

Intellectual Capital for Enhancing Sustainable Industrialization: Towards the Sustainable Development Goal (SDG) 9

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Abstract: Intellectual Capital (IC) has played a major role in driving growth, competitiveness, and sustainability over decades, improving people's well-being and the economic performance of businesses. At the same time, the United Nation's Sustainable Development Goals (SDGs) have emerged as an integrated approach to sustainable development principles of people, planet, prosperity, peace, and partnership, which represent one of the most urgent challenges in our times. The industrial sector is particularly challenged to adopt a sustainable approach to solving development issues by addressing the SDGs. Sustainable Development Goal 9 (SDG 9) is built on three interconnected pillars: infrastructure, industry, and innovation, all of which are strongly interconnected, sharing the common mission of achieving socially inclusive and environmentally sustainable economic development. By adopting SDG 9 and its related targets, the global community can benefit from an industrial development that is inclusive and sustainable, with an impact on all other SDGs. From a strategic perspective, IC is predominantly studied as a bundle of intangibles that creates value, thus embodying a set of resources that are decisive in sustaining competitive advantage, which is necessary for sustainability and for ensuring people's well-being and economic growth, in line with SDGs. Despite an increasing number of studies exploring the links between IC and sustainability, a major gap emerges in what concerns the influence of IC on achieving SDGs in specific or interconnected goals. Based on the relevant literature, the aim of this paper is to explore how the characteristics of the IC can foster the 2030 Agenda for Sustainable Development, specifically, the sustainable and innovative development of organizations by adopting Goal 9 and its targets. This paper contributes to the literature on IC as a driver for SDGs. In more detail, it opens some avenues for future research on strengthening capabilities to solve development challenges, involving different actors, stakeholders, sectors, and regions.

Keywords: Intellectual Capital (IC), Sustainable Development (SD), Sustainable Development Goal9 (SDG9), Sustainable industry, Innovation, Resilient infrastructure

1. Introduction

The concept of Intellectual Capital (IC) has its roots in the early 20th century when economists began to recognize that knowledge and information are important drivers of economic growth, productivity, and prosperity. However, only in the 1990s did the term "intellectual capital" become widespread. Since then, IC has been predominantly studied as the foundation for competitiveness and sustainable competitive advantage, representing a potential for long-term business profitability. Initially addressed in a microeconomic context, IC studies have also proliferated in a macroeconomic perspective, which emphasizes the association of knowledge and city/region, underlying the transition from an industrial to a knowledge society (Januškaitė, and Užienė, 2018). Knowledge-Based Development (KBD) paradigms and the concept of knowledge cities or smart cities encompass technological, academic, cultural, scientific, and innovation capabilities in cities and regions as engines of economic growth. According to Carrillo (2015), KBD concerns the continuity of human civilization, involving the capacity to balance production, consumption, distribution, and vital sources of matter and energy, which requires a set of common value dimensions for ethics, politics, economics, and culture. The author still adverts that "The continuity of human civilization might depend upon human capacity to grasp such principles and redesign coexistence terms, across nations as well as with the planet" (Carrillo, 2015:10). This view aligns with the United Nations (UN) action plan prepared to perform the deep transformation essential to achieve the SDGs outcomes, announced in the 2030 Development Agenda and implemented by all countries and stakeholders working in collaborative partnerships with the UN. Within the different aims of this Agenda, SDG 9 relates to Industry, Innovation, and Infrastructure and aims to "Build resilient infrastructure, promote inclusive

and sustainable industrialization and foster innovation". Even though innovation has been seen as key to achieving economic growth, SDG9 reinforces this significant role in building sustainable economic prosperity for all societies. The Lima Declaration, adopted at the fifteenth session of the General Conference of the United Nations Industrial Development Organization (UNIDO), in December 2013, deepened the commitment towards achieving Inclusive and Sustainable Industrial Development (ISID). Poverty eradication remains the central imperative, and it was recognized that this can only be achieved through strong, inclusive, sustainable, and resilient economic and industrial growth, and the effective integration of the economic, social, and environmental dimensions of Sustainable Development (SD). Industrialization is a dynamic economic process that generates employment, improves living standards, facilitates trade, and promotes efficient resource use.

Assumed as a bundle of intangibles that create value, the strategic view of the IC theory can help us to identify core intangibles that, operating together, drive organizations to achieve ISID goals and targets. Although the concept of Sustainable Intellectual Capital (SIC) or "green IC", integrating IC with environmental concerns, was introduced by Chen (2008), it has been explored very little in IC literature (Yusoff *et al.*, 2019). In the same vein, very few studies (Alvino *et al.*, 2019) address the relationship between IC and SD. To the best of the authors' knowledge, there are no studies on the role of IC in achieving SDG 9. Moreover, IC initiatives carried out by companies in terms of SD must be in line with the expectations of the 17 Sustainable Development Goals (SDGs), which encourage them to contribute to creating a competitive advantage aimed at preserving environmental sustainability and community well-being. This paper, theoretical by nature, explores the IC attributes that drive SDG9, strengthening resilient infrastructure, promoting inclusive and sustainable industrialization, and fostering innovation. Based on the literature review we develop a framework for managing Sustainable Intellectual Capital (SIC) to attain SDG 9. This research contributes to the existing body of IC and SD literature and suggests useful implications for practicing managers and practitioners. The literature review has been carried out aimed at identifying the variables under study: SDG9 and IC, using the SCOPUS research analysis, and 8 results were obtained between the years 2016 and 2023. From this procedure and given the very little research on the combination of two topics, the summaries of the content provided the argumentative support for the development of the research. Despite the evident interrelation between IC and sustainability, the comprehension of its impact on achieving SDG goals is still under-researched and analyzed from different perspectives. This raises a need to better understand how each SDG can be achieved and enhanced through the strategic role of IC. The structure of this paper is as follows. The first section presents the aim of the research and introduces some IC and SD concepts to be developed in the next sections. This is followed, in section 2, by an exploration of the characteristics of IC that make it a key driver of sustainable value. After outlining the role of IC in exploiting business opportunities to achieve social, economic, and environmental benefits, the concept of Sustainable Intellectual Capital (SIC) is developed, in Section 3. Next, Section 4 examines the universal and indivisible nature of SDGs is examined. Section 5 develops a framework for managing SIC to achieve the targets of SDG 9. Section 6 formulates conclusions.

2. Intellectual Capital: The Key Driver of Sustainable Value

Although there is an agreement in the literature that IC is a source of organizational value, there is still a lack of consensus over definitions of it owing to the diversity of disciplinary and interdisciplinary perspectives – strategy, economics, human resources, finance, accounting, reporting, and intellectual capital – from which it can be examined (Marr, 2005). From a strategic perspective, Cabrita *et al.* (2011) define IC as the knowledge that creates value and gives the organization a sustainable competitive advantage. From the accounting point of view, the focus of IC is twofold: external reporting of IC and measuring and visualizing IC for management decision-making. All definitions of IC in the literature emphasize that IC is an intangible asset, that contributes to the production of goods and services that create a competitive advantage for organizations. From all definitions, we can assume that the core element of IC is its intangibility and the potential to create value or wealth. While IC is recognized as a key intangible resource for entrepreneurial success (Crupi *et al.*, 2020), stakeholders heavily pressure organizations to effectively implement corporate strategies that improve sustainable performance (Alvino *et al.*, 2021) and minimize environmental issues arising from production activities. San *et al.*, (2022) found that IC positively influences organizations' sustainable performance in social, environmental, and financial aspects, and emphasizes the role of IC in exploiting business opportunities, encouraging innovativeness, and taking risks for transformation to achieve social, environmental, and economic benefits. Figge and Hahn (2005) introduce the concept of "sustainable value" as the value created by a hyper-efficient use of all forms of capital. The IC concept is linked to the concept of long-term value and the literature (Dwianika and Gunawan, 2020) shows that sustainable value creation can significantly contribute to the deceleration of climate change and the reduction of negative economic impacts (Hariastuti and Lukmandono,

2022). Therefore, the development potential of the IC is linked to the 2030 Agenda for Sustainable Development (SD).

3. Sustainable Intellectual Capital: A Source of Sustainable Value

In line with the cleaner production methods to reduce environmental impact, research has begun mainly focusing on the integration of green practices in the general management systems of organizations, in which Sustainable Intellectual Capital (SIC) becomes part of the development subject, despite very few studies have addressed the concept. Chen (2008) refers to SIC as the sum of all intangible resources, capabilities, knowledge, and relationships that relate to environmental protection, although it can also incorporate social and economic concerns. In the same vein, López-Gamero *et al.*, (2011:21) describe SIC as “the sum of all knowledge that an organization can leverage in the process of conducting environmental management to gain a competitive advantage”. Several authors (Alvino *et al.*, 2021; Popescu, 2020) found that IC management practices have a crucial role in the environmental and ecological goals of promoting SD. Likewise, Yusliza *et al.*, (2020) show that SIC (and its dimensions) and sustainable performance (environmental, social, and economic) are closely related. Therefore, organizations create and add value to their products or services by offering environmentally friendly products or services (Hahn *et al.*, 2007). This study argues that SIC refers to the bundle of intangibles that operating in a combined and interconnected way, produce sustainable value in support of economic growth, people’s well-being, and environmental protection, in line with the Sustainable Development Goals (SDGs).

4. Sustainable Development Goals: A Universal and Indivisible Approach

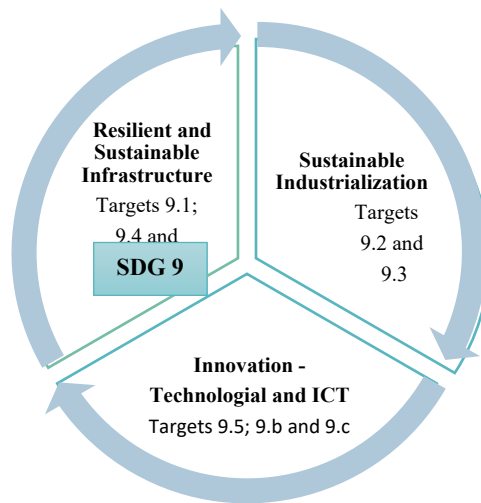
Historically, the concept of SD first appeared in a document entitled “Our Common Future” provided by the United Nations World Commission on Environment and Development (WCED) in 1987 (United Nations, 1987). One of the most recent initiatives for SD is the set of 17 United Nations Sustainable Development Goals (SDGs), with 169 associated targets and more than 230 indicators for monitoring their progress (United Nations, 2015), which were agreed upon by 195 States that aim to move the world to sustainable economic development, environmental sustainability, and social inclusion. Adopting a holistic approach, the 2030 Agenda addresses five critical areas for humanity and the planet: people, planet, prosperity, peace, and partnership.

The literature presents several studies on the synergies (levers) and trade-offs (hurdles) among the SDGs (Moyer and Bohl, 2019; Dörge *et al.*, 2018; Pradhan *et al.*, 2017) and supports the finding that most SDG interactions may act as levers (Anderson *et al.*, 2022). Central to the 2030 Agenda, and a distinguishing feature as compared to other sustainability initiatives, is that it is intended to be treated as universal and indivisible. Universality means that the 2030 Agenda applies to all nations and individuals around the globe, regardless of the current level of income, culture, or sustainability challenges. Indivisibility intends that the implementation of the 2030 Agenda should be based on integrated approaches, and not through a silo mentality. Achieving SD faces many ecological and social challenges that are interlinked and addressing them requires a concerted international and interdisciplinary collaboration beyond independent or specialized programs.

Within the different aims of the 2030 Agenda, SDG 9 relates to Industry, Innovation, and Infrastructure and aims to “Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation”. This SDG encapsulates three key drivers of SD: infrastructure, industrialization, and innovation. Infrastructure provides the basic physical systems, assets, and structures, which are essential for the maintaining of vital societal functions, health, security, and economic or social well-being of people. Industrialization is the engine of economic growth and employment, reducing poverty. Innovation advances the technological capabilities of the industry and the development of new skills. The literature notes the importance of industrialization as a driver of economic and social development. The industry takes a vital role in achieving SDGs, with Agenda 2030 emphasizing the relevance of sustainable industrial development as the basis for sustainable economic growth. Industry acts as a driver of resources that can potentially create sustainable value and achieve the sustainable industrialization envisaged by Sustainable Development Goal 9 (SDG 9). However, there is a consensus in the literature that the complexity of these interactions leads to complex decision-making processes.

SDG 9 operates as a pivotal factor in other SDGs impacting many of them in different ways, such as job creation (SDG 8), women’s employment (SDG 5), health (SDG 3), environmental protection (SDG 7), clean water and sanitation (SDG 6), food security (SDG 2), green technologies (SDG 9) or resilient cities (SDG 11). The literature (Coenen *et al.* 2021; Kroll *et al.*, 2019) stresses SDG9’s synergistic characteristics, advocating its importance in improving the performance of the other SDGs. Nevertheless, according to Pradhan *et al.* (2017), SDG 9 is one of the SDGs involved in additional trade-off situations, which means that, sometimes, the improvement in one target of SDG 9 harms another SDG. The UN defined five key targets (9.1, 9.2, 9.3, 9.4, and 9.5) and three

additional targets (9.a, 9.b, and 9.c), comprising twelve indicators to facilitate actions toward achieving SDG 9. Summing up, we can categorize SDG 9 targets into intervention areas, as depicted in Figure 1.



The three elements of SDG 9, resilient infrastructure, sustainable industrialization, and innovation, reinforce each other.

Figure 1: SDG 9 Targets Categorization

Resilient Infrastructure

Adequate infrastructure is closely connected with the achievement of social development, economic growth, and environmental goals. Poor access to basic infrastructure implies reduced access to a job, education, and health care, compromising the quality and well-being of living standards and creating barriers to making business. Infrastructural progress in railways, roads, water systems, irrigation systems, electrical power, sanitation, and information technologies is visibly linked to economic growth and enables many other goals that depend on it. In times of intense uncertainty, a resilient infrastructure system is understood as a situation that reduces its vulnerability, minimizes the consequences of threats, accelerates responses and recovery, and facilitates adaptation to disruptive events (NIAC, 2009). This is particularly relevant in the context of continuous digital transformations driven by technological developments. A combination of knowledge-intensive activities, innovative actions, and technological advancement has resulted in innovative products and services, supported by digital-centered strategies (Sallos et al., 2019). As society and an increasing number of economic sectors engage in digital transformation strategies, we all face a new type of risk related to digital assets and services. Risks derived from digital incidents are not only disruptive but difficult to predict or avoid and may have major implications for the resilience of businesses and societies. Building resilient infrastructure, therefore, requires thinking and acting for future generations. The UNDRR (2022) establishes a set of six interconnected principles for resilient infrastructure: i) continuously learning, which highlights the challenges to understanding infrastructure resilience due to the internal complexity and external hyperconnectivity of related systems and sectors; ii) proactively protected, which means being prepared for hazards in the recognition that infrastructure is exposed to various hazards both known and unknown, and the nature of hazards is constantly changing; iii) environmentally integrated, recognizing the importance of working in a proactive and positively integrated way with the natural environment: biological (flora and fauna) and physical (land, air, water); iv) socially engaged, aiming to actively engage with people and communities so that they have a better understanding of how they can help to prevent and respond to disruptions; v) shared responsibility, which means that a collaborative approach must be encouraged for the sharing of data, knowledge, and expertise; and vi) adaptively transforming, referring to the ability to change the ways in which infrastructure systems are run, or to change the desired outputs of these systems.

Industrialization

“Industrialization” is a generic term for a set of economic and social processes related to the discovery of more efficient ways for the creation of value. Industrialization is an indirect effect of adequate and resilient infrastructure, promoting jobs with a positive impact on social and economic life (Cammarano et al., 2021). We all know that the impact of the manufacturing industry on the environment is a growing concern, as the industry is being reported as the highest contributor to environmental issues. While Industrialization has brought

economic prosperity, it is also responsible for adverse ecological effects, such as pollution (land, water, and land), forest degradation, and biodiversity loss.

Innovation

Innovation and technological progress are the keys to achieving economic and employment growth and finding lasting solutions to environmental challenges, such as increased resource and energy efficiency. The use of new technologies supports the development of a knowledge economy and the creation of subsequent inventions which contribute to the improvement of living conditions connected with such domains as medicine, transportation, production, or the use of energy. Innovation and creativity are vital to driving more efficient and better use of resources and a key mechanism for achieving the SDGs. As the business environments are in constant change, demanding more dynamic production and management systems for complex environments, innovation, and SDGs should work in broad and flexible manners.

5. Sustainable Intellectual Capital for Enhancing SDG 9

Sustainable Intellectual Capital (SIC) is a concept pertaining to modern economics that aims to emphasize the importance of intelligence for growth and development, where knowledge plays a key role in achieving economic SD (Meramveliotakis and Manioudis, 2021; Cabrita *et al.*, 2016). Its value resides in the identification and monitoring of intangible assets that can determine the failure or success of an organization. Managing SIC is a strategic activity that influences the performance, competitiveness, and long-term success of an organization. As SIC represents the hidden part of the organization's sustainable value, we define SIC as a bundle of intangibles that create value and favor SD. Such intangibles represent the essential conditions for a sustainable competitive advantage and for long-term development.

Based on the literature revision, a framework is proposed for managing SIC processes for SDG 9, as depicted in Figure 2.

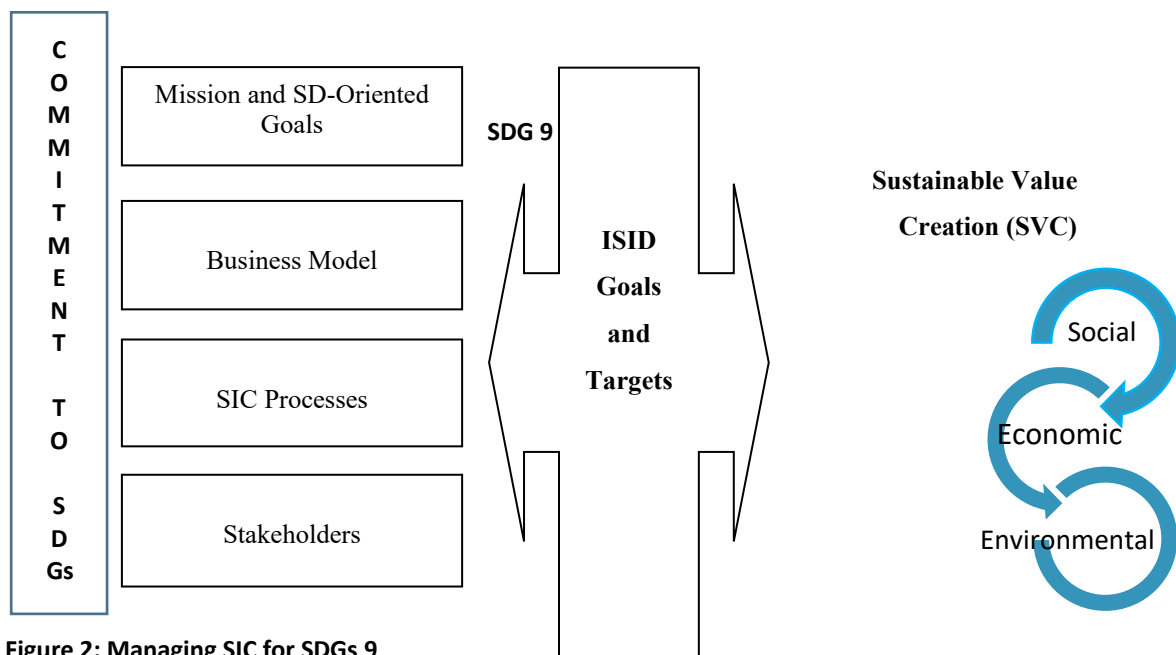


Figure 2: Managing SIC for SDGs 9

To attain the goals and targets of SDG 9 - synergic achievement of economic, social, and environmental results in the medium to long term - the commitment to SDGs needs to be integrated into managerial processes, including the SIC processes. Mission and sustainability-oriented goals define and drive the design and implementation of a business model that affects the value proposition to different stakeholders (customers, employees, providers, competitors, government, and society) (Cabrita and Duarte, 2021). The literature (Wang and Juo, 2021; Singh *et al.* 2020) reveals that to be well succeeded, such a business model, that integrates SDG 9 concerns, requires a wide set of SIC management processes – green training, life-cycle analysis, total quality environmental management, industry eco-design, development of environment-friendly technologies, green waste management, green packaging, green cooperating with customers, eco-friendly behaviors and lifestyles – that enable the exploitation of organizational resources, capabilities, and core competencies to create and

leverage value along the three dimensions (economic, environmental, and social). In this sense, fluxes of knowledge within organizations should be filtered by SDG 9 to build resilient infrastructures, promote inclusive and sustainable industrialization and foster innovation, which is incorporated into the strategy.

6. Conclusions

This work, based on the SD and IC theories explores the arguments to link these two streams of research. The aim of this paper is to explore how the characteristics of the IC can foster the ISID to attain SDG 9 targets. The strategic perspective of IC supports the integration of SDGs into decision-making processes, to create and leverage organizational value. Knowledge as the core element of IC is also the key to achieving the SDGs in every context. Organizations, as an important source of innovation, have a social responsibility to support concerns related to SD. Moreover, organizations should take a holistic view of business, with a focus not only on achieving economic performance but also on the social and environmental dimensions of SD, which aligns with the ecosystem perspective of value creation or SVC. This may be reflected, e.g. in green practices to achieve sustainable industrialization envisaged by SDG 9. Without the focus on the critical value drivers, including technology and innovation, industrialization will not happen, and without industrialization, the development will not happen.

Based on the literature revision, a framework was developed, where is proposed that IC aligned with SDG-oriented practices could help managers to consider the implications of green practices in line with the UN 2030 Agenda when managers decide to redesign and reorganize their operational practices. We show that IC is critical for not only achieving a competitive advantage but also influencing sustainable development (Dalwai *et al.*, 2023). Our future depends on our capacity to adapt, detect opportunities, collect necessary skills and knowledge, and transform them into economic values, in balance with ecosystems. SIC principles and practices are the basis of knowledge-based industrialization.

Despite an increasing number of studies exploring the links between IC and sustainability, a major gap emerges in what concerns the influence of IC on achieving SDGs in specific or interconnected goals. The proposed framework produces an informative base to implement strategies committed to SDGs. Future studies can set forth toward the impact of SIC in each SDG. Several potential improvements could be considered for future research activities on the impact of SIC on knowledge-based industrialization. We believe that more research on sustainability is also needed. The focus should be a punt on interdisciplinary research, i.e. synergy of knowledge from economics, natural sciences, engineering, ecology, etc.

Acknowledgement

Authors acknowledge Fundação para a Ciência e a Tecnologia (FCT - MCTES) for its financial support via the project UIDB/00667/2020 (UNIDEMI).

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