EDITORIAL

The STEP to facilitate achieving Sustainable Development Goals

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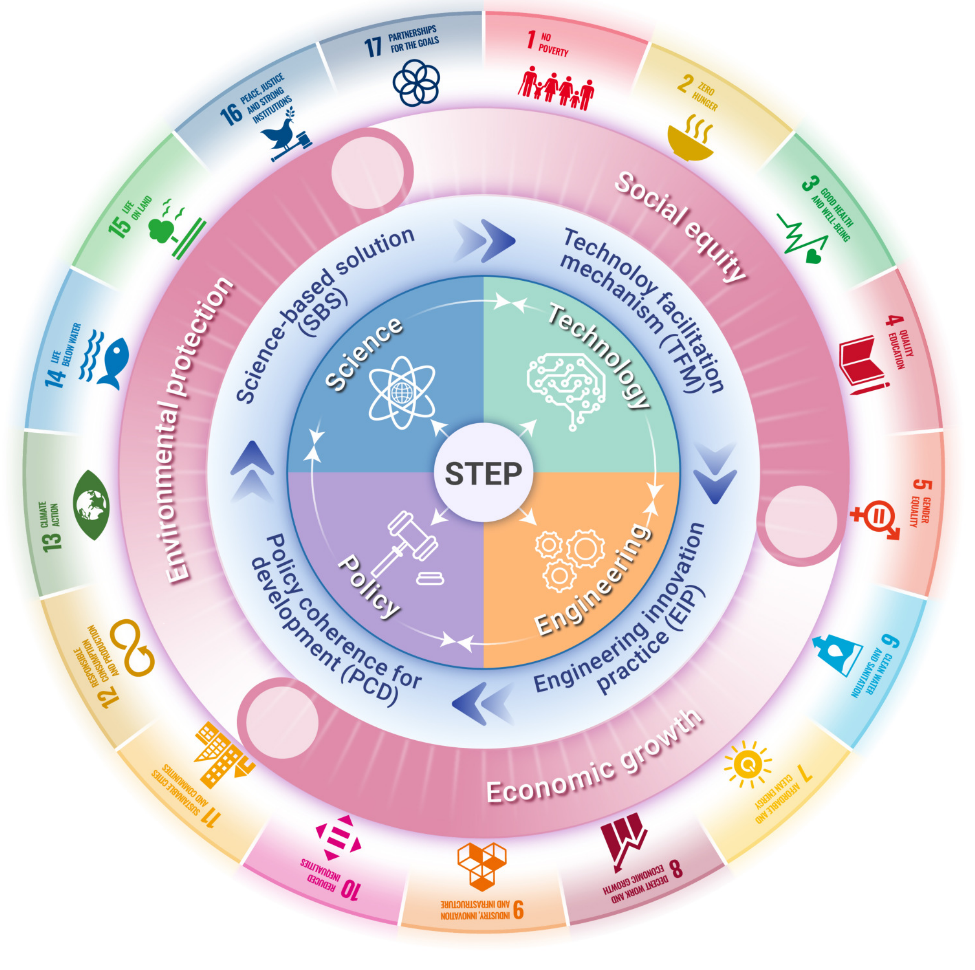

Figure 1. An illustration of the proposed STEP framework to facilitate achieving SDGs.

Sustainable development (SD) necessitates concerted efforts to construct an inclusive, sustainable, and resilient future for both people and the planet. The escalating climate crisis, imminent resource depletion, devastating conflicts, widespread pandemics, and growing inequality have rendered the path to SD both imperative and challenging. Balancing economic, social, and environmental sustainability presents our best strategy not only for survival but also for thriving. "Leave no one behind" stands as the defining principle of the 2030 Agenda for SD, signifying a collective commitment by all countries to collaborate. Regrettably, this commitment remains precarious as we approach the halfway mark to 2030. The latest global-level data and assessments from United Nations (referenced here: https://unstats.un.org/sdgs/report/2023/) paint a concerning picture: roughly half of the approximately 140 assessable targets demonstrate moderate or severe deviations from the desired trajectory.

Meanwhile, China's Sustainable Development Goals (SDGs) pertaining to the environment have made considerable strides[1] and are progressing towards the 2030 Agenda. The year of 2023 marks midway point of the 2030 Agenda, serving as a pivotal moment to reflect on the global progress towards achieving the SDGs and recognize the substantial efforts that still lie ahead. To achieve the SDGs, it is vital to reconcile three core aspects: economic growth, social equity, and environmental protection. Although various studies have proposed conceptual approaches offering feasible strategies for implementing SDGs across different countries,[2] a synergistic approach is required to reverse the current stagnant situation and accelerate the transformation towards SDGs.

In this Editorial, a novel holistic framework has been proposed, aiming to integrate the well-known science-based solution (SBS), the technology facilitation mechanism (TFM), engineering innovation practice (EIP), and policy coherence for development (PCD) into a comprehensive "SBS-TFM-EIP-PCD (STEP)" framework. This Editorial introduces the synergy of the STEP framework and delineates the distinctive strengths of its four components, as depicted in Figure 1.

SBS: UNDERSTANDING OUR WORLD

Science is the cornerstone of our understanding of the global challenges threatening SD. At its essence, SD focuses on achieving harmony between humanity and the environment. Understanding the impact of anthropogenic activities —such as global warming, biodiversity loss, land degradation, and environmental pollution —is critical to achieving SD.[3] Rigorous scientific observation and research unravel the complexities of ecosystems, social patterns, economic growth, and resource constraints. This science-based understanding enables us to identify challenges and opportunities for sustainability, driving innovation in technology and engineering practices to address various challenges.

SBS has provided profound insights into both natural and socio-economic Earth systems, directly influencing SD. It aids in delineating sustainable boundaries, whether concerning resource extraction rates, pollution thresholds, or biodiversity conservation levels. For the 2030 Agenda, SBS offers pathways to achieve the SDGs. By shedding light on climate change mechanisms or health threats' epidemiology, science creates roadmaps for interventions such as Climate Action (SDG 13) or Good Health and Well-being (SDG 3). Importantly, SBS provides data and evidence forming the foundation for informed policy decisions. Policymakers can devise strategies and actions based on scientific knowledge and empirical evidence, rather than conjecture. Acknowledging that there are still shortcomings in current SBSs promoting the achievement of SDGs, enhancing comprehensiveness understanding of the Earth system through scientific research related to SD should extend beyond the Earth's surface, including exploration of the Earth's interior and outer space as crucial components of SD strategies. This extension could offer a more holistic perspective contributing to a broader understanding of the challenges and opportunities in SD.

TFM: TOOLS FOR TRANSFORMATION

Once specialists comprehend the dimensions of threats and challenges through science, technology offers tools and solutions to address them. The development of renewable energy technologies, like solar panels and wind turbines, has provided viable alternatives to fossil fuels, consequently reducing greenhouse gas emissions. TFM plays a pivotal role in realizing the SDGs. For instance, Information and Communication Technology (ICT) can facilitate access to Quality Education (SDG 4), while biotech solutions support the recovery of endangered species (SDG 15). Advancements in Earth observation technology, from big Earth data monitoring deforestation to mobile apps promoting sustainable forest management, act as deterrents to unsustainable practices while catalyzing positive change.[1]

The digital age has introduced technologies with the potential to redefine sustainability. Internet of Things (IoTs) devices in agriculture, such as soil sensors, enable farmers to optimize water and fertilizer use, promoting sustainable farming. TFM emphasizes inclusivity, ensuring technology benefits reach even the most marginalized. Emphasis may shift towards 'green technologies' —those with minimal environmental footprints. The rapid pace of tech advancements often leads to unforeseen environmental and social repercussions. The proliferation of renewable energy technologies, digital tools for real-time monitoring of climate variables and environmental metrics, and AI-powered predictive analytics are transformative.

EIP: DESIGNING A SUSTAINABLE FUTURE

Engineering, driven by its problem-solving ethos, translates scientific theories and technological tools into practical solutions, playing an indispensable role in the pursuit of a more sustainable future. EIPs are essential in bringing sustainable visions to life, whether it involves designing green infrastructure, improving waste management systems, or creating energy-efficient transportation solutions. EIPs have consistently led the way in translating engineering innovations into tangible changes aligned with the SDGs. For instance, engineers address the challenge of Affordable and Clean Energy (SDG 7) by designing efficient renewable energy systems. Similarly, Sustainable Cities and Communities (SDG 11) are realized through civil engineering feats that incorporate green infrastructure and transportation solutions.

Engineering acts as a bridge, transforming ambitious goals into physical realities. Although EIPs are innovative, their implementation requires significant resources. Moreover, they need to be adaptable to various socio-cultural and geographical contexts. The future might witness a rise in eco-inspired engineering, where designs mimic nature to create sustainable solutions. For instance, 'ocean negative carbon emission (ONCE)' integrating biological carbon pump (BCP), carbonate counter pump (CCP), newly established microbial carbon pump (MCP), and solubility carbon pump (SCP) into a comprehensive "BCP-CCP-MCP-SCP" approach could become a reality.[4]

PCD: SHAPING THE PATH FORWARD

While science, technology, and engineering provide the insights, tools, and practices, it's often policy that shapes their applications. By establishing coherent and well-informed policies, governments can promote research in SD, incentivize green businesses, and educate their populace about sustainable practices. Additionally, PCD plays a crucial role in balancing immediate socio-economic progress with long-term environmental protection, ensuring an equitable path towards SD.[5] It can incentivize achieving Zero Hunger (SDG 2), legislate protections for Life below Water (SDG 14), or establish frameworks to support Responsible Consumption and Production (SDG 12).

Through crafting regulations, policies, and guidelines, policymakers ensure that advancements align with sustainable objectives, setting the pace and trajectory for achieving the SDGs. International frameworks, such as the Paris Agreement, underscore nations' commitment to sustainability. Several countries have introduced carbon pricing, whether through taxes or cap-and-trade systems, incentivizing businesses to reduce carbon emissions. Governments are increasingly advocating legislation promoting a circular economy, emphasizing resource efficiency and waste reduction. Policy acts as the roadmap for SD efforts, providing structure, direction, and mechanisms for transitioning towards a more sustainable future. However, policymaking often lags behind technological advancements. Additionally, policies sometimes prioritize immediate economic gains over long-term sustainability, resulting in implementation gaps.

THE SYNERGY OF STEP

The pursuit of SD doesn't follow a linear nor solitary path. It requires the combined strength of STEP working in unison. Each component contributes unique strengths, but it's their synergy that propels transformative change. Illustrating this through sustainable agriculture, consider how SBS provides insights into soil health and crop genetics, TFM offers tools like satellite imaging and AI-driven predictions for optimized farming, EIPs develop irrigation systems and supply chains, and PCD establishes agricultural subsidies and global partnerships. Together, these fields can transform aspirations like achieving Zero Hunger (SDG 2) into attainable targets.

The discussion on sustainable agriculture illustrates how each facet of STEP collaborates to address SDG 2. These components are interconnected, where advancements in one aspect impact and influence others, creating a cycle of continuous improvement and adaptation. For instance, scientific research informs technology advancements, influencing engineering viability and policy formulation. While their sequential relationships may vary based on specific contexts or goals within the STEP framework, each component reinforces the others, fostering continuous improvement.

However, challenges persist. Integrating these components requires interdisciplinary collaboration, overcoming siloed thinking, and fostering a shared vision. Bureaucracy often lags in addressing the demand for sustainable solutions, necessitating adaptive policy frameworks that evolve with new knowledge and technologies. Enhancing collaboration among STEP components can occur through interdisciplinary institutions and organizations (SDG16), public-private partnerships (SDG 17), and adaptive policy-making that responds to advancements.

CONCLUDING REMARKS

The SDGs envision a world free from poverty, inequity, and environmental degradation. Achieving this vision is complex and challenging but harnessing the synergy of STEP enhances success and accelerates SDGs achievement. While each component of STEP offers unique strengths, their convergence holds transformative potential. Fostering interdisciplinary synergy is vital, underscoring not only the goal of human progress but also our shared commitment to a better future through SD.

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DECLARATION OF INTERESTS

The authors declare no competing interests.