**How Do Companies Conceive Sustainable Infrastructure? Evidence from Construction Companies' Reports' Content Analysis**

***How do companies conceive sustainable infrastructure? Evidence from a content analysis of construction companies' reports***

**AUTHORS:**

**Silvia Gordano**, silvia.gordano@unito.it

**Daniel Torchia**, daniel.torchia@unito.it

**Laura Corazza**, laura.corazza@unito.it

**Dario Cottafava**, dario.cottafava@unito.it

**Silvia Gordano** is Ph.D. in Business and Management, Department of Management, University of Turin. Her Ph.D thesis looks at mergers and acquisitions in the sustainable era. Her research interests cover topics at the intersection between corporate social responsibility and corporate reorganisation.

**Daniel Torchia**, Ph.D. in Business and Management at the Alliance Manchester Business School, University of Manchester, UK. Currently, he is a PostDoc Research Fellow at the Department of Management, University of Turin. He is interested in researching organisations from a critical point of view to promote more humane forms of management. He has published research in both organisational and accounting journals, including *Culture and Organization*, and *The British Accounting Review*.

**Laura Corazza** received the Ph.D. degree in Business and Management from the University of Turin, Turin, Italy, in 2014. Currently, she is a Researcher and Adjunct Professor at the Department of Management, University of Turin, also qualified as Associate Professor. She is the Editor of the University of Turin's annual Sustainability Report and Editor-in-Chief of Journal of Public Affairs. Her research has been published in books and peer-reviewed journals, including *The British Accounting Review, Accounting, Auditing and Accountability Journal, Journal of Business Research, IEEE Transaction on Engineering Management, Sustainability Accounting, Management and Policy Journal, Knowledge Management Research and Practice, Journal of Applied Accounting Research, Corporate Social Responsibility* and *Environmental Management,*

and *Business Society and the Environment*. Her research interests include stakeholder engagement, sustainability accounting and accountability in private, public, and social enterprise organizations.

**Dario Cottafava**, Ph.D. in "Innovation for the Circular Economy", currently is a PostDoc Researcher in "Accounting of socio-economic impacts in megaprojects" at the University of Turin. He is a multidisciplinary scholar, and his research focuses on the intersection among Circular Economy, Open Data and Sustainability. His works have been published in journals that include *Journal of Business Research*, *Sustainability Accounting, Management and Policy Journal, and Environment, Development and Sustainability*.

**ABSTRACT**

Infrastructure plays a crucial role for the advancement of sustainable development. The concept of 'sustainable infrastructure' (SI) has been put forward by scholars and professionals, however further reflection is needed (Chan et al., 2022). By adopting a company-centric perspective, this chapter provides evidence on how the notion is conceived by 'Big Players' in the construction industry, by means of a content analysis of corporate reports. Findings suggest that SI is largely anchored to the early phases of projects lifecycle. 'Green' aspects of SI are commonly recognised – in line with a prevailing use of environmental assessment criteria – but the emphasis placed on other sustainability issues and the broadness of stakeholders addressed vary considerably across companies. This supports that SI is a still fragmented and lively concept.

***How do companies conceive sustainable infrastructure? Evidence from a content analysis of construction companies' reports***

## 1. INTRODUCTION

Infrastructure is the backbone of society and economy around the world. It plays a crucial role in driving countries' immediate economic growth – by means of creating jobs, generating earnings, and boosting spending – and longer-term wealth – by increasing accessibility to employment, enhancing education opportunities through better connectivity, and increasing equality through access to critical utilities (KPMG, 2020). It has been proven that, over a timeline of 20 years, there is an additional US$3.7 injected into the economy for every US$1 invested in infrastructure[1]. This is why, in the aftermath of COVID-19 pandemic, governments have placed infrastructure development on top of their agenda. The significance of digital connectivity and infrastructure resilience to natural disasters has also become apparent during the COVID breakdown.

Although infrastructure may generate huge positive impacts on society and economies, their negative externalities are widely recognised by civil society (Corazza et al., forthcoming). Integrating sustainability in infrastructure development is undoubtedly a core issue and key challenge in the construction industry. Discussions around the issue are not only relevant for the global size of construction industry – US$1.75 trillion for the world's top 200 constructors in 2020 (International Construction, 2021) – but especially for the large-scale effects on society and the environment that construction activities have, from smaller endeavours, to mega or giga-projects (Gellert & Lynch, 2003). As society needs change, calling for energy transition and solutions to fight climate change, infrastructure needs to initiate and stimulate change. For instance, considering that around seventy percent of the world's carbon emissions result from infrastructure construction and use (KPMG, 2022), infrastructure built in current times will likely determine the world's ability to meet the 2050 Net Zero targets outlined by the Paris Agreement. Therefore, infrastructure has the power to strongly contribute to delivering socio-economic benefits (Chan et al., 2022), as well as environmental ones (OECD, 2019), for future generations.

---

[1] https://www.businessroundtable.org/delivering-for-america-full-report

The concept of sustainable infrastructure (SI) is at the heart of the United Nations' Sustainable Development Goal (SDG) 9 - *Industry, Innovation and Infrastructure*, which promotes the transition towards sustainable industrialisation. In particular, targets related to SDG 9 include, among the others, the development of quality, reliable, sustainable, and resilient infrastructure to support economic development and human well-being (target 9.1); and the upgrading of infrastructure to make them sustainable, with increased resource-use efficiency and greater adoption of green technologies and processes (target 9.4).

Given the centrality of infrastructure for societies, it is rather unsurprising that SDG 9 is one of the best examples to show the interconnection among SDGs (Nilsson et al., 2017). It likely connects with SDG 6 (*Clean water and sanitation*), 7 (*Affordable and clean energy*), 8 (*Decent work and economic growth*), 11 (*Sustainable cities and communities*), 12 (*Responsible consumption and production*), 13 (*Climate action*), 14 (*Life below water*) and 15 (*Life on land*). Infrastructure, by relating with transport, energy, water, telecommunications (Thacker et al., 2019), has a direct or indirect influence on most targets included in the SDGs, therefore playing a crucial role for the advancement of sustainable development, which justifies the necessity for ways to identify sustainable infrastructure.

However, how this concept should be defined, and consequently assessed, has given rise to debate over time. SI incorporates a multitude of interconnected dimensions, is long-term by nature, and involves numerous risks and stakeholders (Ferrer et al., 2018). The multifaceted concept of SI is reflected in the variety of sustainability assessment frameworks developed by professional bodies and authorities (for instance, CEEQUAL, NYSDOT, Greenroads, ISI, ISCA), as well as across relevant studies throughout the infrastructure sustainability literature (Sahely et al., 2005, Dasgupta & Tam, 2005; Ugwu & Haupt, 2007; Shen et al., 2011; Chan et al., 2022), to measure infrastructural projects' performance.

Drawing from the different conceptualisations and related assessment methods proposed in theory and practice (Thomé et al., 2016; Chan et al., 2022), this chapter aims to explore how the concept of SI is conceived by companies operating in the construction industry. In order to capture the meaning that companies attach to the concept of SI, a content analysis on the latest-available non-financial disclosures published by the top 10 European construction companies is conducted.

The chapter aims to advance the ongoing debate on sustainable infrastructure (e.g., Berardi, 2013; Chan at al., 2022; Corazza et al., forthcoming). Sustainable infrastructure is a new and ever evolving field (Ferrer et al., 2018). Therefore, we add to the academic literature on the topic and to existing professional assessment frameworks, a company-centred perspective. This helps understanding how conceptualisations provided by scholars and professionals are interpreted by companies and expressed in their corporate disclosures, in order to contribute to their mutual shaping.

## 2. LITERATURE REVIEW

### *2.1. Sustainable Infrastructure*

Infrastructures enclose a set of engineered facilities, utilities, and systems (Ferrer et al., 2018). This complex engineering systems involve high uncertainties, risks and profound and lasting impacts on the economy, environment, and society (Zeng et al., 2014). Such complexity is reflected in in the high rates of projects failure, in terms of cost overrun and time delays (Flyvbjerg et al., 2003). Zeng et al. (2014), after reviewing relevant literature on the theme, cluster infrastructure complexity into technical, organisational, and environmental. The discourse around infrastructure has traditionally developed around themes of physical infrastructure and its socio-technical aspects (Ferrer et al., 2018). Organisational complexity can be linked to the differentiation and interdependency of organisations involved (Baccarini, 1996): infrastructural projects are a place where different levels of governance are intertwined, from supranational institutions to national, regional, and local governments (Ferrer et al., 2018). The environmental component of complexity instead has been associated with elements, such as trust, availability of resources and skills, political influence, level of competition, strategic pressure, interference with existing site, weather conditions (Bosch-Rekveldt et al., 2011). Zeng et al. (2014) pick up that, especially the organisational and environmental elements of infrastructure complexity, being strictly linked to considerable social responsibility challenges, clearly reveal the urgent need of sustainability management in infrastructure.

The sustainability concept, by encapsulating engineering, environmental, economic, and social sciences (El-Diraby & Osman, 2011), is multidisciplinary, and still maintains openness to adaptation to different social and ecological contexts. Along the literature, it commonly goes hand in hand with the concept of sustainable development, so that the two terms are often used interchangeably. The origin of these concepts can be traced back to the 1980s from a publication entitled Our Common Future, also known as the Brundtland Report, which defines sustainable development as: "Meeting the needs and aspirations of the present generation without compromising the ability of future generations to meet their needs" (Brundtland, 1987, p. 292). The concept mainly rests on three dimensions, i.e., economic development, environmental protection, and social equity, as stated at the UN Rio Summit for "Environment and Development", in 1992. When it comes to reconcile business' profit-oriented goals with the principles of sustainable development, the concept of the "triple bottom line" (TBL), or three-P (People, Planet, and Profit), becomes relevant. Under the TBL approach, integrating sustainability in business organisations is about balancing a company's social, environmental, and economic impacts (Elkington, 1994).

Traditionally time, cost and quality compliances, commonly referred to as 'iron triangle', have been accepted as the most widely used criteria for measuring construction project performance (Atkinson, 1999). However, over time, the validity of the iron triangle has been questioned throughout the academic and industry literature on project management, due to its efficiency-based focus which neglects business-oriented results and customer satisfaction (Garrett, 2008). Besides attempts made to introduce additional constraints to the traditional model (PMI, 2009), the integration of the notion of sustainability in project management has gained attention (Grevelman & Kluiwstra, 2010; Silvius & Schipper, 2011). As a consequence, scholars and practitioners have started referring to sustainable project management, which can be defined as 'the management of project-orientated change in policies, assets or organizations, with consideration of the economic, social, and environmental impact of the project, its result, and its effect, for now and for future generations' (Silvius et al., 2009).

The role of infrastructure in advancing sustainable development was early recognised in the 1980s, however the discussion appeared to be mostly limited to the sphere of environmental stewardship. Related to this, Berardi (2013) argues that the notion of 'sustainable building' has often suffered from a conceptual misconception that (almost) solely relates to energy efficiency, wrongly leading to an interchangeable use of sustainable building, green building, and even high-performance building. What the scholar advocates is the need to move towards a strong and eco-systemic view of sustainability for buildings. This means to consider all the dimensions of sustainability and how they are interrelated, hence going beyond the mere environmental approach and looking at the building as a live system that flows dynamically with nature (Reed, 2007).

Over time, the sustainable infrastructure field has gradually broadened its scope from green infrastructure (GI) to the TBL of sustainability (Thomé et al., 2016). This is testified by the definition provided by the Inter-

American Development Bank (2018), which refers to SI as "infrastructure projects that are planned, designed, constructed, operated, and decommissioned in a manner to ensure *economic* and *financial, social, environmental* (including climate resilience), and *institutional* sustainability over the entire life cycle of the project" (p. 11, emphasis added). By adopting this position, it clearly emerges that referring to sustainable infrastructure entails taking into account the broad range of environmental, social and economic impacts generated and the multitude of stakeholders directly and indirectly involved, throughout the whole project lifecycle.

The evolution of the concept is emphasized as well by review works recently carried out (Thomé et al., 2016; Ferrer et al., 2018). For instance, Thomé et al. (2016) highlight that studies conducted on the topic progressively shifted from early concerns related to materials for the greening of buildings, resource efficiency, and storm water runoff, to a broader integration of economic and social aspects of environmental sustainability. For instance, by means of replacement of construction materials, refinements of GI assessment tools, and adaptation of assessment tools to urban settings in the developing world.

Nonetheless, the field of sustainable infrastructure is relatively new and ever growing (Thomé et al., 2016). Furthermore, given the wide range of issues that should be encompassed within sustainable infrastructure, it is not surprising that a significant body of research is developing around tools and assessment methods to support project teams in managing and delivering sustainable construction.

### *2.2. Sustainable Infrastructure Assessment Methods*

Moving away from traditional monetization-based methods used to evaluate infrastructure projects, in the last decade, a number of methods and assessment tools have been proposed to assess the sustainability of infrastructure projects (Mostafa & El-Gohary, 2014). Among the most popular sustainability assessment frameworks, it is worthy to mention the Building Research Establishment Environmental Assessment Method (BREEAM) (formerly CEEQUAL), Green Leadership in Transportation Environmental Sustainability (GreenLITES), Greenroads, Envision and the IS rating scheme. For instance, BREEAM was launched by the U.K. Building Research Establishment (BRE) in 1990. It comprises sustainability issues related to energy, health and well-being, transport, water, materials, waste, land use and ecology, pollution. The Envision framework, which is the result of a successful collaboration between the Institute for Sustainable Infrastructure

(ISI) and the Zofnass Program for Sustainable Infrastructure at the Harvard University Graduate School of Design, is adopted in North America and applied to more than 100 infrastructure projects, that collectively account for more than US$106 billion in infrastructure development. It includes 64 sustainability and resiliency criteria, divided into five major categories (i.e., quality of life, leadership, resource allocation, the natural world, and climate and resilience). Yet, the IS rating scheme, developed by the Infrastructure Sustainability Council of Australia and used in Australia and New-Zealand, is made up of 15 major components, categorised into six themes – management and governance, using resources, emission, pollution and waste, ecology, people and place, and innovation – to assess the sustainability of infrastructure projects.

Review works of these rating systems reveal that that existing rating systems are imbalanced in relation to the relevance dedicated to the three pillars of the TBL, with an emphasis placed on environmental credits compared to economic and social aspects (Shaw et al., 2012; Surbeck & Hilger, 2014). To overcome such limitations, a wide array of assessment methods has been proposed as well by scholars across the literature. For instance, Diaz-Sarachaga et al. (2017) develop a Sustainable Infrastructure Rating System (SIRSDEC) aimed at balancing the relevance of the three pillars of sustainability in developing countries. Liu et al. (2021) propose a metric system consisting of 4 measurement dimensions - the TBL with an additional managerial pillar - 15 criteria, and 50 metrics required for lifecycle SI evaluation.

Against this background, Chan et al. (2022) recently review the major existing frameworks developed by professional bodies and proposed across the academic literature, in order to develop a comprehensive assessment framework for SI. Starting from the reviewing work, they additionally collect data from professionals, sustainability experts and project managers, and conduct a confirmatory factor analysis to find out the components and subcomponents mostly associated with the evaluation of SI. The final framework is reported in Table 1.

We leverage Chan et al. (2022)'s framework, as one of the most comprehensive and updated SI assessment framework, to find out if those or other components of sustainable infrastructure emerged from our analysis of corporate disclosures.

<TABLE 1 ABOUT HERE>

## 3. METHODOLOGY

### *3.1. Research method and sample selection*

Our research goal is to investigate the underlying ideas that companies associate to the concept of SI. To this aim, we conduct a content analysis of corporate reports. Corporate narratives contents and characteristics have been proved to be meaningful means for detecting how the discourse around social issues, such as environmentalism, sustainable development, and corporate social responsibility (CSR), is constructed and reflected in organizational messages and disclosures (Buhr & Reiter 2006; Tregidga & Milne 2006; Laine 2009; O'Connor & Shumate 2010; Beauchamp & O'Connor 2012).

The nature of our content analysis is both deductive and inductive. It is deductive since the research starts from models and definitions of sustainable infrastructure provided in theory and practice, and we subsequently look at how the concept plays out in corporate narratives. Specifically, we draw upon Chan et al.'s assessment framework (2022), to analyse the components and subcomponents associated with the notion of sustainable infrastructure. At the same time, the inductive element highlights the nature of the data, as several information on sustainable infrastructure can be gained, which not only applies to the manifest content, but mostly to latent contents, resulting from the interpretation of the texts (Graneheim & Lundman, 2004).

The study focuses on companies operating in the construction industry. To select our sample, we leverage the 2021 CE100 list of European Contractors, compiled by Construction Europe[2], in which construction companies are ranked by revenues. In particular, we concentrate on the top 10 companies in the list. For each company, we analyse all the up-to-date disclosures on sustainability-related topics available on the company's website. Companies' literature includes mostly sustainability reports, annual reports, integrated reports, as well as other more specific documents, such as climate strategy, sustainability plan, etc.

### *3.2. Data collection and analysis*

To carry out our analysis, we first screen sustainability-related information provided by companies in the documents published on their website by entering a search query based on the following keywords: "*sustainable infrastructure*", "*sustainable construction*", "*sustainable building*", and "*resilient building*". This keyword-based search allows us to limit information reported throughout the whole document to information

---

[2] Available at: https://www.construction-europe.com/Files/Download/20210927-112301-CE-09-2021-CE100.pdf

specifically related to the notion of sustainable infrastructure. We do not include terms such as "green infrastructure" or "green building" to not restrict the conceptualisation of SI to environmental issues. Additionally, we look for text paragraphs where the SDG 9 was explicitly referred to, by conducting both a terminology and visual search. Subsequently, we extract information located in the same paragraphs where the identified keywords/icons are mentioned/represented. Even though a company does not specifically provide a definition of sustainable infrastructure or building, its reported targets and/or relevant actions put in place can be seen as implicit statements, from which interpretation of the concept can be reasonably derived. Thus, all relevant information is manually coded. Specifically, the coding procedure aims to identify the following key aspects related to SI, as emerged from the literature:

1) the project life-cycle phase(s) addressed (OECD, 2019);
2) the components (i.e., sustainability issues/topics) and sub-components (i.e., sustainability sub-topics) related to SI (Chan et al., 2022);
3) the metrics employed to assess SI.

After the coding procedure, quantitative and qualitative analyses are accomplished, to both objectively present facts from the text in the form of frequencies and facilitate the interpretation of the analysed data.

## 4. FINDINGS AND DISCUSSION

### *4.1. Project life-cycle phase*

Almost all SI-related information analysed applies to the *design* and *execution* life-cycle phases of projects, thus indicating that environmental, social, and economic positive/negative impacts related to the project are viewed as crucial elements to be considered since the genesis (i.e., planning) of the building/ infrastructural project, as well as during the following construction and operation stages. Only one company in the sample refers to the final life-cycle phase of infrastructure, i.e., the dismantling and disposal phase. This is consistent with the notion that project processes are dynamic, non-linear, and involve progressively decreasing levels of risk and uncertainty through time (Winch, 2001). Indeed, decisions and behaviours related to the early phases are highly risky and have profound and irreversible impacts (Ma et al., 2017). Additionally, recent research highlights a substantial lack of tools, practices, and standards addressing the ultimate life-cycle stages in the assessment frameworks panorama (Corazza et al., forthcoming). Nevertheless, this is essential for embracing a long-term perspective and implementing circular economy practices, which can help restoring land and natural ecosystems.

*4.2. Components and subcomponents of SI*

In Table 2 a re-elaboration of Chan et al.'s (2022) framework is presented, based on the components and subcomponents identified through the content analysis. Frequency of reporting are shown, deleting elements that were not detected from corporate reports. Furthermore, components and subcomponents (marked in bold) are added where a more suitable coding label is attributed by the authors.

<TABLE 2 ABOUT HERE>

The component 'Energy' records the highest relative importance, appearing in all corporate disclosures. This testifies that the attribute 'sustainable' is largely anchored to the project's capability of reducing negative impacts stemming from greenhouse gas (GHG) emissions and positively contributing to climate neutrality. Unsurprisingly, SI-related information is often provided in corporate disclosure sections related to environmental issues and climate change actions. These findings can be mainly motivated by the strong impact exerted by the construction sector in terms of energy consumption and GHG emissions, which account for 38% of total global energy related $CO_2$ emissions (Global Alliance for Buildings and Construction, 2020). Traditionally, energy-related criteria represent the most influencing measurement for assessing the sustainability of a building (Berardi, 2012), so that the terms 'sustainable buildings' and 'energy efficient buildings' have been often used interchangeably (Berardi, 2013). This aspect is likely to be perceived as even more relevant in the light of the EU classification system – the so-called EU Taxonomy – publicly presented in March 2020. Indeed, the purpose of the EU Taxonomy is to translate the EU's climate and environmental objectives into criteria for specific economic activities. The analysis also shows that the majority of subcomponents concerns the efficient use of energy and the reduction of electrical and petroleum consumption, while fewer companies mention investing in renewable energy sources. The component 'Materials' is also recurrent. The analysis supports that planning and operating a sustainable infrastructure calls for devoting attention to materials employed. Previous studies indeed reveal that issues tied to materials are prominent in almost all existing assessment frameworks (Chan et al., 2022), and are highlighted by recent research works as a core matter in sustainable infrastructure development (Thomé et al., 2016). In particular, companies show a great focus on reducing the impact of their material usage, by reusing and also recycling them. While reusing entails keeping materials out of the waste stream, by passing materials used in the same infrastructure or in another production cycle, with little or no processing, recycling involves collecting, segregating, processing, and manufacturing materials into new products. Some companies also report about the usage of certified and innovative low-carbon building materials, i.e., low-energy-embodied materials. By contrast, using local materials appears not to be a prevailing option for construction companies. Indeed, this practice may lead to higher costs and delays in building projects (Hayles & Kooloos, 2005). Topics related to 'Water' are quite often connected to the notion of SI as well. Particularly, water management is usually mentioned in reference to water use reduction and stormwater management (for instance, rainwater recovery and reuse, and flood prevention systems implementation). Furthermore, 'Biodiversity' goals, in terms of ecosystem protection and biodiversity restoration, appear to be attributed to the function of SI. These SI attributes clearly evoke the notion of 'green' infrastructure promoted by the European Union (EU) – *Green infrastructure: Enhancing Europe's natural capital* (2013) – as infrastructure planned and designed '… to ensure that natural areas remain connected together, to restore the health of ecosystems and allow species to thrive across their entire natural habitat so that nature keeps on delivering its many benefits to us'[3]. Under this perspective, infrastructure must become an integral part of spatial planning and territorial development. Moving forward, components related to the community, specifically 'Impact on local community' and 'Community engagement', find space. Intangible impacts of infrastructure have been highlighted as a white spot in many existing assessment frameworks (Chan et al., 2022), where the focus on environmental components largely outweighs social sustainability. However, companies analysed appear to link, to some extent, the concept of SI to social responsibilities and efforts. Indeed, the conceptualisation of SI looks to be related, on the one hand, to the capability of limiting, as much as possible, negative effects falling over local communities (noise and dust control, traffic congestion avoidance, etc), and on the other hand, to the involvement in community development actions aimed at empowering them for their own and each other's wellbeing. The latter may include initiatives such as information-sharing endeavours, seminars, and workshops on sustainability issues

[3] https://ec.europa.eu/environment/nature/biodiversity/strategy/target2/index_en.htm

to raise awareness along the supply chain, educational events dedicated to youngsters, apprenticeship and work placement opportunities. In some cases, SI is also linked to innovation, in terms of ground-breaking project design and sharing of innovation to improve people's life. By contrast, the concept is rarely associated with waste management (for instance, construction and operational waste reduction). Consistently with the paucity of consideration concerning the dismantling phase of infrastructural projects, no company refers to waste management in demolition. Furthermore, in line with prior research (Marcelino-Sádaba et al., 2015; Chan et al., 2022), our findings support that project management is hardly considered in connection with SI, therefore suggesting that the project management practice needs to enlarge its horizon departing from the 'iron triangle' to fully incorporate sustainable development principles.

### *4.3. Assessment metrics*

Data collected on metrics employed by companies to measure SI-related aspects, reveal that the majority of companies assess the sustainability of infrastructure by means of environmental assessment criteria. These include, for instance, revenues from projects with environmental certifications (such as, LEED, BREEAM, etc), indicators drawn from the Global Reporting Initiative (GRI) - particularly the GRI 302 (*Energy*), GRI 305 (*Emissions*) - sustainable materials (i.e., with an environmental certification) as a percentage of sales, rate of environmental self-assessment as a percentage of sales, the building's energy balance, R&D expenditures related to eco-projects. These findings testify an overall coherence with the (mis)conception that SI is akin to green infrastructure, being mostly linked to the environmental dimension, while leaving the other dimensions as secondary. The social sphere is considerably less represented, with seldom recalls to the social value of projects, through impact and engagement with the local community, including local contractors and supply chain. The economic dimension is again rather peripheral with sporadic references to the direct and indirect economic project outcomes (GRI 201 - *Economic performance*, GRI 203 - *Indirect economic impacts*).

## 5. CONCLUSIONS

Infrastructure has the potential to strongly contribute to delivering economic, social and environmental benefits. However, for the infrastructure sector to stimulate change towards sustainable development require a shift from the traditional paradigm of the 'iron triangle' to integrate sustainability considerations.

The chapter has aimed to provide novel evidence on how the notion of 'sustainable infrastructure' is conceived and interpreted by companies. The concept of SI has evolved over time and developed towards a comprehensive conceptualisation of sustainability (Berardi, 2013). However, the variety of definitions used to categorise sustainability components and the still prevailing environmental façade of SI in existing assessment frameworks (Chan et al., 2022), call for the necessity of further investigation and reflection on the concept. In particular, how companies interpret SI needs additional consideration. To fill this gap, we analysed SI-related contents as disclosed by companies of the construction industry in their corporate reports.

Our findings suggest that, for companies, addressing sustainability in infrastructure projects means devoting strong consideration of sustainability-related issues in the early phases of the project lifecycle (i.e., planning and execution). Very little linkages to the final project stages emerge instead. This is coherent with previous research highlighting a paucity of assessment tools related to the deconstruction/demolition phase (Corazza et al., forthcoming). Furthermore, the analysis supports that there is not an unequivocal representation of the components of SI. While sharing the view that environmental, or 'green', aspects of sustainability are a fundamental feature for sustainable infrastructure participants to consider (Gupta et al., 2021), differences in the conceptualisation of SI emerge. This is particularly evident when it comes to sustainability aspects less directly linked to the most significant negative environmental impacts stemming from construction activities (e.g., energy consumption, GHG emissions, materials utilisation). To different degrees, initiatives related to the efficient use of water, the prevention of damages caused by natural forces, and the protection and/or restoration of ecosystems, appear to be attached to the concept of SI, thus embracing a broader view of SI which includes a wider range of stakeholders involved and scaled-up actions. At the same time, sustainability in infrastructure is also linked, to a varying extent, on the one hand, to engaging in initiatives for community wealth development and conservation, and on the other hand, to bringing technological advancement and disruptive innovative ideas that can benefit people's life and the industry. In this vein, the notion of SI also encloses social-related issues. Finally, in line with prior research (Chan et al., 2022), the analysis supports that economic considerations (related, for instance, to project management) are rarely associated with SI, as well as waste management, especially in the deconstruction phase.

**REFERENCES**

Atkinson, R. (1999). Project management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria. *International journal of project management*, *17*(6), 337-342.

Baccarini, D. (1996). The concept of project complexity—a review. *International journal of project management*, *14*(4), 201-204.

Beauchamp, L. L., & O'Connor, A. (2012). America's most admired companies: A descriptive analysis of CEO corporate social responsibility statements. *Public Relations Review*, *38*(3), 494-497.

Berardi, U. (2012). Sustainability assessment in the construction sector: rating systems and rated buildings. *Sustainable development*, *20*(6), 411-424.

Berardi, U. (2013). Clarifying the new interpretations of the concept of sustainable building. *Sustainable cities and society*, *8*, 72-78.

Bosch-Rekveldt, M., Jongkind, Y., Mooi, H., Bakker, H., & Verbraeck, A. (2011). Grasping project complexity in large engineering projects: The TOE (Technical, Organizational and Environmental) framework. *International journal of project Management*, *29*(6), 728-739.

Brundtland, G. H. (1987). Our common future—Call for action. *Environmental Conservation*, *14*(4), 291-294.

Buhr, N., & Reiter, S. (2006). Ideology, the environment and one world view: A discourse analysis of Noranda's environmental and sustainable development reports. In *Environmental Accounting*. Emerald Group Publishing Limited.

Chan, M., Jin, H., van Kan, D., & Vrcelj, Z. (2022). Developing an innovative assessment framework for sustainable infrastructure development. *Journal of Cleaner Production*, *368*, 133185.

Corazza, L., Cottafava, D., & Torchia, D. (2022). Toward Sustainable Infrastructural Megaprojects. In W.Leal Fihlo et at. (eds.), *SDGs in the European Region, Implementing the UN Sustainable Development Goals – Regional Perspectives*, Springer Nature, Switzerland AG

Dasgupta, S., & Tam, E. K. (2005). Indicators and framework for assessing sustainable infrastructure. *Canadian Journal of Civil Engineering*, *32*(1), 30-44.

Diaz-Sarachaga, J. M., Jato-Espino, D., & Castro-Fresno, D. (2017). Methodology for the development of a new Sustainable Infrastructure Rating System for Developing Countries (SIRSDEC). *Environmental Science & Policy*, *69*, 65-72.

El-Diraby, T. E., & Osman, H. (2011). A domain ontology for construction concepts in urban infrastructure products. *Automation in Construction*, *20*(8), 1120-1132.

Elkington, J. (1994). Towards the sustainable corporation: Win-win-win business strategies for sustainable development. *California management review*, *36*(2), 90-100.

Garrett, D. (2008). Is the Triple Constraint the WRONG way to Define Success. *Gantt Geneve: ILO*.

Graneheim, U. H., & Lundman, B. (2004). Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. *Nurse education today*, *24*(2), 105-112.

Grevelman, L., Kluiwstra, M., 2010. Sustainability in Project Management A case study on Enexis. PM World Today.

Gupta, H., Kumar, A., & Wasan, P. (2021). Industry 4.0, cleaner production and circular economy: An integrative framework for evaluating ethical and sustainable business performance of manufacturing organizations. *Journal of Cleaner Production*, *295*, 126253.

Flyvbjerg, B. (2014). What you should know about megaprojects and why: An overview. *Project management journal*, *45*(2), 6-19.

Haigh, N., & Griffiths, A. (2009). The natural environment as a primary stakeholder: the case of climate change. *Business Strategy and the Environment*, *18*(6), 347-359.

Hayles, C. S., & Kooloos, T. (2005). The challenges and opportunities for sustainable building practices. *Benefits*, *2*.

Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative health research*, *15*(9), 1277-1288.

Inter-American Development Bank. (2018). What is sustainable infrastructure? A framework to guide sustainability across the project cycle. IADB: Washington, DC.

KPMG. (2020). The sustainable infrastructure opportunity. Available at: https://home.kpmg/xx/en/home/insights/2020/06/covid-19-recovery.html

KPMG (2022). Emerging trends in infrastructure 2022. Available at: https://assets.kpmg/content/dam/kpmg/xx/pdf/2022/01/emerging-trends-in-infrastructure-2022.pdf

Laine, M. (2009). Ensuring legitimacy through rhetorical changes? A longitudinal interpretation of the environmental disclosures of a leading Finnish chemical company. *Accounting, Auditing & Accountability Journal*.

Liu, B., Xue, B., & Chen, X. (2021). Development of a metric system measuring infrastructure sustainability: Empirical studies of Hong Kong. *Journal of Cleaner Production*, *278*, 123904.

Levitt, R. E. (2007). CEM research for the next 50 years: Maximizing economic, environmental, and societal value of the built environment. *Journal of construction engineering and management*, *133*(9), 619-628.

Marcelino-Sádaba, S., González-Jaen, L. F., & Pérez-Ezcurdia, A. (2015). Using project management as a way to sustainability. From a comprehensive review to a framework definition. *Journal of cleaner production*, *99*, 1-16.

Moldavska, A., & Welo, T. (2017). The concept of sustainable manufacturing and its definitions: A content-analysis based literature review. *Journal of Cleaner Production*, *166*, 744-755.

Mostafa, M. A., & El-Gohary, N. M. (2014). Stakeholder-sensitive social welfare–oriented benefit analysis for sustainable infrastructure project development. *Journal of Construction Engineering and Management*, *140*(9), 04014038.

Nilsson, M., Griggs, D., Visbeck, M., Riegler, C., & McCollum, D. (2017). Introduction: A Framework for Understanding SDG Interactions. *A guide to SDG interactions: From science to implementation. International Council for Science (ICSU)*.

OECD. (2019). Sustainable Infrastructure for Low-Carbon Development in Central Asia and the Caucasus. Paris.

O'Connor, A., & Shumate, M. (2010). An economic industry and institutional level of analysis of corporate social responsibility communication. *Management Communication Quarterly*, *24*(4), 529-551.

Opoku, A., Deng, J., Elmualim, A., Ekung, S., Hussein, A. A., & Abdalla, S. B. (2022). Sustainable procurement in construction and the realisation of the sustainable development goal (SDG) 12. *Journal of Cleaner Production*, 134294.

PMI, 2009. A Guide to the Project Management Body of Knowledge: PMBOK Guide, 4th ed. Project Management Institute.

Reed, B. (2007). Shifting from 'sustainability' to regeneration. *Building Research & Information*, *35*(6), 674-680.

Sahely, H. R., Kennedy, C. A., & Adams, B. J. (2005). Developing sustainability criteria for urban infrastructure systems. *Canadian Journal of Civil Engineering*, *32*(1), 72-85.

Shaw, G., Kenny, J., Kumar, A., & Hood, D. (2012). Sustainable infrastructure operations: a review of assessment schemes and decision support. In *Proceedings of the 25th Australian Road Research Board Conference* (pp. 1-18). Australian Road Research Board (ARRB).

Silvius, A.J.G., Brink, J. van den, Köhler, A. (2009) Views on Sustainable Project Management. In "Human Side of Projects in Modern Business", Kalle Kähköhnen, Abdul Samad Kazi and Mirkka Rekola (EDS.), IPMA Scientific Research Paper Series, Helsinki, Finland, June 2009.

Shen, L., Wu, Y., & Zhang, X. (2011). Key assessment indicators for the sustainability of infrastructure projects. *Journal of construction engineering and management*, *137*(6), 441-451.

Silvius, G.A.J., Schipper, R., 2011. Taking Responsibility: The integration of Sustainability and Project Management. PM World Today 13.

Surbeck, C. Q., & Hilger, H. (2014). Social sustainability and important indicators in infrastructure. In *World Environmental and Water Resources Congress 2014* (pp. 2078-2093).

Thacker, S., Adshead, D., Fay, M., Hallegatte, S., Harvey, M., Meller, H., ... & Hall, J. W. (2019). Infrastructure for sustainable development. *Nature Sustainability*, *2*(4), 324-331.

Thomé, A. M. T., Ceryno, P. S., Scavarda, A., & Remmen, A. (2016). Sustainable infrastructure: A review and a research agenda. *Journal of Environmental Management*, *184,* 143-156.

Tregidga, H., & Milne, M. J. (2006). From sustainable management to sustainable development: a longitudinal analysis of a leading New Zealand environmental reporter. *Business Strategy and the Environment*, *15*(4), 219-241.

Ugwu, O. O., Kumaraswamy, M. M., Wong, A., & Ng, S. T. (2006). Sustainability appraisal in infrastructure projects (SUSAIP): Part 1. Development of indicators and computational methods. *Automation in construction*, *15*(2), 239-251.

Wang, X., Yuen, K. F., Wong, Y. D., & Li, K. X. (2020). How can the maritime industry meet Sustainable Development Goals? An analysis of sustainability reports from the social entrepreneurship perspective. *Transportation Research Part D: Transport and Environment*, *78*, 102173.

Zeng, S. X., Ma, H. Y., Lin, H., Zeng, R. C., & Tam, V. W. (2015). Social responsibility of major infrastructure projects in China. *International journal of project management*, *33*(3), 537-548.

APPENDIX

Table 1. Assessment framework for sustainable infrastructure (Chan et al., 2022)

| **Components of sustainable infrastructure** | **Subcomponents** |
|---|---|
| **Materials** | Material quality control |
| | Materials reuse |
| | Local materials |
| | Innovative materials |
| | Material intensity |
| **Waste** | Divert from landfill |
| | Construction and operational waste |
| | Deconstruction |
| **Energy and ecology** | Energy use |
| | Air quality control |
| | Greenhouse gas emission control |
| | Protection of biodiversity |
| | Ecological connectivity |
| | Renewable energy |
| **Water** | Water use |
| | Protection of water quality |
| | Stormwater management |
| **Community engagement** | Tangible heritage management |
| | Public opinion |
| | Future visions |
| | Level of engagement |
| | Intangible heritage management |
| | Skill development opportunities |
| **Health and safety** | Occupational mental health |
| | Occupational physical health |
| | Public physical health |
| | Public mental health |
| | Safety |
| **Corporate social responsibility** | Anti-discrimination |
| | Anti-corruption |
| | Fair wage |
| **Project management** | Procurement and supply chain governance |
| | Type of contract |
| | Lifecycle cost management |
| | Environmental management |
| **Environmental impact on local community** | Vibration control |
| | Noise control |
| | Light pollution control |

Table 2. Components and subcomponents of sustainable infrastructure recognised by the authors.

| Components | Subcomponents | Frequency of components | Frequency of subcomponents |
|---|---|---|---|
| Materials | | 5 | |
| | Material quality control | | 1 |
| | Materials reuse | | 4 |
| | **Materials recycling** | | 2 |

| | | | |
|---|---|---|---|
| | Local materials | | 1 |
| | Innovative materials | | 2 |
| | Material intensity | | 1 |
| Waste | | 2 | |
| | Divert from landfill | | 1 |
| | Construction and operational waste | | 2 |
| Energy | | 9 | |
| | Energy use | | 9 |
| | Renewable energy | | 5 |
| | Greenhouse gas emission control | | 8 |
| **Biodiversity** | | 3 | |
| | Protection/**restoration** of biodiversity | | 3 |
| | Ecological connectivity | | 1 |
| | | | |
| Water | | 3 | |
| | Water use | | 1 |
| | Stormwater management | | 2 |
| Community engagement | | 3 | |
| | Future visions | | 1 |
| | Level of engagement | | 1 |
| | Skill development opportunities | | 2 |
| | **Quality relationship** | | 1 |
| Project management | | 2 | |
| | Procurement and supply chain governance | | 1 |
| | Type of contract | | 1 |
| | Environmental management | | 1 |
| **Impact on local community** | | 3 | |
| | Noise control | | 2 |
| | **Traffic issues** | | 2 |
| **Innovation** | | 3 | |
| | **Design for change** | | 2 |
| | **Innovations sharing** | | 2 |