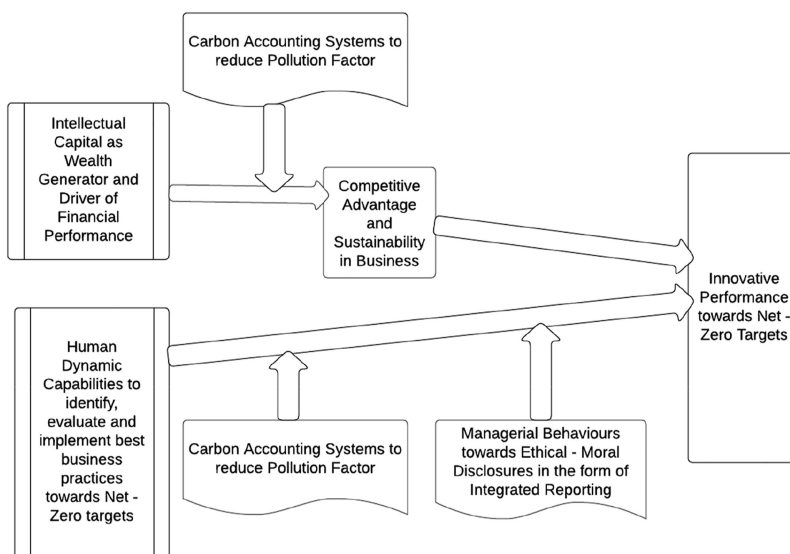
In terms of RQ3, the 17 articles selected stressed the need for firms to develop sustainable business models using IC and HDCs. Firms are a major cause of environmental problems;

however, depending on their use of natural and renewable energy resources, they can contribute to saving the planet (Boso *et al.*, 2022). According to previous literature, firms can treat IC as a door that opens numerous ways to acquire technological innovation and design sustainable business models to achieve competitive advantage. Firms require to properly implement their IC strategies to sustain their sustainable competitive advantage (Xiao and Yu, 2020). Moreover, IC positively impacts the environment and can increase firms' performance by justifying societal pressures (Li *et al.*, 2022), whereas under institutional pressures, firms are forced to use their HDCs to show more sustainable performance to meet environmental challenges (Jain *et al.*, 2022). Firms' human, relational, and structural capital can serve as positive signals to start sustainable business models (Nigam *et al.*, 2021). Moreover, IC aims to affect sustainability in the triple bottom line to develop circular economy business models (Minoja and Romano, 2021). Some authors state that the designs of sustainable business models will be insufficient until firms address environmental and social issues by developing multiple initiatives, such as environmental, human and economic resource exploitation (Bocken and Short, 2021). Farzaneh *et al.* (2022) highlight that IC with ambidexterity encourages knowledge practices to align to develop firms' HDCs.

### 5.1 Conceptual framework

Based on our analysis, we propose a conceptual framework for "IC and HDCs for n-ZBMs toward sustainability transition" for firms (Figure 4). The framework will enable firms to develop the best strategies for using their existing human resources with the help of IC and HDCs. The resource-based view and ambidexterity theories focus on the increased use of internal resources to gain competitive advantage over competitors. This allows firms to compete in today's challenging environment by focussing on stakeholder needs and institutional pressures, enabling them to understand their responsibility towards the environment and society for sustainability transition by maintaining their legitimacy.

Our conceptual framework elaborates the role of carbon accounting and IR as measures to reduce carbon emissions and increase NFDs for decarbonization processes. The adoption of



Source(s): Authors' compilation

**Figure 4.**  
Theoretical framework  
for firms to adopt IC  
and HDC measures  
toward  
decarbonization

green technologies and renewable resources can help firms move towards a sustainability transition in response to institutional pressures and stakeholder expectations. However, high adoption costs represent a significant barrier to this transformation (Ahmed *et al.*, 2021). We focus on the ambidexterity, institutional, legitimacy, resource-based view, and stakeholder theories to support firms to focus their existing resources, specifically human capital, which is a connection between HDCs and IC, to create competitive advantage for themselves in this competitive era. To operate in such challenging environments, firms must prove their legitimacy by responding to stakeholder concerns towards adopting IR and carbon accounting tools under the lens of legitimacy because both can improve their reliability (Pitrakkos and Maroun, 2020). In the first phase, firms must meet environmental challenges to maintain their legitimacy by adopting decarbonization practices in their routine activities to minimise their negative impact on society. In the next phase, using resource-based view and ambidexterity theories, firms must best utilise their existing resources and adopt renewable resources and green technologies to meet the requirements of institutional bodies. Meanwhile, they are encouraged to meet their stakeholders' needs by incorporating efforts towards reducing carbon emissions through IR. Thus, by communicating progress towards net-zero targets and engaging stakeholders in the transition process, firms prioritise transparency and engagement. Finally, firms can collectively implement all these steps by designing sustainable business models. Ensuring accountability in the top rung of the management is pivotal for innovative performance towards net-zero targets. Strategic management efforts align corporate growth strategies with net-zero targets and involve top leaders and managers in sustainability efforts. Their impact and advantages can be expanded by involving employees, suppliers and partners in sustainability initiatives. Thus, through HDCs, firms can bridge the gap between strategic management and innovation performance (a dynamic framework). By implementing these strategies, firms can not only contribute to the global transition to net zero emissions, but also potentially gain competitive advantages and attract sustainability-valuing customers.

## 6. Conclusion

Firms face severe challenges in adopting decarbonization practices. Considering the importance for firms to adopt these practices to gain competitive advantage, this study conducts a bibliometric analysis to enable researchers to develop academic fields and raise questions for practitioners to focus on. In the current competitive era, firms are striving to achieve sustainable development through routine activities, making it essential for them to engage in sustainable value-creation processes by developing n-ZBMs. Designing n-ZBMs require the adoption of green technologies and renewable resources, which positively impact firms in meeting institutional needs and stakeholder demand through IR. While regulatory bodies require proper policy design to meet transition goals, n-ZBMs help firms preserve the environment by contributing to carbon emission reduction and enhancing NFD reporting quality. Firms must adopt carbon accounting tools and decarbonization practices to deal with climate change. By linking IC with HDCs, this study emphasises that the firms should make use of their human capital at their highest potential to enjoy their dynamic capabilities.

### 6.1 Theoretical implications

First, this study stresses on the existing gap in the literature, which is that although carbon accounting is helpful in adopting decarbonization processes to reduce climate change, there is insufficient studies directly linking it to IR, which is important for sustainability transition. This study contributes to the literature by revealing that it is important to focus on human capital, as it links both carbon accounting and IR, meeting institutional and stakeholders' requirements. Second, this study explores the relationship between IC and HDCs in terms of

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IR, which can lead towards sustainable development in terms of firms' legitimacy. Therefore, firms are restricted from having a keen interest in aligning their business activities with institutional pressure. This study focusses on IC and HDCs in decarbonization processes to achieve n-ZBMs, information on which is scarce in the literature. It increases the understanding of IC and HDCs by providing information on the use of green technology and renewable resources to minimise carbon emissions, thereby, adding knowledge to the research area. Moreover, it asserts not only the environmental impacts of firms' operations but also their social aspects.

### *6.2 Managerial implications*

The transition towards n-ZBMs is very challenging. Revamping firms' activities by adopting decarbonization practices is time consuming (Glynn and Cooper, 2022). Therefore, management should evaluate their future position when competitors have transition goals. They cannot risk relying on their current situation. Management must consider their obligation to transition. Therefore, firms must adopt n-ZBMs depending on their carbon accounting practices reducing their carbon emissions. This requires managers to incorporate strategies, implementing decarbonization practices to achieve sustainability transition, which can help them achieve their climate-stability goals. As carbon accounting can help IR, managers should design business models, adopted at the corporate level and communicated through the chain of command to better respond to climate change and fully utilise their IC and HDCs. Human capital is an important pillar for firms to achieve their goals. Therefore, managers should encourage training programs for human capital involved in decarbonization processes. IC with HDCs can enable firms sustain their performance in an external environment, addressing climate change challenges.

### *6.3 Policy implications*

Firms are pressured by institutional forces to adopt and implement n-ZBMs to achieve sustainability transition to save the environment by minimising their carbon emissions. Therefore, firms are trying to re-route their functions through the decarbonization process by adopting green technology and renewable resources, which will help them in the future in financial profits and societal acceptance. In this regard, regulatory bodies such as policymakers, reporting standard-setting bodies, the government and non-governmental agencies should help firms face these environmental challenges by helping them identify innovative ways to do so.

### *6.4 Recommendations and propositions*

This study finds that with IR's help, carbon accounting can meet environmental challenges for sustainability transition, and that renewable energy resources and green technology are important pillars for decarbonization practices in the design of n-ZBMs. Based on RQ1, we develop the following propositions:

- P1.* Firms should focus on their existing resources, specifically human capital, for the best adoption of decarbonization practices.

Firms should use resources to achieve their goals. Their performance is positively associated with environmental performance because of which they must comply with the environmental regulations designed by regulatory bodies. Thus, firms should improve their environmental performance by integrating their human capital with HDCs (Li et al., 2022).

- P2.* Management should actively disclose carbon accounting to meet environmental and social criteria.

Incorporating decarbonization practices is key to reducing climate change. Firms must align their routine operations according to the regulations and policies designed by regulatory bodies and institutions (Luo *et al.*, 2015).

Based on RQ2, the following proposition is proposed:

P3. Adopting HDCs helps promote decarbonization practices with stress on IR.

IR helps firms move towards sustainability transition. Furthermore, it helps them integrate capital resources to add value to their financial and sustainable performance (Busco *et al.*, 2021). HDCs also encourage decarbonization practices by promoting technological advancements.

Finally, with reference to RQ3 and based on the existing literature, we develop the following proposition:

P4. Firms should act flexibly when designing n-ZBMs to address climate change.

Firms that maintain HDCs are not only eco-friendly, but also more innovative in enhancing their performance (Teece, 2007). Thus, firms must adopt carbon accounting in the future to protect the environment from its own negative impacts.

### 6.5 Limitations and scope for future research

This research faces several constraints. First, Scopus and GS data undergo frequent updates, leading to fluctuations in the count of articles and citations they encompass. Further, the indexing process in Scopus is not perfect. Although the database claims to use state-of-the-art technology to match citing references and cited articles, there can still be errors or inconsistencies. This is because the database relies on algorithms to identify and link documents, which may not always be accurate. Additionally, the database includes web pages and patents, which can further complicate the indexing process (Valenzuela-Fernandez *et al.*, 2019). Next, VOSviewer software version 1.6.19 was employed in this study to construct and formulate bibliometric networks. A cautious analysis of outcomes in conjunction with expert opinions is the most effective approach for interpreting bibliometric network visualisations. Validation of the authors' thematic evaluations could be achieved through the application of more advanced tools like CiteSpace, capable of automatically labelling clusters using titles/keywords/abstracts. Additionally, scientific mapping and profiling methodologies are quantitative techniques utilised for analysing diverse publications, providing a comprehensive overview of the research domain and facilitating an in-depth exploration of specific subject areas.

The practice of keyword co-occurrence analysis (co-word analysis) is subject to specific limitations. Furthermore, certain publications might be inadequately represented in bibliometric databases. The quality of the co-word evaluation is determined by the indexing systems, with the authors having limited control over this (Di Vaio *et al.*, 2022). Consequently, forthcoming research endeavours should adopt a systematic approach that integrates both quantitative and qualitative methods.

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## Appendix

The supplementary material for this article can be found online.

## About the authors

Assunta Di Vaio, Ph.D. is Associate Professor of Business Administration at the University of Naples Parthenope, Italy, where she served as Deputy-Director of the Department of Law (2017–2022). Since 2013 she has been serving as Delegate for International Affairs and since 2023 as Delegate for Research of this Department. Since 2022 she has been serving as Member Gender Equality Plan (GEP) Local Board of her university. Assunta achieved the National Scientific qualification as Full Professor in the Italian higher education system, in the call 2018/2020 (Ministerial Decree n. 2175/2018) for the disciplinary field of 13/B1 – Business Administration and Accounting Studies. She holds her Ph.D. degree in Business Administration from Cà Foscari University, Italy. She teaches Sustainable Disclosure and Reporting, Labor accounting towards SDGs, Business Administration. Her research fields include managerial accounting for the decision-making processes in the public and private sector; intellectual capital; performance measurement; non-financial disclosure and sustainability reporting; sustainable accounting; UN 2030 Agenda; SDGs; digital transformation, artificial intelligence and blockchain technology, biodiversity accounting, knowledge sharing, carbon accounting and net-zero business models.

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